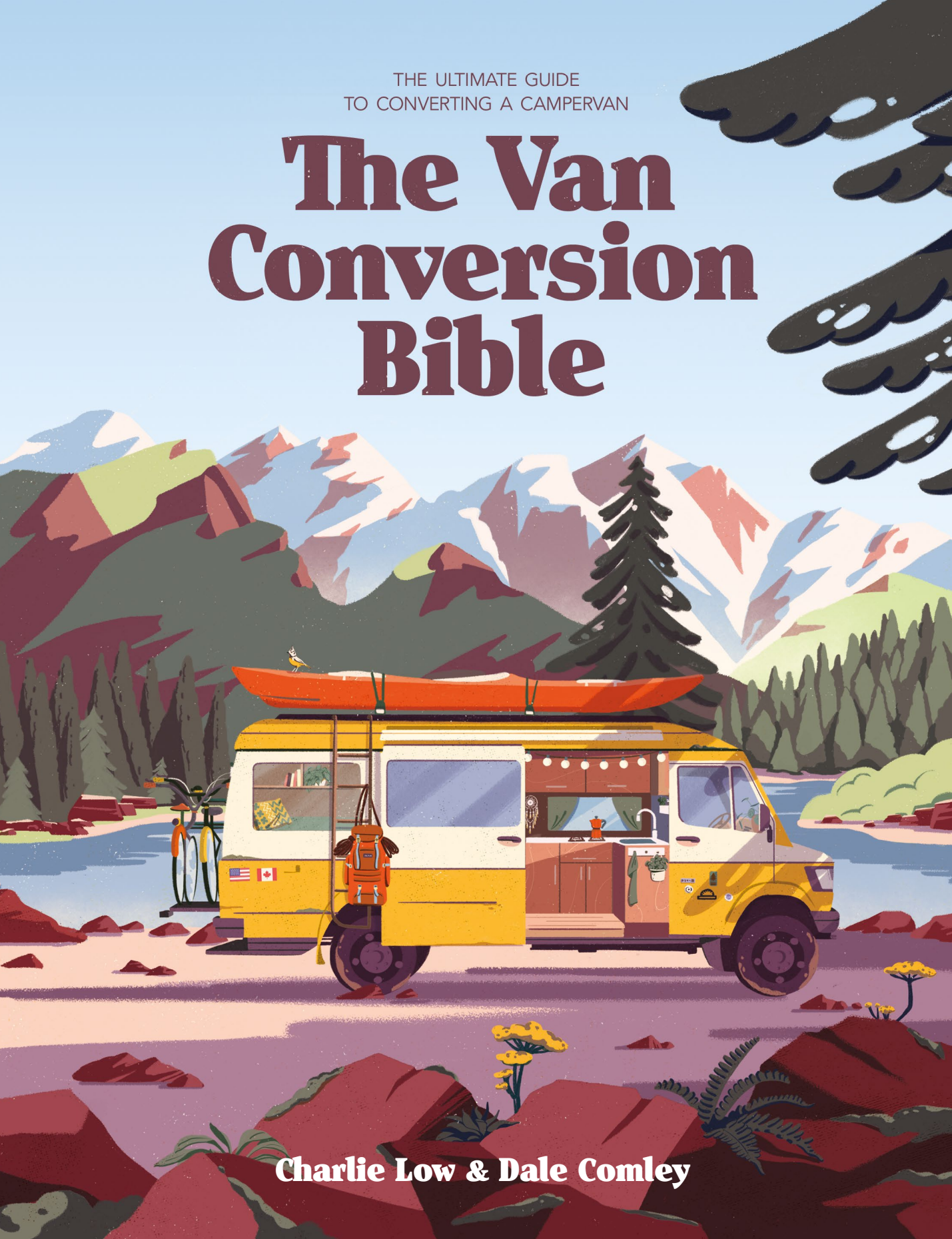
THE ULTIMATE GUIDE
TO CONVERTING A CAMPERVAN

The Van Conversion Bible



Charlie Low & Dale Comley

Note from the uploader

I have made this e-book available because I believe in free access to educational media. However, the authors of this book have clearly put an incredible amount of effort into the creation of this book, much more so than anyone else that I have seen. I therefore recommend you to look through this e-book, and if you like what you see, purchase the book directly from them at **climbingvan.co.uk**.

Enjoy :)

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CONVERTING A CAMPERVAN

The Van Conversion Bible

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About us

Charlie

Charlie loved maths and astronomy when she was young, and always dreamed of being an astronaut. She studied Astrophysics at university, and went on to work in data analysis and digital marketing for an adventure travel company, selling trips to the ends of the earth (but unfortunately not beyond!).

Charlie has always enjoyed photography, trying to capture the atmosphere of a moment, whether that's a climber on a sea cliff or Dale wrestling with cladding midway through their van conversion. She works as a freelance outdoors and events photographer in her 'spare' time (not that there is ever much of that!). She also organises an annual women's climbing festival, combining her passion for climbing with her love of spreadsheets and all things organisation.

She has been climbing for over eight years, and enjoys nothing more than being outside on the rock, whether on a sunny Spanish sport climb, an alpine mountain, or a rugged British sea cliff.

Dale

As a child, Dale could either be found up a tree, or dismantling something he probably shouldn't have been! He has always been intrigued by how things work, and spent much of his childhood building and inventing things with his granddad. He learnt about physics the hard way, crashing handmade go-karts and falling out of dubiously constructed treehouses.

His inquisitive nature followed him to university, and led him to study a degree in Product Design. Since graduating, he's worked as an engineer for both a small design consultancy and a large tech company, designing everything from medical devices to sections of submarines, and everything in between!

Dale's fascination with tree climbing also followed him into later life, and he has now been rock climbing across the world for over 20 years. From competing in competitions as a teenager to attempting some of Europe's hardest climbs as an adult, he has always set his aspirations high.

Our story

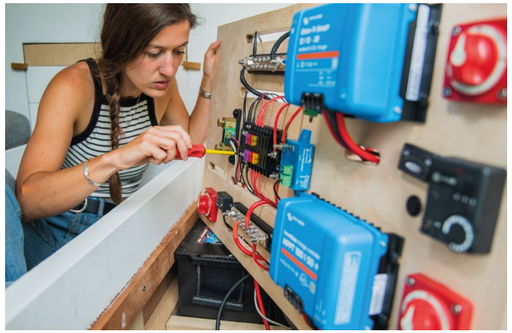
We met back in 2016 on a climbing trip to Northern Italy. Ironically, we were meant to be travelling around in a motorhome. Unfortunately, it broke down a week before we made it out there, but that sparked conversations about converting a campervan. Ever since then, we had a shared dream of building our own climbing home on wheels.

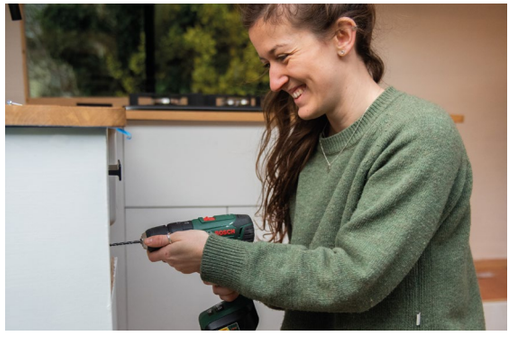
Fast forward to January 2019. We drove up north to pick up a bright yellow Mercedes Sprinter, now aptly named 'Ringo'. We returned to Bristol and the first snow of the year, but we were eager to start. We made the terrifying first step of cutting a big hole for a window in the side of our brand new van, warming the adhesive, which had frozen solid, under our many layers.

We were both working full-time jobs, so our weekends were spent driving forwards and backwards to Charlie's mums, where we had set up our 'workshop' on her driveway (thanks mum!), slowly seeing Ringo transform from an empty yellow courier van into what we now call home.

Although we had a limited amount of manual DIY experience, our planning personalities mixed with our technical backgrounds meant we approached the conversion logically. We spent countless hours researching, planning and designing before committing to the build.

Even once our own build was complete, we found ourselves answering hundreds of questions about the process, and so we continued to refine our knowledge to ensure we were giving people the best possible guidance. We have now easily spent enough time to have converted several vans (each!) understanding the van conversion process and the most efficient way of taking your very first idea, to your very own home on wheels.





FIRST Insulating above the cab. **SECOND** Installing our electrical system. **THIRD** Adding some finishing touches. **FOURTH** Our first night in our finished van. *@climbingvan*

ONE

Introduction

Why we wrote this book

Before we started our own van conversion, we spent hundreds of hours researching everything we possibly could. Despite this, we still fell foul of inaccurate information that led to costly mistakes and frustrating evenings sacrificed to correcting faults. This gave us the motivation to better understand the process of planning, designing and building a campervan, so others could avoid the same pitfalls.

There are swathes of information on self-conversions smattered across the internet in the form of YouTube videos, blog posts and lightweight e-books. Wading through all of this content can be exhausting, so we wanted to condense everything we had learnt into a single point of reference, to make the process easier for others. We decided to write this book with the vision of creating the ultimate van conversion guide for all aspiring van owners, making the dream of converting a van accessible to all.

For many, converting your own campervan will be the single largest DIY project you ever undertake, and it can feel daunting to start. The reality is many first-time van builders have very little prior experience or knowledge, but they have taken the plunge nonetheless. The majority of the complexity of converting a van resides in the planning and design stages, and many of the practical elements simply aren't that complicated. By the time you finish your build, you will have learnt woodworking, electrics, plumbing, gas, fitting windows, furniture upholstery, and even interior design. Converting a van is like building a tiny house, but without having to wait three years for planning permission!

There isn't one van to suit everyone as each person has different needs, budgets and skills, so you should design a van that works for you. Most motorhome and caravan manufacturers design their vehicles in a set way, trying to come up with a layout that works for everyone. But by trying to meet the needs of the many, they only satisfy a few. The beauty of building your own campervan is that you can design something completely unique to your lifestyle and aspirations. From weekend surf wagons to supersized bus conversions, Scandinavian minimalist masterpieces to quaint and homely cottages on wheels, you really can do anything you want.

Recognising everyone has different needs, we wanted to write a book that was more than just a story about how we converted our own van. Instead, we wanted to provide people with the tools to design something completely bespoke, and give them the confidence to start their journey. Converting a campervan isn't about finishing in record time or bang on budget, it's about building something you're proud of, and will enhance your adventures for years to come. Van life really is possible for anyone, and hopefully, this book will help to make your dream a reality.

Climbingvan 2020 Van Conversion Survey

To build up a reliable source of data on van owners and aspirational van owners, we conducted a van conversion survey. The survey asked a set of questions based on whether someone had already converted a van, or was planning to convert a van in the future. We asked van owners questions about build cost and time, the size, make and model of the van converted, and how people found the process. We asked aspirational van owners about their current skills, their concerns and their budget. We collected data from over 1,200 people and have used this data and the insights gained from the survey throughout the book, denoting it with a footnote each time the data is used.

Planning
Learn what's required to convert a van and investigate the possible methods of achieving your aspirations

Define
Understand what you need to create the perfect van and what layout and systems will make it possible

Concept
Explore all of your ideas and establish what is and isn't possible through sketches and scaled models

Develop
Generate detailed plans to inform the build through challenging your design and integrating systems

Build
Create the van of your dreams with the understanding and confidence gained from the design process

The van conversion process

The secret to converting a van you're truly happy with is not in the physical conversion, but in the theoretical planning and design. There are different approaches you can take when tackling a campervan build, but spending adequate time before getting your hands dirty will give you the chance to properly explore different concepts and ideas.

So exactly what process should you follow? We have architected the aptly named 'van conversion process' which underpins the structure of this book. It borrows concepts from product and software development, but we have tailored it to, you guessed it, the van conversion process. You can follow it step-by-step throughout your journey, from initial research to finished van, to creating a campervan that meets all of your requirements and is a joy to travel and live in.

The history of van life

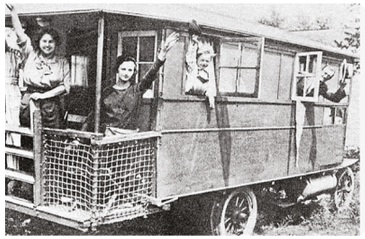
You may think van life is a modern phenomenon, but as early as 1910 vehicles such as a Packard truck were being modified for travel; this particular conversion could sleep a staggering 11 people! A few years later in 1919 the first caravan was released to market, designed to be towed by a car in much the same way as a modern caravan, and the first self-proclaimed 'motorhome' was built on a Pontiac base vehicle in 1935. But it wasn't until the '60s that campervans similar to what we recognise today started to become commonplace.

Volkswagen launched their known and loved VW Type 2 bus in 1959, and later worked with Westfalia to produce a pre-converted campervan. This was adopted by the hippy counterculture movement in the '60s, enabling them to break away from mainstream living and live an anti-establishment lifestyle.

The first pre-built motorhomes such as the Winnebago also came onto the market in the 1960s, enabling middle-class families to experience van life. In the following years, self-build campervans gained more traction, with people utilising commercial vehicles to build bespoke campers. 'Rolling Homes', published in 1979, showcases a collection of beautiful and quirky 'homemade houses on wheels', built from wood and adorned with crocheted blankets, stained glass and window boxes.

Over the past few years, van life has boomed once again. The rise of social media has meant the lifestyle is more visible than ever before - at the time of writing, over eight million Instagram posts have been tagged with #vanlife! High-speed internet has made van life much more attainable as a full-time lifestyle, allowing people to live location-independent and travel as full-time digital nomads. With rising house prices prohibiting younger generations from getting on the property ladder, van life enables you to become a homeowner at a fraction of the cost and live a much simpler life. As of 2020, it's estimated there are over 225,000 campervans and motorhomes on Britain's roads, and in Germany there are almost half a million![1]

1 Thencc.org.uk. 2021. Industry Statistics. Available at: <https://www.thencc.org.uk/our_industry/statistics.aspx>



A 3 ton Packard truck was converted to sleep 11 people, and featured a toilet and a salon!

1910

1919

The 'Eccles Motor Caravan' was the first of its kind but only 50 were ever built.

1935

The first motorhome, a Pontiac ordered by Captain Dunn of Bexhill.

1959

VW launch their known and loved Type 2 bus.

1966

The first pre-built motorhome, the Winnebago rolled off the production line.

1970's

Self built campervans gained traction, such as this whimsical 1949 delivery vehicle.

Sprinter, an icon of modern day van life.

2010's

FIRST The first known example of a motor caravan. *RVshare.com* **SECOND** The Eccles motor caravan. *practicalcaravan.com* **THIRD** A Pontiac motorhome. *Bonhams* **FOURTH** The quintessential VW. *Caleb Morris* **FIFTH** A 1966 Winnebago ad. **SIXTH** Rolling Homes: Handmade Houses on Wheels. *Jane Lidz* **SEVENTH** Ringo bathing in the dawn mist. *@climbingvan*

TWO

Planning

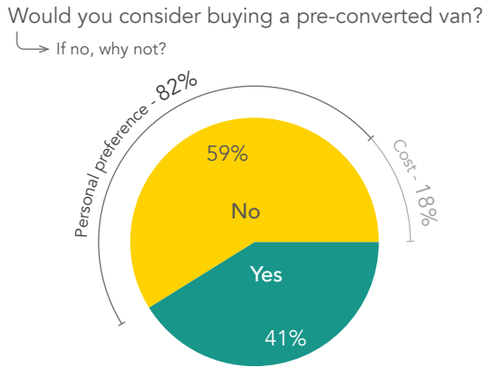
Importance of planning

Converting a van is no mean feat. It's a complex endeavour that will likely take a fair amount of time and money, but it's also a rewarding process to navigate, providing you with lifelong skills and years of adventures once complete! It's important to spend time researching your build to understand what's possible before you commit to designing and building your van, as it will make the process easier and ensure you don't make any costly mistakes. We have structured this chapter clearly and methodically to ensure you can plan your build thoroughly, whether you are a natural planner or a spontaneous rebel!

The cost of converting a van

To buy or to build

Many people would never consider converting their own campervan. They would simply buy a pre-converted van or motorhome, or employ a professional van builder to save them the time and effort of planning, designing and building something themselves. If you are cash-rich and time-poor it makes sense. You get instant access to an adventurous nomadic lifestyle, and the vehicle itself has a relatively low depreciation rate, meaning it's not a bad investment.



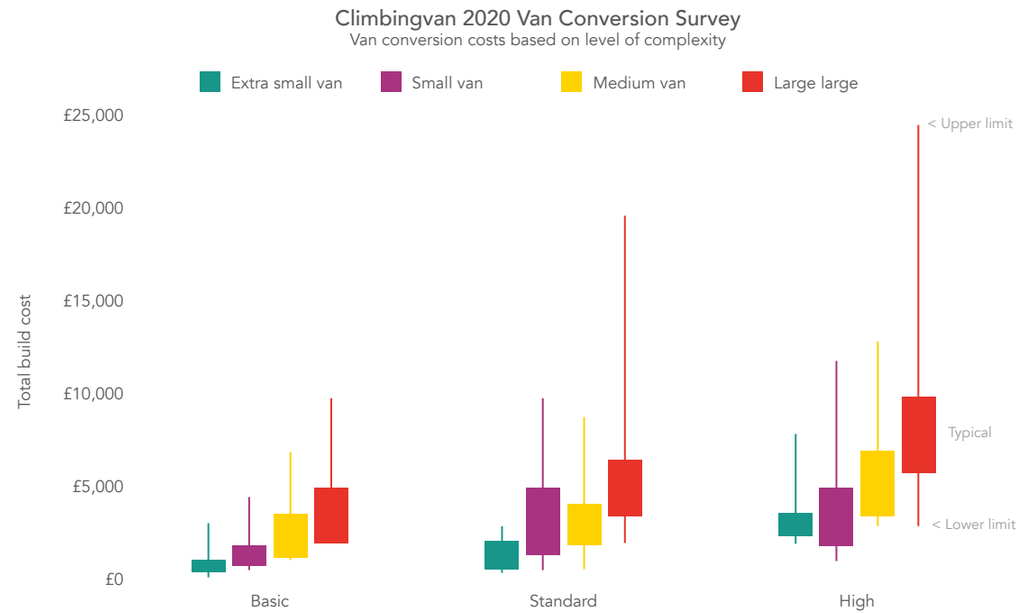
However, many aspirational van owners will not have the budget for an expensive motorhome or a pre-converted campervan, or they simply don't want to. The main reason many choose to convert a campervan, other than the cost, is that they want to create something that fits their own requirements and vision.

Converting your own campervan means you can design a little home exactly how you want it, with features and a look fitting you and your lifestyle. Of course, it's possible to pay a professional van converter to design and build a campervan exactly the way you want it, and for some people who have the money, that's the best option. But for those who aren't in a position to pay a professional, or just want the rewarding feeling of building their little home themselves, converting your own campervan means you have the opportunity to build something which looks and feels exactly how you want it to.

How much does it cost to convert a campervan?

So, the question on everyone's mind - how much does it cost to convert a campervan? As you would expect, the answer is not black and white. The cost of converting a van will depend on numerous factors, such as the specification of your systems and the level of finish you are trying to achieve, as well as how shrewd you are throughout your build, and how many extravagant extras you decide to include! If you plan to include a full van respray, a pneumatic elevator bed or a suspension upgrade, don't expect your conversion to come close to our indicative costs! Many people may also choose to have some aspects of their van conversion done professionally which will of course affect the total build cost.

The more time you have to spend on your build, the more money you are likely to save.



If you can spend time sourcing reclaimed materials and restoring them as opposed to buying everything brand new, you can save a lot of money.

There are so many different variables affecting total cost. The physical size of the van you are converting, the specification of systems you have included and the finish you are trying to achieve will all affect your total build cost. We have collated data from our van conversion survey on the average cost of converting different size vans to different finishes and specifications to give you a rough idea of how much it might cost to convert a campervan.

CHARLIE SAYS:
The graph of van conversion costs uses a candlestick graph. The solid bar in the middle shows the range of the typical cost of a van conversion, and the lines that protrude from the top and bottom illustrate the minimum and maximum spent. So if we look at the large, high spec van, the typical cost of a conversion is between £5,000 and £10,000. The minimum spent on a van with those attributes was £4,500 and the maximum was £25,000.

Case studies

We have put together four case studies to illustrate the different kinds of approach people can take to converting a van. The vans we have included are all great examples of successful builds, but they are also very different from one another. They showcase a variety of sizes, finishes and functionalities. There is a very large disparity between total time spent and cost between all of the vans, which illustrates how much cost and conversion time can vary from van to van. We have included a bit about what each person was trying to achieve with their van, as this reflects the decisions and choices they've made.

OPPOSITE Rachel and Sam's beautiful skoolie conversion is the perfect tranquil home for their little family. *@thedixietribe*

@avancalledfred

Winterthur, Switzerland | Dec 2019-May 2020

Vehicle: Volkswagen Transporter T5 | Area: 4.3m²

Vehicle cost: 20,000 CHF (£17,000) | Build cost: 3,500 CHF (£3,000) | Build time: 550 hours

Stef & Niko

For Stef, an architect, building a van was all about functionality and design. Everything needed to be multi-purpose, every corner was planned, and no space was wasted. One of Stef and Niko's priorities was for the space to look clean and have a bit of boho flair, but not be too overloaded in details. Their ultimate goal was to have a home they could go everywhere with, which is why they picked a small van as their base vehicle, but they built in lots of clever features to maximise their space (such as the pop-top roof).

Van Specification

Electrical system

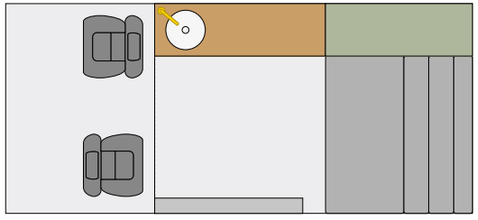
- 110Ah AGM batteries
- VSR
- Shore hook up
- Portable 500Wh power bank
- 50W portable solar panel

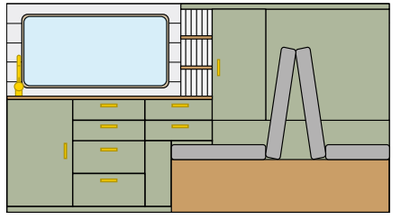
Water system

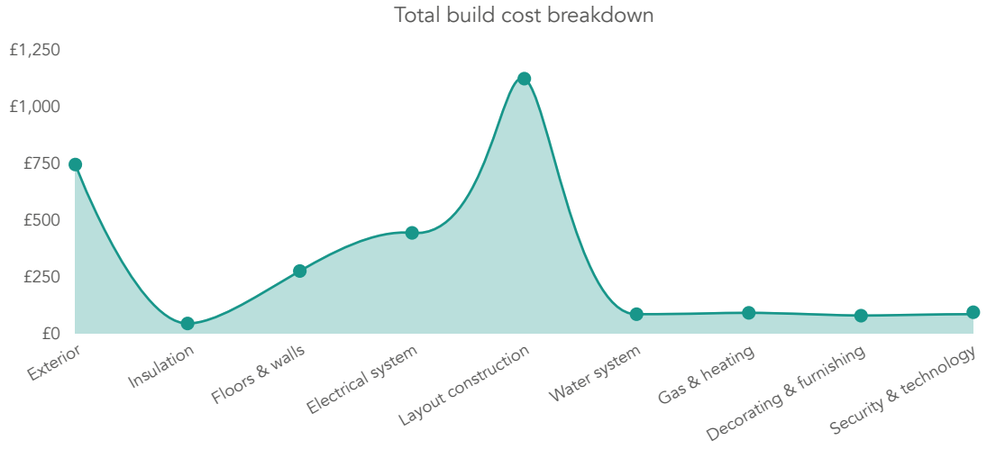
- 16L water tank
- Kitchen tap & sink
- 16L waste water tank

Gas system

- Portable hob & gas cartridges







[@josephine.hicks1](#)

Sheffield, UK | Nov 2018-Jan 2019

Vehicle: Vauxhall Movano | Area: 6.3m^2

Vehicle cost: £3,700 | Build cost: £2,000 | Build time: 1,800 hours

Josephine

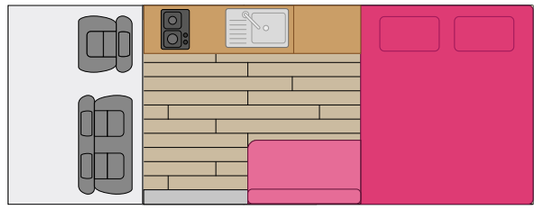
Jo worked full time for two months to convert her van, using upcycled materials. She wanted to create a homely, quirky and rustic van that she could use to spend a year exploring France. She wanted to minimise her carbon footprint throughout the build, using materials that would have otherwise gone to landfill, which also had the benefit of saving her money. She prioritised a large boot space with enough room for a bike and her outdoor gear.

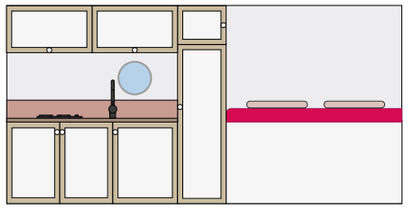
Van Specification

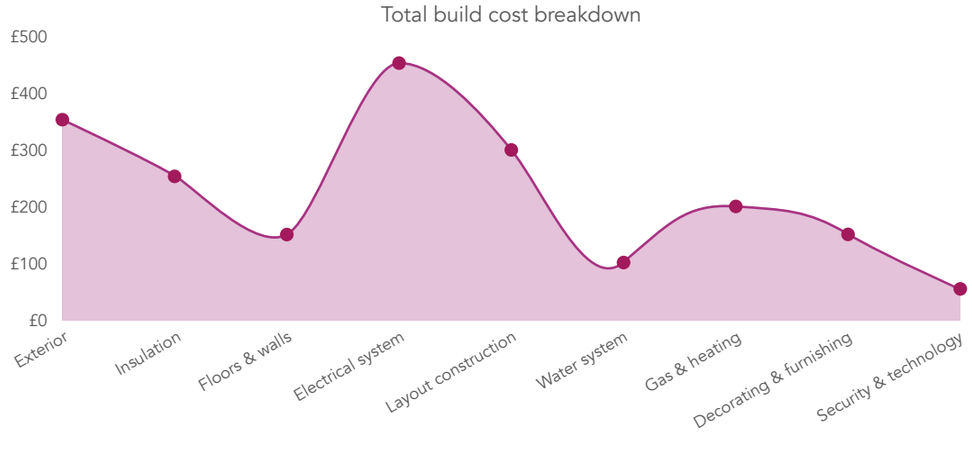
Electrical system
- 77Ah lead acid batteries
- VSR
- 100W solar panel & MPPT charge controller

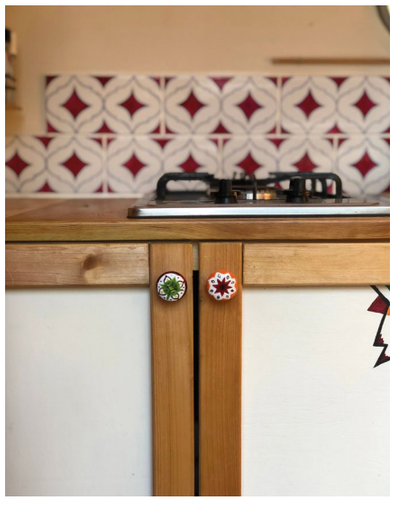
Water system
- 25L water tank
- Kitchen tap & sink
- 10L waste water tank

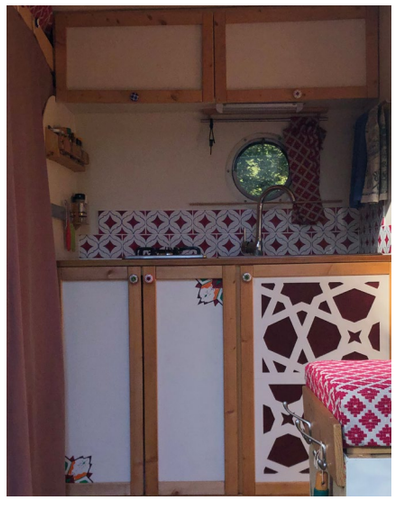
Gas system
- 2.7L butane bottle
- 2 ring hob
- 2kW diesel heater











@climbingvan

Bristol, UK | Jan 2019-Mar 2020

Vehicle: Mercedes Sprinter | Area: 7.3m^2

Vehicle cost: £8,800 | Build cost: £6,700 | Build time: 1,000 hours

Charlie & Dale

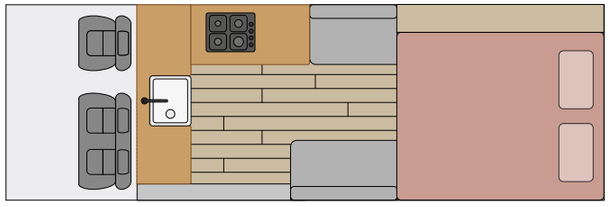
Our goal was to create a little climbing home that we would take anywhere. We wanted a space with a good remote working setup, but where we could also relax after a day at the crag. We designed a clean and cosy Scandinavian interior that wouldn't feel like the back of a van, but like a cosy little apartment. As we would live in the van full-time, we needed to have enough space, so we built a spacious kitchen, a big seating area, and a full-length double bed with ample storage for all of our climbing gear.

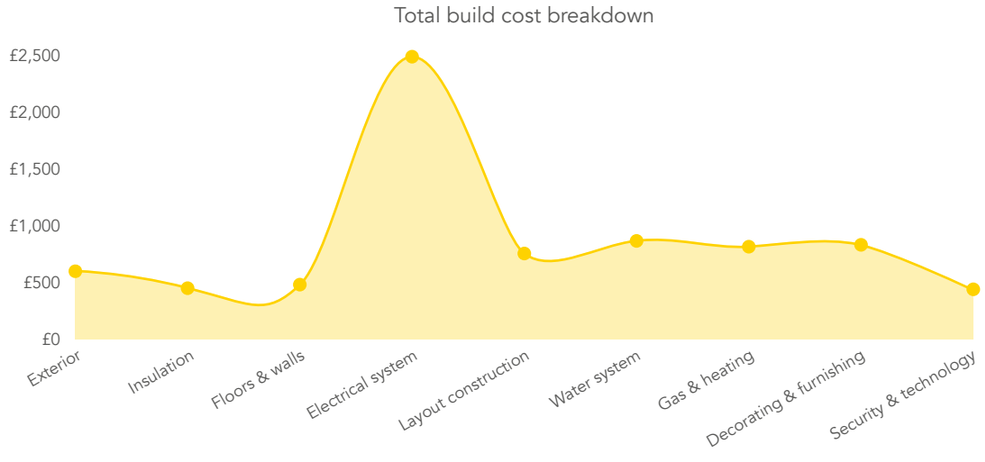
Van Specification

Electrical system
- 360Ah AGM batteries
- Battery monitor
- 300W solar panels & MPPT charge controller
- Battery to battery charger
- 500W inverter

Water system
- 70L cold water tank
- Kitchen tap
- Outdoor shower

Gas system
- 25L underslung LPG tank
- 4 ring domestic hob
- 2kW LPG heater
- Instant water heater





@goandlivefree

Florida, US | Nov 2019-Jul 2020

Vehicle: Mercedes Sprinter | Area: 7.3m^2

Vehicle cost: $16,000 (£11,700) | Build cost: $17,900 (£13,000) | Build time: 1,000 hours

Jake & Heather

When designing and building their van, Jake and Heather wanted to create a luxe van that felt as close to home as their bricks-and-mortar house. Their priorities for the build were that they didn't want to feel that they were roughing it as they were keen to focus on their travel experiences and not have to worry about their quality of life. That's why they chose to install a shower, a hob and oven, and a whopping 800Ah battery bank!

Van Specification

Electrical system

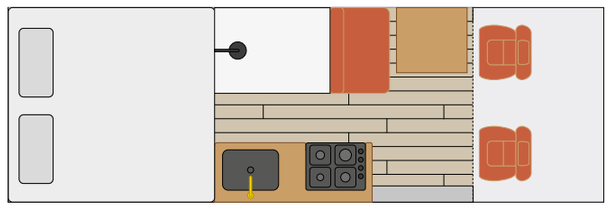
- 800Ah lithium batteries
- Battery monitor
- 400W solar panels & MPPT charge controller
- Shore hook up
- Battery to battery charger
- 3000W inverter

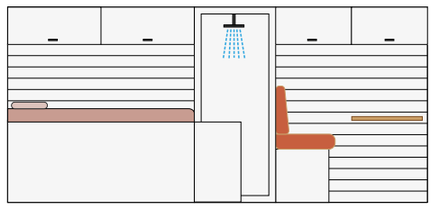
Water system

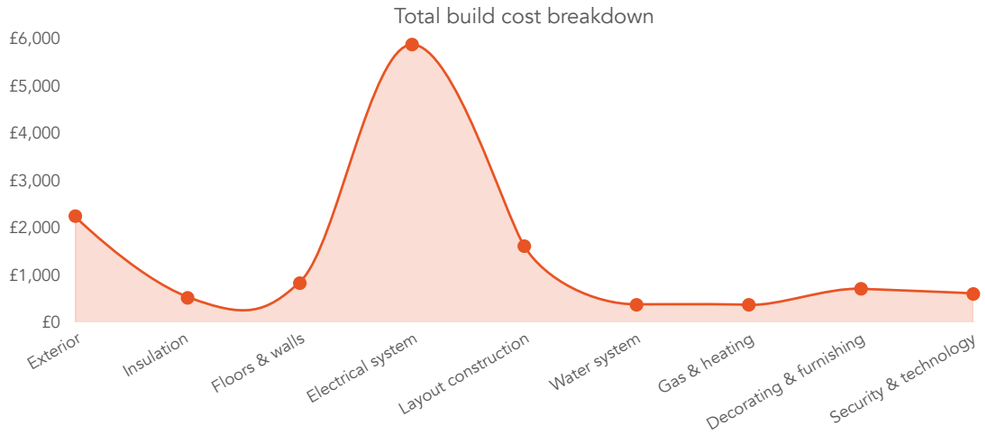
- 180L fresh water tank
- 65L grey water tank
- Kitchen tap
- Shower cubicle
- Composting toilet

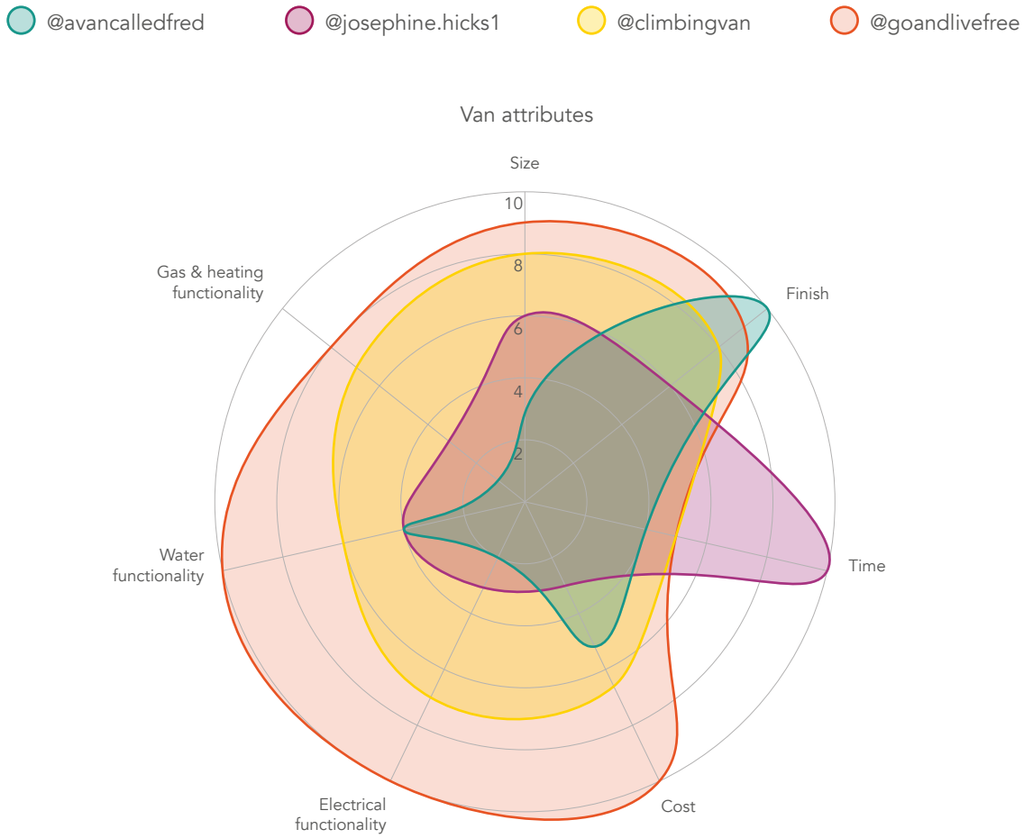
Gas system

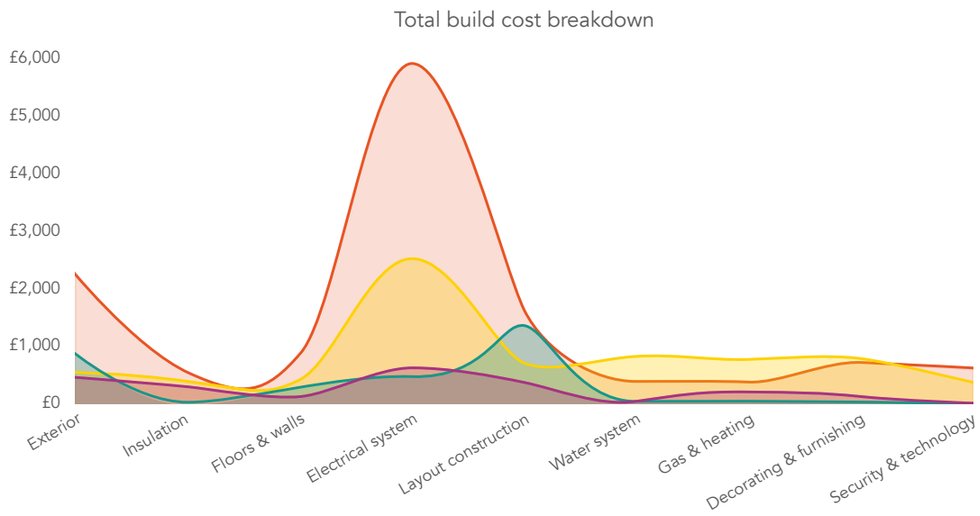
- 18L bottle in gas tight locker
- 3 ring hob & oven
- Instant water heater
- Diesel heater











Case study analysis

Stef and Niko's van is exactly what you would expect from an architect; it's beautiful, well-considered, and meets all of their requirements. As their van was designed for weekends away, they were able to save money forgoing expensive systems. Their build time was kept relatively low by spending significant time on the planning and design phases.

Jo wins the award for the budget build, and impressively still managed to achieve a cosy, bohemian aesthetic. However, she is solidly in last place when it comes to time; she spent more than twice as many hours as the average for a van of her size finishing her build!

Jake and Heather's van has it all: a hot shower, an oven, even a TV screen! But all that functionality comes with a high price tag - they are certainly in the lead for total build cost. Their electrical system alone cost more than Jo and Steph and Niko's conversions combined!

Charlie and Dale (that's us!) managed to find a bit of a balance. We were shrewd and built everything ourselves, but we also made sure to spend money in the areas that mattered most. We achieved a relatively high spec system that suits our needs, with an electrical system that can support our lifestyle as digital nomads.

Hopefully, you can relate to at least one of these case studies. We'll explain how to forecast the breakdown for your own conversion at the end of *Shopping* on page 192, so you know when to expect costs to occur.

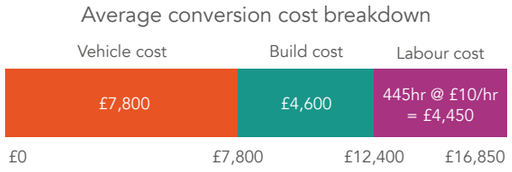
The hidden cost

There's a hidden cost to converting your own campervan that many don't consider...your time. When considering costs, it's important to factor in the time you will spend converting your van, especially if it's a larger van, or you plan on installing more complex systems and hope to achieve a high-quality finish.

Applying a labour rate to your time can help you decide whether you should outsource certain tasks to a professional or if you should adopt the low-cost, high-effort approach.

Paying a professional for certain jobs may simply be cheaper once you factor in the time it will take to learn how to do something and the slower pace you will work at. Paying someone to fit a non-opening window will cost you around £200, whereas buying one yourself will cost around £80. If it takes two hours to research how to fit one, and it takes two of you another four hours to fit it, if you value your time at £10/hr, that works out at £180, only £20 less than paying someone to do it for you.

Of course, if you are fitting more than one window there are economies of scale - you only need to research it once, and you will probably get a little quicker with each window you fit - and you might just simply want to attempt it yourself. However, it's worth doing this little calculation for a few jobs to get an idea of whether it makes financial sense to outsource anything. Using data from our van conversion survey, if you apply an hourly rate of £10/hr to the total time spent converting a van, on average a person's time makes up 26% of their total expenditure.



There is more to converting a van than simply how much it all costs. You may have a vision in mind and are happy to spend the extra hours creating the perfect bespoke countertop or painting a detailed mural on your kitchen units. You may be excited for the rewarding challenge of tackling everything yourself. Throughout your build you will learn a wide range of new skills, many of which are transferable and will be useful for future projects too.

It's also okay to pay a professional if you're apprehensive about certain tasks - a lot of people frequently outsource certain jobs such as fitting electrical systems or gas systems, and you shouldn't worry about this! 37% of people who have converted a van paid for at least one job to be done by a professional.[2] Ultimately you should find the balance between what you're comfortable doing yourself and what you can outsource to a professional.

How much do van converters charge?

While researching your own van conversion, you might have considered paying a professional van builder to convert one for you. Using a professional will save you time, but you will be paying the wage of one or more van builders for several weeks. An average van build could take anywhere from one to four months depending on the size and finish of the van, so paying for someone's time over that period, as well as all of the material costs, will quickly add up.

We reviewed several UK based professional van builders' websites to get an idea of what you might pay for a conversion. The costs vary wildly because there are so many factors affecting the cost, such as the level of finish and the specification of the van. If you live in the US, these costs can more than double!

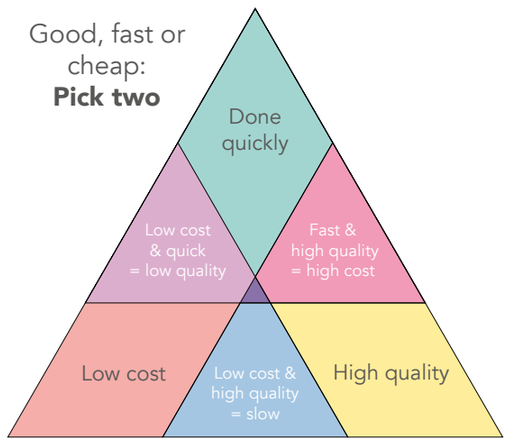
It's also worth noting a lot of these companies will charge you a premium on products and materials to make an additional margin, or simply because it's not in their interest to spend time looking for the best deal. We saw one converter charging £960 to install a Dometic CRX50 fridge! After a quick google, we found you can easily source one for under £600, and the installation is as simple as connecting two wires to your 12V fuse box.

Balancing cost, quality and time (and weight!)

Looking at the project management triangle commonly used in business is a great way to perfectly represent the dilemma faced by all van builders. It's unrealistic to hope you can build a van quickly at a low cost, and be able to achieve a high-quality finish. Instead, you should focus on the two areas most important to you. Before you start your build you should think about where your van is likely to sit within the triangle to manage expectations. Each part of your build may sit within a different cross-section of the triangle, or even just under a single corner.

2 climbingvan.co.uk. 2020. The Climbingvan 2020 Van Conversion Survey.

Van Size	Standard build & spec	Bespoke build, higher spec
Small *VW Transporter*	£2,500- £11,000	£15,000-£21,000
Medium *Ford Transit*	£10,000-15,000	£15,000-£28,000
Large *Mercedes Sprinter*	£12,000-18,000	£21,000-£35,000



The cheap build

A cheap build means saving money wherever you can, so you will be tackling all aspects of your build yourself and not spending money on expensive appliances, fixtures or fittings.

Attributes

- Don't buy any standard units or kits
- Forget having a fancy electrical system
- Stick to cladding your walls with ply
- Paying a professional is out of the question

The quick build

You're unlikely to have time to make much yourself so will probably need to use either standard domestic products and appliances or buy a campervan kit where you can quickly assemble the major structures and connect all of the appliances.

Attributes

- You won't be making anything bespoke other than basic structures
- You're likely to need a professional to help you with the tricky bits
- Achieving something unique that still functions well is very difficult
- You risk either spending a lot or getting a poor quality conversion

The quality build

A top-quality build is what many people set out to achieve, although few manage after they either burn through their budget or decide the #vanlife isn't for them after three years of meticulously building every element of their palace on wheels!

Attributes

- You will need to spend a lot more time planning and designing your build than the other options
- You're going to be spending either a lot of money or a lot of time
- Call on the professionals whenever you're out of your comfort zone
- You will need to watch your weight using premium materials and installing extravagant extras

Every aspect of your build doesn't necessarily need to sit within the same area; you may wish to build your structures quickly but include a complex electrical system which sits in the quality build section. Ultimately this section just helps you to manage expectations of what is likely to be possible with different outlooks on the design and build phases.

There's also an additional consideration when building a campervan...weight. In the UK, until 1 January 1997 (and this is much the same in many European countries), anyone with a standard driving licence was allowed to drive a vehicle with a 'maximum authorised mass' of 7.5 tonnes. Anyone who has passed their driving test after this point will have a category B licence, meaning they can only drive a vehicle up to 3.5 tonnes. To gain the same rights as someone who passed their test before these new rules came in, you would have to take your category C1 test. This requires you to have a number of expensive lessons and take a test in a 7.5 tonne lorry!

As well as driving licence complications, most vans have a gross vehicle weight of 3.5 tonnes. This means that your van, your build and yourselves inside it cannot exceed this weight limit. Whilst this isn't an issue for smaller van builds, if you are converting a large van you may quickly find that you start to creep towards this limit. An LWB Mercedes Sprinter has a kerb weight (the empty vehicle weight) of 2.3 tonnes, so this gives you a mere 1.2 tonnes to play with. This may sound like a lot, but once you start to consider the weight of ply, cladding, batteries, yourselves and all of your belongings, it quickly adds up!

In 2015 the Driving and Vehicle Standards Agency stopped over 10,000 vans on UK roads and found that 89% of them were overweight.[3] If you're stopped and your vehicle is over 3.5 tonnes you will receive a fine, and it can also invalidate your insurance.

Even in a smaller conversion, it's worth taking weight into account. As a general rule of thumb, you can assume that for every 45kg added to your build, you will experience a 1% fuel efficiency loss. By the time you've finished your build, that can have a noticeable impact on your vehicle's miles per gallon (and your ability to make it up a hill!). Therefore, weight should be just as important a consideration as time, cost and finish when converting your van, and you should make sure to factor it into any decisions for your build.

What's the right van for you?

Van size

So what size van should you buy? In an ideal world, you should go through the initial stages of designing your campervan layout before deciding on the van you will base your conversion on. This will remove the risk of buying a van that isn't suitable for your needs. At the bare minimum, you should consider:

- How many people will be living or staying in your van?
- What type of trips will you be taking in your van?
- What equipment will you need to store in your van?
- What facilities do you need in your van?

If you are struggling to weigh up all of your options and decide on the right size van for your build, we have created an online van layout configurator which can help you decide! After you answer some questions it will suggest a van layout based on your requirements. You can find it at **climbingvan.co.uk/resources**.

Large vans

Large vans are the go-to for full-time van dwellers and those seeking leisurely luxury. They provide enough room to include fixed beds, full kitchens, and even a bathroom cubicle if required.

There are two main types of large van body available, as most makes and models are based on a very similar body. The Fiat Ducato, Citroën Jumper, the Peugeot Boxer, and the Ram Promaster found in the US and Canada all have a boxier body shape. The XL wheel-base only just reaches 4m internally, but the straighter sides mean you get more width to play with. The Mercedes Sprinter, VW Crafter and the Man TGE have a longer internal length, with the LWB measuring 4.3m, and the XLWB measuring a mighty 4.7m. They taper in at the top considerably more than the boxier vans, meaning you have a slightly reduced volume and space in the top portion of the van.

You may want to choose a boxier van shape if you are hoping to fix your bed across the van, as the extra width may make all the difference. However, if you are too tall to fit across even the wider vans, the Sprinter and Crafter's offer the option of a slightly longer internal length to accommodate a lengthways bed.

Some people worry about the idea of owning a large van as they think it will be hard to drive and hard to park. Of course, there are downsides to owning a large van versus a small one, as you will need to find a parking space that is around two cars long rather than a standard size. However, there are also a myriad of benefits to owning a large van that definitely outweigh the inconveniences. Although it might be trickier to find a space big enough, actually parking a large van is easy as long as you install a reversing camera.

3 Rac.co.uk. 2021. Available at: <https://www.rac.co.uk/insurance/van-insurance/overloaded-van>

OPPOSITE The weight of our climbing gear quickly adds up, so we had to be extra cautious with weight during our build! *@climbingvan*

Large vans have a much heavier base weight, which means you need to be much more careful throughout your conversion that you don't go over 3.5 tonnes with your final conversion weight. Therefore, it's worth having weight in the front of your mind throughout your conversion if you're converting a large van.

Large van internal dimensions

	Ducato, Jumper & Relay	Sprinter, Crafter & TGE
Length	4.07m	4.30m / 4.70m
Width	1.87m	1.78m
Height	1.93m / 2.17m	1.92m / 2.14m

Medium vans

Medium vans are a more practical version of the somewhat barge-like larger vans. They still provide enough room for almost everything other than a bathroom, and usually tend to have enough internal height to allow you to stand up. A popular option for a medium-size van is the LWB Transit, and the LWB or MWB Ducato, Jumper and Boxer's mentioned above make for a good medium-sized van.

Medium van internal dimensions

	Ducato, Jumper & Relay	Sprinter, Crafter & TGE	Transit
Length	3.10m / 3.71m	3.27m	3.39m
Width	1.87m	1.78m	1.76m
Height	1.93m / 2.17m	1.92m / 2.14m	1.88m

Small vans

The essential tool of a weekend warrior, small vans are big enough for a surfboard, a bike and a bed. There's usually enough room to squeeze in a compact kitchen, providing hot drinks after chilly adventures. The most common smaller van is the iconic VW Transporter, which is available in a series of different models depending on the age of the van. They have internal dimensions of 1.7m x 2.6m. The Peugeot Expert, Vauxhall Vivaro, Mercedes Vito and Ford Transit Custom are all available in a similar size.

Small van internal dimensions

	Transporter & Vito	Expert & Vivaro	Transit Custom
Length	2.57m / 2.67m	2.51m / 2.67m	2.55m
Width	1.69m	1.63m / 1.69m	1.77m
Height	1.41m	1.40m / 1.28m	1.40m

Extra small vans

If you're looking for a van to fuel microadventures on a budget (or want to leave the kids at home!) then an extra small van such as a VW Caddy, Citroën Berlingo or Ford Transit Connect might be the right choice. A van this small will allow you enough room for a bed and maybe a very small kitchen and storage area, but you will need to mainly rely on expandable storage and utilising space outside your van. The Nissan NV200, Renault Kangoo and Fiat Doblo are all based on a similar body to the Citroën Berlingo.

Extra small van internal dimensions

	Caddy	Berlingo, Partner & Doblo	Transit Connect
Length	1.79m / 2.15m	1.81m / 2.16m	1.75m / 2.15m
Width	1.61m	1.55m	1.53m
Height	1.27m	1.23m	1.26m

Buying a van

Your van will be the base on which you build your little home on wheels, so it's extremely important to get it right. If you spend hundreds of hours converting a base van that ends up having critical mechanical faults or extensive rust issues, you could end up spending thousands to save it. There are lots of considerations, from make and model to age and mileage, that are all important to consider when looking for your base vehicle.

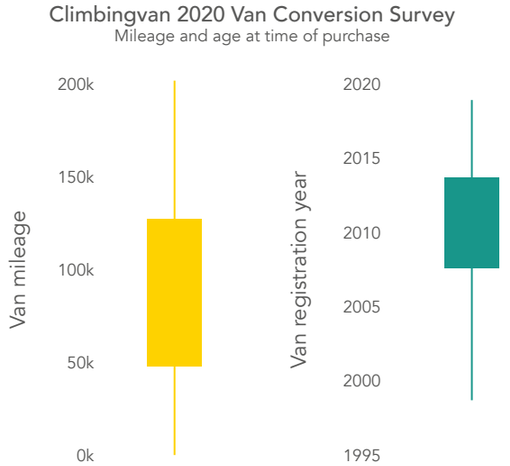
What to look for when buying a van

Once you have a budget for your van in mind, you can start looking at different makes and models to see what combination of age and mileage you can afford. The older a van is, the higher the chance of complications; extremely high mileage should also be a warning sign. It's important to remember a van will typically reach a much higher mileage over its lifespan than a car, so where a car with over 100K miles on the clock may be considered old, a van with the same mileage is likely to keep going for quite some time. A diesel van will typically have a 30% longer lifetime mileage than a petrol car.

ABOVE A beautiful example of a compact kitchen in a little VW T3. *Sarah and Carl Oscar @ifyoudrift*

Whilst the average mileage a van will reach in its lifetime is 140K miles, the data is heavily skewed by scrappage schemes that encourage van owners to trade in older vehicles to purchase new ones, bringing the average down from where it might otherwise be. Over 50% of vans have a lifetime mileage between 140-250K[4], and a quick search on Autotrader will bring up second-hand vans with over 300K miles on the clock! Ultimately most people will retire their vehicle once it becomes more expensive to mend it than the value of the vehicle, but for your home on wheels, the value of the vehicle will be much higher than an empty panel van. That means you should be able to keep it on the road for much longer than the average, it may just become more expensive as the mileage increases and faults occur more frequently.

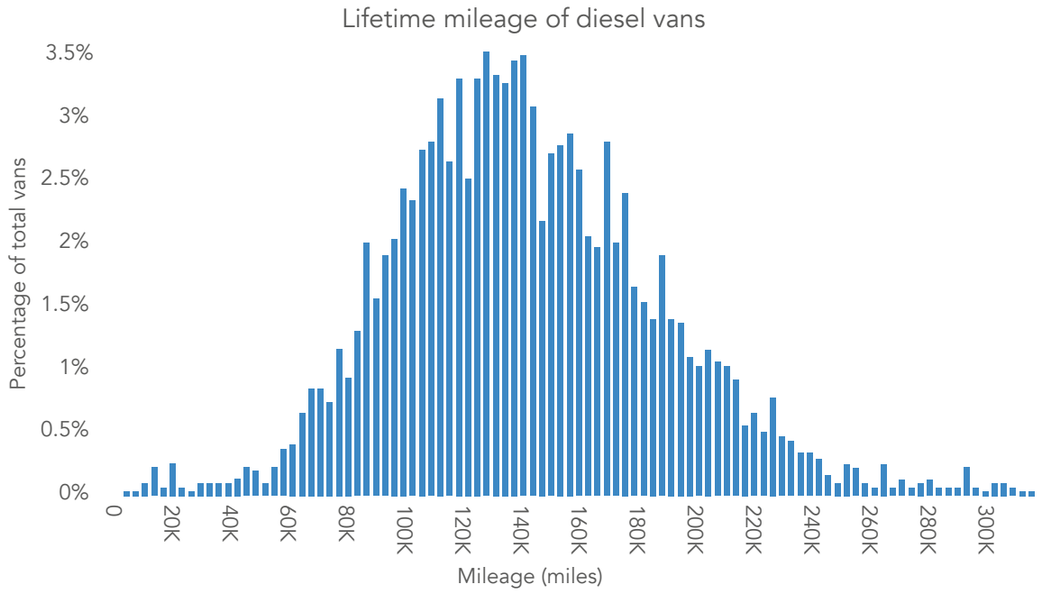
When looking at used vehicles, it's worth bearing in mind that a newer model will typically have a longer lifetime mileage than an older model of



the same van. A van manufactured in 2012 will typically have a 45% longer lifetime mileage than a van manufactured in 2007. Older vehicles also tend to be more prone to rust issues due to lack of galvanisation and other protective measures, whereas some newer vehicles are galvanised to prevent rusting (such as the VW T5 and the 2013 Mercedes Sprinter).

In our van conversion survey, 49% of people who had converted a van had bought a vehicle

4 European Commission. 2015. Available at: <https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/ldv_mileage_improvement_en.pdf>



with over 100K miles on the clock. The data shows that people typically buy a van with a mileage between 50K and 125K, and a van between six and 13 years old.

As important as age and mileage are, they shouldn't be the only considerations. Previous owners and service history also play a big role in the condition of the vehicle you're buying. A van with 150K miles that's 10 years old but has been meticulously looked after by one owner and serviced regularly is likely to be in much better condition than a van with 80K miles that's six years old but has been ragged around by numerous previous owners and not looked after. It's generally worth avoiding vans that have had a lot of previous owners or have no service history, as it's likely the vehicle won't have been maintained or looked after. You should also consider a van's MOT history to highlight any recurring problems or defects there may be with the vehicle.

When considering makes and models, it's worth remembering that vehicle engines are not all built to last the same amount of time. Some engines will be made to last tens of thousands of miles more than others. Fleet News conduct a yearly survey of over 200,000 companies on the reliability of vans to create the FN50 van reliability index.[5] It measures manufacturers and models of LCVs (light commercial vehicles) by the fewest mechanical breakdowns and warranty claims per 100 vehicles. The Mercedes Sprinter has secured the top spot on the reliability index for five years in a row.

When searching for a van, it's worth considering ex-fleet vehicles. These vans were owned as part of a fleet, whether that be as delivery vehicles with companies like Royal Mail and

5 Fleetnews.co.uk. 2021. Mercedes-Benz vans leads FN50 reliability survey. Available at: <https://www.fleetnews.co.uk/news/latest-fleet-news/fn50-insight-and-analysis/2020/11/29/mercedes-benz-vans-leads-fn50-reliability-survey>

FN50 van reliability index - 2020

Pos	Van make and model	Size
1	Mercedes-Benz Sprinter	Large
2	VW Caddy	XS
3	VW Transporter	Small
4	Renault Trafic	Small
5	Vauxhall Vivaro	Small
6	Citroën Berlingo	XS
7	Peugeot Partner	XS
8	Mercedes-Benz Vito	Small
9	VW Crafter	Large
10	Ford Transit Custom	Small

DHL, or as force vehicles such as ambulances. They tend to be serviced very regularly as the risk of them breaking down directly impacts the business they're serving. They're also typically sold after around five years, which means you are purchasing a relatively new van with a full service history and one owner from new, making them fairly reliable vehicles.

Before you purchase any van it's important to test drive it to check that it drives well and there aren't any rattling or knocking noises, and to do a check for any dents, bumps and most importantly, rust. Rust can be a substantial issue in older vans and is very expensive to repair, so it's best to try and avoid this at all costs!

When viewing used vehicles it's a good idea to have a checklist to refer to so you can ensure you're making the right choice:

1. **Engine**: check for any leaks, the state of the exhaust smoke, the oil level, and the condition of the head gasket.
2. **Gearbox and clutch**: test the bite point of the clutch, and how smoothly the vehicle changes gear.

3. **Bodywork**: check for any bumps and dents, and importantly check the underside of the vehicle for any signs of rust.
4. **Wheels and tyres**: check the condition and tread depth of the tyres.
5. **Interior**: check the mileage is as advertised, check for any warning lights, inspect the condition of the interior and the boot area, and ensure all of the electrics work.
6. **Test drive**: drive the vehicle for as long as necessary to ensure you're happy with it.
7. **Documents**: check the service history, MOT history, and vehicle logbook.

Euro 6

If you are buying a newer van, you may find it has a Euro 6 engine. Euro 6 is a standard introduced by the European Commission to regulate the level of pollutants released by vehicles engines. The emission standards specify the level of nitrogen oxide emitted from a diesel engine has a limit of 80mg/km and a limit of 60mg/km for petrol engines.

Euro 6 engines use new technologies to lower the emissions of the vehicle. If your van uses the Selective Catalytic Reduction (SCR) method, it will require you to top up a solution called AdBlue every couple of thousand miles. Euro 6 vehicles have an increased fuel economy, meaning you'll achieve a higher mpg from your vehicle. They are also exempt from any low emission zones and diesel taxes due to the reduced amount of carbon dioxide they produce. It's worth considering looking for a Euro 6 van if you live in a city where a diesel tax may be introduced in the future.

All vans made after September 2016 will be Euro 6 compliant, and some vans made before this may also be, so it's worth checking on a case by case basis before you purchase a van. It's important to note Euro 6 vans have a smart alternator and regenerative braking, which means if you want to charge your leisure batteries as you drive, you will need to use a battery to battery charger rather than a standard voltage sensing relay (don't worry, we'll explain more in *Electrics on page 73*).

Electric vans

Electric vehicles are becoming much more popular, and with many people looking to live a more sustainable lifestyle and reduce their carbon footprint, the idea of an electric van may seem appealing. However, electric vans are a relatively new concept, and it's only very small vans such as the Citroën Berlingo that have been available in electric models for the past few years. A couple of larger electric vans have become available recently such as the Renault Master ZE. However, the battery is only capable of driving 75 miles before recharging, and it takes six hours to fully recharge the battery. This makes the feasibility of using this type of vehicle for a van conversion pretty unrealistic. As electric vans are so new, a lack of second-hand options means you can expect to pay upwards of £50,000!

There are a few more electric vans planned for release at the time of writing such as the Mercedes ESprinter, but these don't fare much better, with a maximum range of 96 miles. However, this model will charge much quicker than existing electric vans, with the battery able to charge from 10% to 80% in an astonishing 20 minutes using a DC rapid charging station. Still, if you wish to use one of these as your base vehicle you will be looking at a price tag upwards of £52,000.

The other consideration when buying an electric van is that you will be severely limiting where you can travel, as you will need to ensure you're near a charging point any time you need to recharge. Although you may think you'll be able to charge your electric vehicle using the same solar panels you will be using to charge your leisure batteries, unfortunately, this is not possible with current technology. Shore power isn't currently an option for charging an electric

OPPOSITE Ben lovingly restored his 1985 Vanagon Jozette over two years, giving her a facelift both inside and out. *@funwagen*

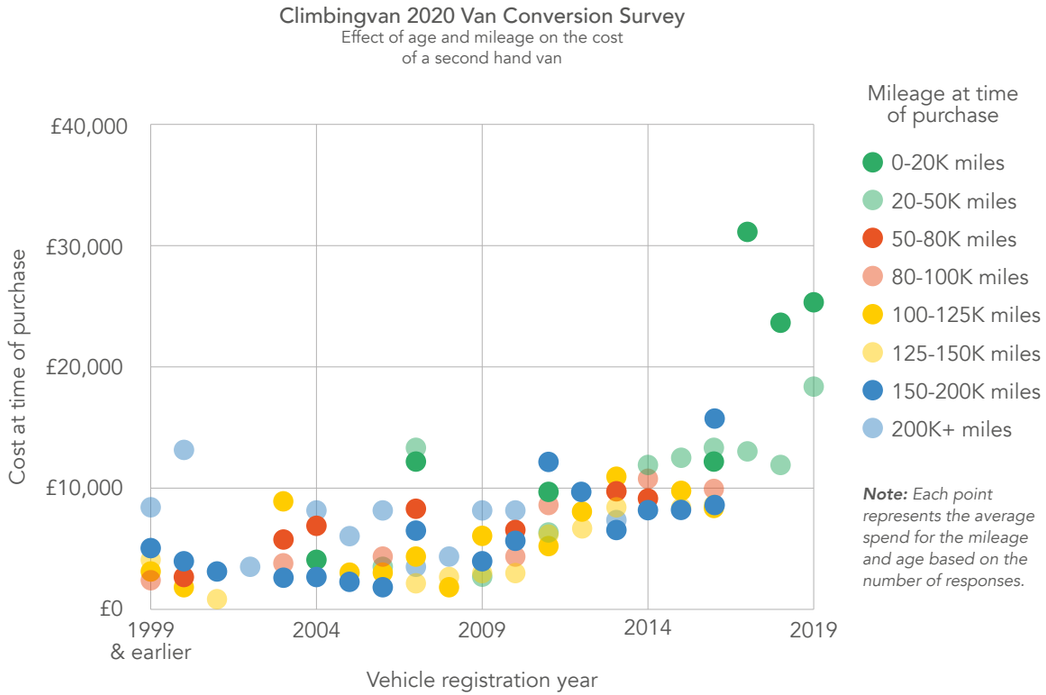
vehicle battery as you have to use a specific charging point. These are often scarce in some of the remote spots you are likely to explore.

If you have been considering an electric vehicle to reduce your carbon footprint, you're probably better off buying a used van to keep it running for longer rather than buying a brand new electric van. In 2004, Toyota found that over 25% of the CO2 emissions generated during the lifecycle of a standard car can occur during its manufacture and transportation to the dealer.[6] Because of this, you will decrease the emissions per mile of a vehicle if you drive it for longer - getting a car to last to 200,000 miles rather than 100,000 miles can reduce the emissions per mile by as much as 50%.

It's an interesting idea to consider an electric van with batteries large enough to cover a decent distance and which could be solely charged by its own solar panels. If this was possible, it would make the concept of electric campervans much more viable. Unfortunately it looks like this could still be a long way off - Toyota have been working on a solar panel roofed Prius, which even in full sun is only able to produce 860W of power, whilst the car can use up to 53,000W when accelerating!

Tesla makes the pipe dream perhaps look a little more promising - their electric lorry 'Semi' which is due to be released shortly will have a range of 500 miles and it will be possible to charge up to 80% in 30 minutes using a solar-powered 'Tesla Megacharger' charging station. Unfortunately, it comes with a whopping £140,000 price tag, meaning for now it's probably best to just keep watching the electric van market to see what's possible in the future!

6 American, S., 2021. When Used Cars Are More Ecofriendly Than New Cars. Scientific American. Available at: <https://www.scientificamerican.com/article/when-used-cars-are-more-ecofriendly/>.



How much should you spend on a van?

Looking at the second hand van market can be a bit of a minefield, with so many different factors affecting price. You should decide on your vehicle budget by first considering what your overall budget is. Generally if you're planning to spend quite a lot on your build, you should probably do so on a van that costs more than £500, so the time and money you are investing isn't spent on a vehicle with a short lifespan. Equally if you only have a small budget, you will need to balance the cost of your vehicle with making sure you have enough left over to complete your conversion. On average, people spend around 60% of their total budget on the base vehicle,[7] so this is a useful rule of thumb to keep in mind when calculating your vehicle.

Buying a brand new van for your campervan conversion is probably not a wise move, as the depreciation of a new vehicle is high, and you'll be spending a lot of money upfront when it's sensible to save a decent amount of your budget for the build itself. You will also pay VAT on a brand new vehicle, and 20% is a lot when the cheapest new vehicles on the market will cost upwards of £20,000! If you're looking for a newer vehicle, it's a better idea to look for something two to three years old with only a few thousand miles on the clock to avoid the initial depreciation and VAT costs.

Vehicle preparation

Albert Einstein once stated, "If a cluttered desk is a sign of a cluttered mind, of what, then, is an empty desk a sign?" It turns out he didn't know much about van conversions! Before you start converting your van, you will need to prepare it by transforming it into a blank canvas for you to work your magic on. For some vans that may be easier than others.

Servicing your van

Before you do anything else, book your van in for a service. There is nothing worse than ploughing hours of your time and money into a build and then realising you have a real issue, so invest now to save yourself the worry.

7 climbingvan.co.uk. 2020. The Climbingvan 2020 Van Conversion Survey.

ABOVE Michel and Nina's Ford Transit utilises the available space with a clever layout and features a lovely neutral colour palette. *@_fordfahren*

Removing old structures

Don't underestimate the faff of removing old structures. If your van was a delivery vehicle in its past life, or perhaps an old work van, then you may have some work on your hands. You should remove all internal structures, including bulkheads (the metal wall separating the cab from the back of the van) and any existing wall panelling, as you need to strip your van back to the bare bones before you can start your conversion. Whilst it may seem like a great idea to use the existing bulkhead, these typically tend to be made of metal and will be very heavy compared to what you are likely to install.

CHARLIE SAYS:
Ringo served as a DHL delivery vehicle for five years, and although that rewarded us with his shiny golden exterior, it also equalled several hours of painstaking work removing old parcel racking when we were eager to start our build.

Rust

The dreaded R-word every van owner fears to find on their recently purchased van...rust. When you buy a van, you should make sure to check for rust as thoroughly as possible, making sure to inspect the underside of the van. Carefully considering the age of the vehicle you buy will help, but ultimately it's hard to know how much rust you'll have to contend with until you strip your van back to the bare bones. Once you've removed all of the internal features in your van, you'll be able to see the state of the body work underneath and determine whether or not your van needs treatment.

When planning your build, it's important to factor in time to deal with any rust, as you won't know what work is needed until you have stripped it right back. It's important to know that whilst surface level rust can be dealt with yourself, if you have any structural rust issues, you may need to pay a professional welder to fix them unless you have experience in this area. Structural rust issues will become apparent if you push the area with your finger and it goes straight through, or if large chunks flake away.

Bulkheads and over cab storage

Thankfully most of the walls of your van are already present (unless your rust problems are really severe!), but you may need to add an additional one in the form of a bulkhead. A bulkhead is the part of a van that separates the cab from the back of the van. If you're considering including a permanent bulkhead in your campervan design, you should build this very early on so you can insulate it when you insulate the rest of your van.

The same goes for utilising the ceiling space above the cab - a lot of people choose to add a lower ceiling to this area to give access to the space as storage from the back of the van. You will lose a bit of headroom in the cab, but you will still be left with a similar amount to what you typically find in a car and you will gain a good-sized storage space.

Seating

The vehicle preparation phase isn't all dull! There are a couple of upgrades you might want to make to your cab seating before you start your build.

Captain seats

Captain seats are more comfortable than standard van passengers seats. They have arm rests and are usually larger than a regular seat, so you may choose to install one if you want a bit of extra comfort and you only require two seats rather than three.

Swivel seats

Swivel chairs are sometimes used in an open layout without a bulkhead. Seats are mounted on a swivelling base, allowing you to twist them round to face back into the van to provide additional seating. You can purchase double swivel seats or captain swivel seats, and both the passenger seat and the driver's seat can be set up to swivel.

Exterior

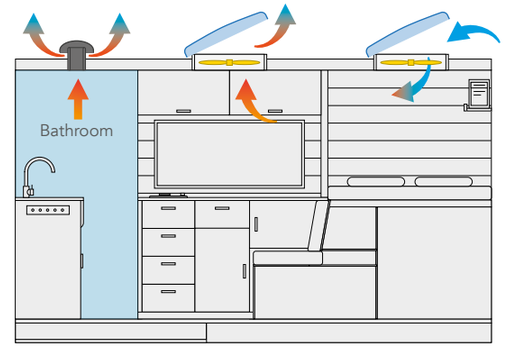
Exterior covers everything from swanky roof decks to windows. Anything that's attached to the outside of your vehicle is important to plan at the start of your build. If you decide you want to add a water fill point on the outside of your van after you've already finished cladding, it will add a lot of faff and complexity to what would otherwise be quite a simple job. Although certain exterior features like roof racks and awnings may not seem like they need to be planned well in advance, many require access from the inside to fit them, as you will need to attach a nut from inside of the van to clamp them to the roof.

Another reason to start with the exterior jobs is that it gives you very clear visibility of any leaks that may appear after you've fitted something externally. It's amazing how much water can leak through the smallest of holes and commonly down the threads of bolts. The exterior is the easiest area to add vast amounts of weight and cost to your build, so before you decide to build a dreamy roof rack deck with an access ladder and hammock, just make sure you balance the weight and cost against your budget with the potential Instagram fame!

Ventilation

Windows, skylights, fans and air conditioning

The natural light that windows and skylights provide can make a huge difference to the ambience inside your van, and they also provide much-needed ventilation. When you are trying to maintain a certain internal temperature, it may seem like you shouldn't include any windows or skylights as these will allow air to infiltrate your van and bring down the temperature. However, it's important to include ventilation within your build as this reduces condensation and humidity, which if not dealt with can lead to damp and mould issues. As well as passive ventilation such as windows and skylights, you can install active ventilation in the form of fans which will promote air circulation.



Choosing how many windows and skylights to include in your build is a balancing act; if you install too many, your van will not be able to retain heat well, and you will end up spending a lot more on fuel for your heater! You should also consider the wall space taken up by windows and the impact this will have on the structures you are building.

Windows

A window covered by a thermal window blind has far worse thermal properties than an insulated section of wall, and so the more windows you install in your build, the quicker it will cool down when you've got it nice and toasty in winter. Windows also make stealth camping harder - the ultimate stealth vans don't install any windows, as without them you'd never know someone was inside.

There are two main types of campervan window. Bonded window panes are simple sheets of glass usually tailored to the body of your specific van. They can be bought with either a clear finish to let in more natural light, or a stealthier black tinted finish to provide

more privacy. There are also both static and opening versions available.

Alternatively, motorhome-style windows are available in a wide range of sizes, from small and narrow shapes used mainly for ventilation, to very large windows that let lots of natural light into the van. Most feature a slide mechanism or gas struts to open them, and some have integrated blinds and fly nets. You don't have to decide on just one type of window, you can choose to combine different types in your van.

Window comparison

	Bonded window panes	Motorhome-style windows
Price	£100-£180	£450-£600
Material	Glass	Acrylic
Example	Van Demon	Dometic S7

Skylights and fans

Skylights can provide natural light and passive cooling, while fans actively promote air circulation. There are a few options available when it comes to skylights, from fairly small and basic models which can be popped open, to larger versions with inbuilt fans. Skylights are often installed over the kitchen area as they're a good way of encouraging warm, humid air from cooking to escape the van.

You can install as many skylights in your build as you like. Many people decide to install a skylight above their bed, and whilst the idea of stargazing from bed may seem lovely, you may also notice a cold draught as you sleep as they're not completely air-tight. When you're having a hot shower or drying wet clothes, a skylight installed in a bathroom can allow the warm, humid air to escape from the van and reduce water vapour.

Vents or fans in addition to or instead of a skylight can help to improve ventilation. As mentioned above, it's possible to buy a skylight with an inbuilt fan.

We used PC case fans with mushroom vents to create two fans which circulate the air in our van. One draws air in from the outside (above the bed) and one draws air out of the van (above the kitchen). As they're much smaller than skylights, they don't cause a draught in the same way as a skylight, so they can be a good option above a bedroom area.

ABOVE LEFT We installed tinted bonded windows in Ringo for maximum stealthiness. *@climbingvan* **RIGHT** Motorhome-style windows like the Dometic S7 are so easy to open, even a dog can do it! *@billietheshibainu and @lara_crafter_van*

Skylight comparison

	Dometic Mini Heki	Dometic Fantastic Vent	Dometic Heki 2	Mushroom vent & PC fan
Cost	£80	£380	£450	£15
Natural light	Medium	Low	High	None
Visual appeal	Medium	Low	High	Low
Encourage air flow	No	Yes	No	Yes
Heat loss	Low	Low	Medium	Very low

TOP LEFT Installing the Dometic Mini Heki S. *@climbingvan* **TOP RIGHT** Fixing the Dometic Fantastic Vent in place. *@andrew__muse* **BOTTOM LEFT** The Dometic Heki 2 makes the most of natural light. *@dometic* **BOTTOM RIGHT** All of the components required to make your own mini fan. *@climbingvan*

Air conditioning

Campervan air conditioning units are used to maintain a comfortable internal temperature in your van if you are living or travelling in a hot climate. More commonly seen in parts of the US and Australia, air conditioning systems use a fan to draw air in and pass it over chiller pipes containing coolant before blowing it back out into the room. They are mounted to the ceiling of the van in a similar way to a skylight, but are made up of a unit which sits on top of the van and a grille which expels the cool air inside.

However, air conditioning units tend to have quite a large power draw. The power consumption of a small air con unit is 620W, which means you'll need a fairly large inverter to power one, and running one for four hours will use over 50Ah of power. If you do want to install an air conditioning unit, you will need to include a very high spec electrical system in your build to account for the power draw (unless you plan on spending a lot of time on campsites connected to shore power). The most basic versions cost around £1,500, and the larger, more powerful systems are much more expensive.

Pop-top roofs

Pop-top roofs can transform the space in a smaller van, in some cases almost doubling their volume! They help to make the space inside more liveable, allowing you to stand upright and potentially providing extra space for sleeping. Most pop-top roofs use a mechanism to translate the position of the roof from a stored state to a pop-top state. They are typically held in position by a gas strut which will assist the opening of the pop-top but also easily allow it to return to a closed state.

You can either use your pop-top purely to provide space to stand up within your smaller campervan, or you can purchase a roof bed with your pop-top that will provide an additional sleeping space when it's open.

As well as having a pop-top roof installed professionally, it's possible to install them yourself, but it's not the most straightforward job to attempt! Cutting out a large portion of your van's roof will weaken the structure, so as part of the process you will need to install strengthening beams. It's also incredibly important to ensure that all of your measurements are accurate to ensure the pop-top covers the portion of roof removed from the van!

Roof racks, ladders and awnings

Roof racks and ladders

Roof racks and ladders not only provide somewhere to store bulky gear like surfboards and kayaks, but can also be used to create extravagant decking areas where you can sit, relax and watch the sunset. When deciding whether or not to install a roof rack, have a think about your requirements - if you have large equipment you will otherwise struggle to fit inside your van, then installing a roof rack is certainly a good idea.

If your requirements for a roof rack are purely to have something that looks cool with a decking area, it's worth considering if this is really necessary. Gaining a couple of metres in height is very unlikely to vastly improve your view, and you will most likely be able to achieve the same outcome with a nice rug and some chairs next to your van. Roof racks and decking weigh a considerable amount and are also fairly expensive, so make sure to weigh up the pros and cons before committing to installing one.

It's also important to consider how the roof rack will interact with other features on your roof - if you're installing solar panels or a skylight, you may need to get a custom roof rack made to ensure it's compatible with any other features. We have also heard quite a few stories from people with roof racks and ladders on their van, parking up for the night somewhere and kids climbing onto their van whilst they were

inside of it! Roof racks typically weigh upwards of 50kg and cost over £1,500 for a medium to large van, and ladders will add an additional £100 and 10kg of weight.

Awnings

Campervan awnings are a great way to add some additional space to smaller vans. Opening up an awning on a hot day to provide some shade can give you a great additional outdoor space that feels like an extension of the van. It can also be useful on rainy days, allowing you to expand outside when you'd otherwise be stuck in a small space.

However, awnings can also be quite heavy and expensive. An awning bar installed on the roof of your van will weigh around 10-15kg and will cost upwards of £300. There are many different types of awning you can install.

Pull-out awnings comprise a single sheet of canvas that rolls out from an awning bar either manually or automatically to give shade and cover. Alternatively, drive away awnings are a full tent-style awning that can be attached to your campervan; these tend to be seen more in campsites and used by families who require the extra space. It's also possible to use a portable awning which doesn't need to be permanently fixed to your van, as they use suction cups or can attach to a pre-installed roof rack. These are generally lighter, but still quite expensive.

Awning comparison

	Pull out awning bar	Drive away awning tent	Portable sun canopy awning
Cost	£300-£600	£150-£800	£100-£300
Weight	10-15kg	10-30kg	4kg
Setup	Easy	Medium	Medium
Protection	Medium	High	Medium
Example	Dometic PerfectWall	Dometic Rally Air	Moonshade

Tyre and suspension upgrades

If you plan on using your campervan on more demanding terrain and not just well-tarmacked roads, you may want to consider upgrading your tyres. There are a few different options when upgrading your tyres, from winter and all-terrain tyres to mud-terrain tyres for those who plan to do a lot of off-roading. These tyres provide higher traction on tricky terrain, so should be considered based on your requirements. It's worth noting that these tyres will be louder than standard tyres when driving and are also less efficient so will slightly reduce your mpg.

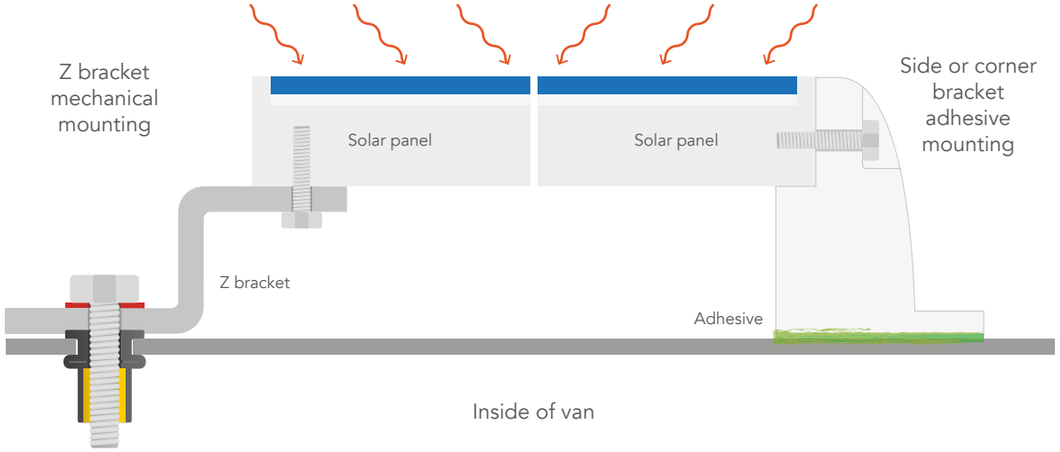
Suspension upgrades are necessary if you put more weight in your van than it's rated to carry. Vans are typically rated to carry either 3,000kg or 3,500kg depending on the van, and so if your build ends up weighing more than this, you'll need to upgrade your suspension.

Solar panels

Despite solar panels being a component in many electrical systems, most of the complexities lie in mounting them. To connect a solar panel to your electrical system, you will need to drill a hole through the roof of your van to pass cables through. If you don't start planning at this point in your build, you could end up having to undo a lot of your hard work.

There are a few methods of fixing solar panels to the roof of a van, from mounting them to pre-installed roof racks, to using brackets that can either be fastened to the roof via a drilled hole or bonded with adhesive. If you're already installing a roof rack it makes sense to make the most of this and mount the solar panels directly to it. If you are not installing a roof rack, you can use either Z brackets or side mounting brackets to secure the solar panels.

OPPOSITE TOP A pull out awning like the Dometic PerfectWall can quickly double your liveable footprint. *@dometic* **LEFT** Drive away awnings are great for families who need a bit more space. *@yari_ghidone* **RIGHT** Portable sun canopies are quick and easy to erect and provide cover on hot days. *@fenimoreadventuremore*



Z brackets are made from small pieces of aluminium and are designed to create an offset between the roof of the van and the underside of the solar panel which encourages airflow and keeps the panel cool. They are typically attached with fasteners which require you to drill holes through the van roof to mount them. You can also attach them by using a strong adhesive to glue them securely to the roof. The brackets attach to existing mounting points on the solar panels.

Side mounting brackets are made of plastic and mount either to the sides or corners of the solar panels, either using screws or glue. These are typically bonded onto the roof of the van using a strong adhesive.

Whichever method you choose, you will need to drill a hole through the roof of your van to connect your solar panels to your charge controller inside. You will also need to install a cable entry housing which protects the cables and stops any water ingress.

Fill points, vents and external electronics

One of the most common mistakes made during a van build is to install fill points for gas and water halfway through a conversion. This involves chopping through layers of insulation, vapour barrier and cladding to access the spot where it needs to be installed, making a bit of a mess of your previous hard work. It's much more sensible to consider any external fittings such as fill points and vents at the start.

It's good practice to install gas and water fill points on the exterior of your van, and if you detail where these will be positioned whilst designing your layout (we'll go into more detail on this in *Design* on page 136), you will be able to install them as one of the first jobs you do. The same goes for any vents required for fridges, flues for boilers or log burners, or any device which needs to be installed externally.

WiFi boosters are a good example, where a small antenna can be installed on your van roof to boost WiFi signal from a MiFi router. It's something you might not think of until you have been living in your campervan for a couple of months, but retrofitting one could end up causing quite a lot of extra faff.

TV aerials also work in a similar fashion, where they're typically attached to the roof of your campervan and will require a wire to run into the van to connect to a television. If you're planning on installing multiple products on the roof, these should ideally enter the van at a single entry point to make cable management easier and reduce the risk of a leak.

Reversing cameras and sensors can also be a good idea to install, especially in larger campervans. Ideally, these should be installed at the start of your build. We have a big Mercedes Sprinter and we would struggle without our reversing camera! They provide a lot of extra visibility, making parking much easier.

Paying a professional

Window fitting is typically the most common job outsourced during a van build, along with fitting a roof rack or a pop-top.[8] Although window fitting made the top of the list, fitting a campervan window yourself is actually a very simple process once you know what to do.

We have included some rough costs when paying a professional to do some jobs versus doing it yourself. Many van builders can take on just a single part of your build such as fitting a window or awning. The costs are based on a standard specification or setup, and prices have been gathered from van builders websites.

Be aware - supply and fit prices can vary wildly depending on availability. If a van builder is very busy, they may charge a much higher rate just to see if they can get away with it. Don't assume that because you could do the job in 10 hours, they will be able to do it in half of that and will only charge £30 per hour. In reality, it may be much more than this, and you'll likely need to pay a half or full-day rate as a minimum.

8 climbingvan.co.uk 2020. The Climbingvan 2020 Van Conversion Survey.

Exterior install costs

	Parts cost	Professional supply & fit
Window fitting	£100-£180	£200-£300
Reversing camera & screen	£200	£400
Ladder	£100	£275
Roof rack	£250-£2,500	£450-£2,700
Air conditioning	£1,800	£2,200
Awning 2.6m	£400	£650
Solar panel 100W	£100	£300
Pop-top roof	£2,750	£4,000

Insulation

Why do you need to insulate?

Thermal insulation aims to reduce heat transfer between objects in contact or close proximity of one another - put simply, it enables you to keep the inside of your van warm in the winter and cool in the summer. There are several different methods you can employ to achieve this, but to know what type of insulation is most important for the areas you will live and travel in, we need to do a quick trip back to the physics classroom. As a van dweller, understanding the three different forms of heat: radiation, conduction and convection will inform how to use insulation most effectively, not only preventing heat loss or gain, but also saving space and money!

In summer, radiation from the sun hits the outside of your van. Most of this is reflected by

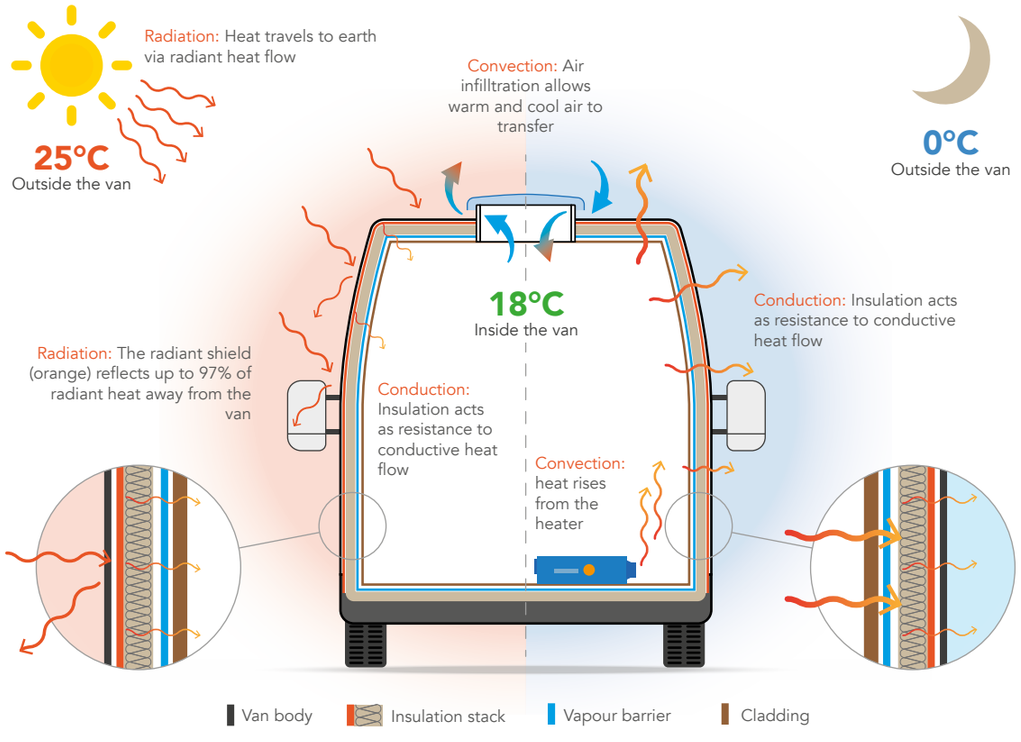
the metal exterior, but certain surfaces such as the windows allow radiant heat to easily enter the van and subsequently drive up the internal temperature. Radiant heat does not require a physical object for temperature change to occur (unlike convection and conduction), so can quickly cause temperatures to soar.

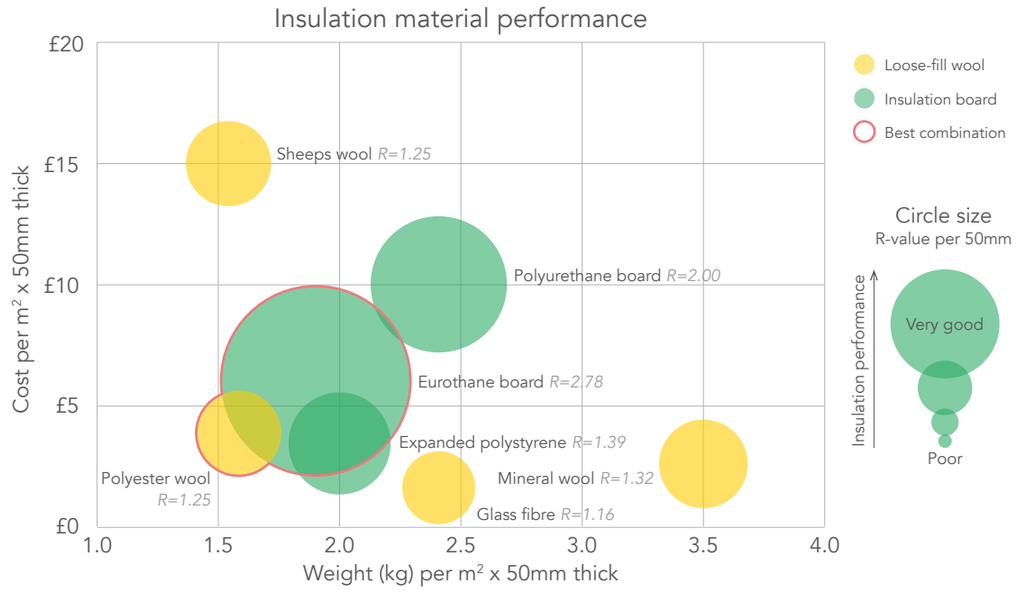
A radiant barrier such as a thermal blind reflects heat away from the inside of the van, keeping it cooler, so using thermal blinds is a must if you plan to have lots of windows and plan to live or travel in warm climates. Thermal blinds use a shiny metal surface, which has a low emissivity (the effectiveness of emitting energy as thermal radiation) and can be used to reduce heat transfer in both directions. Radiant heat is also a good reason not to paint your van matte black as it will absorb the illuminating light and heat up quicker than lighter colours and metallic surfaces.

So that's how to keep the heat of the sun out, but what about keeping the inside of your van nice and toasty in winter?

Heat Loss = Conduction + Infiltration

When it's nice and warm inside your van and cold outside, the warm air wants to transfer from the warm to the cool side through the walls and ceiling of the van. This is called conduction. In winter, almost all heat loss is through conduction, so to reduce this effect you need to insulate your van with materials that have a low thermal conductivity. The illustration shows how heat transfers with a constant 18°C in the van but with different conditions on the outside of the van 25°C on the left side and 0°C on the right. As you can see, in cold conditions the majority of the heat is lost through conduction so high-performance insulation can make a big difference to the temperature in your van.





Insulation materials

Insulation materials are generally ranked by their R-value which denotes their thermal resistance. The higher the number, the more insulative the material is relative to its thickness. The R-value measures how efficient a material is at preventing heat transfer, but not how well it prevents convection or radiation. Because space is at a premium in a van, it's important to use a high R-value material so you can get the best insulative performance within the wall cavities of the van and not encroach into the living space. The other way heat can escape is through air infiltration, where warm air escapes the van through vents and small gaps and is replaced by cold air from outside.

The insulation material performance graph shows the R-value of several different types of commonly used van conversion insulation materials. They are plotted against their cost and weight, based on 50mm thick insulation. The size of the bubble denotes the R-value of the material, so the bigger the bubble, the better the insulation performance. The materials are divided into insulation board which is commonly used in large wall cavities, and loose-fill wools which are used to fill smaller, more awkward areas.

The graph shows that eurothane insulation board has an extremely high R-value, as well as being light and fairly cheap, making it perfect for a van build. It tends to come in standard sheet sizes which are easy to cut to size so it's great for most of the floor, walls and ceiling. However, it's difficult to use these panels in tight spaces and to fill awkward shaped areas, so using a loose-fill wool for these areas is recommended. Recycled polyester wool is a great option for this as it's easy to work with and has good green credentials compared to the alternatives.

Whilst fibreglass wool is a good insulator and easy to pack into awkward spaces, it's also an irritant because it is made of tiny glass fibres, so you'll need to wear PPE (personal protective equipment) if you use it. It also contains microfibres and styrene, a synthetic material which is suspected to be carcinogenic. Further problems can also arise when water vapour

gets into the insulation space and condensates on the cold wall of the van, as its effectiveness is drastically reduced when it gets wet.

Polyurethane foam, which has a similar R-value to polyurethane board, may seem tempting to use due to its quick application speed, but you need to remember that it will expand and can quickly become very messy, as well as running the risk of deforming the bodywork of your van! Panel distortion is possible due to the large temperature change during the application process - the foam can reach temperatures of 80-90°C!

The foam also releases volatile organic compounds (VOCs) which can cause adverse health effects, so it's critical you leave your van well ventilated and unoccupied for 48 hours after application. Even if you circumvent these issues, you will still be paying a premium for a lower R-value product than other insulation types mentioned.

Vapour barriers

When you are living in your van, performing everyday tasks and using certain products or appliances will raise the temperature inside. When the temperature rises, so does the relative humidity level and the opportunity for condensation to form. If this is not managed carefully it could cause foul smells, wood to rot, insulation to go mouldy or even cause rusting to the van itself. Condensation can also harm your health, as living in a humid environment can exacerbate asthma and allergy symptoms.

When there's a temperature difference between the inside and the outside of a van, the warm, humid air can condense on the cooler surface of the van and turn the water vapour from a gas into a liquid. As the water is unable to escape, over time it can pool and cause all sorts of problems. A single person produces four litres of water vapour on average each day through breathing and performing common daily tasks like cooking. A common example can be seen when you cook near a window. The heat and water vapour from the cooking contacts the comparably cold surface of the window and creates condensation. It's the same with the metal walls of your van, except you can't reach to dry them because of the insulation and internal structures.

To avoid this issue, you will need to install a vapour barrier. A vapour barrier creates a non-permeable membrane, sealing the insulation between it and the outer wall of your van. This means that when water vapour condensates, instead of condensation forming on the cold wall of your van, it will form on the vapour barrier, protecting the insulation and inaccessible areas that are hard to ventilate.

Whilst it's important to install a vapour barrier to protect your van and its contents from the effects of damp, it's difficult to create a true vapour barrier in a van due to the awkward shapes you'll be dealing with, and difficulties with attaching structures and cladding without penetrating the vapour barrier. This means it's really important to consider ventilation in your van too, to reduce the amount of condensation build-up. A vapour barrier will also act as a radiant heat barrier, deflecting radiative heat away from your van.

Once you have a vapour barrier in place, it's important to remember that if you breach it and contact the metal structure of the van, you will create a thermal bridge. It doesn't matter how well you insulate, leaving any surface of metal exposed to the internal ambient air will create a path for cold (or heat) to enter the van. This can sometimes be seen where screws breach the vapour barrier and subsequently condensate, forming water droplets which start dripping.

You have a few options when choosing a vapour barrier, but the two most common options are

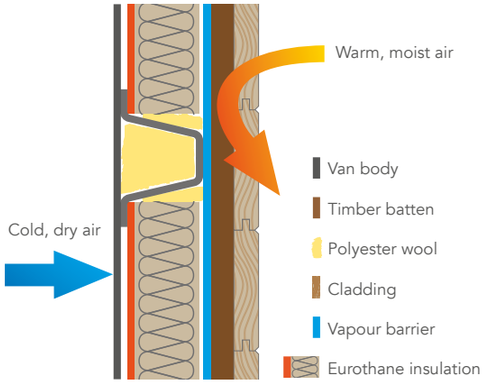
OPPOSITE Stuffing bottle wool into nooks and crannies can take forever, but it's worth the time to keep your van toasty warm in the winter! *@climbingvan*

single-ply aluminium foil membranes and a twin skin aluminium foil bubble wrap. Both options are attached with spray adhesive and the gaps and edges sealed with aluminium tape.

In theory, creating a perfect vapour barrier is easy; however, there are a few areas in a van which can leak and allow water to ingress between the wall of the van and the vapour barrier. Many vans have plastic side bumpers which are typically clipped to the metalwork of the vehicle. You may notice water streaks on the inside of the van where each clip penetrates the metalwork. These panels can easily be pulled off, sealed up with silicone and clipped back in place. This is the same for sidelights and other external fixtures, so have a good search around and apply copious amounts of silicone to keep your mind at ease! Of course, it's more than possible you will break the vapour barrier or allow very small amounts of water to ingress, so make sure you have chosen an insulation medium that doesn't absorb moisture.

We have detailed an insulation scheme that should be applicable to most vans and utilises the highest performing insulation pairing (using data from the insulation material graph). The eurothane insulation board can be used to fill large voids and rest up against the ribs and baffles on the van walls, floor and ceiling. You must create a 20mm gap between the eurothane board and the van wall so that the reflective radiant barrier can be most effective.

As van walls are rarely flat, their subtle curvature makes this easy to achieve. In awkward spaces and small gaps polyester wool (commonly known as recycled bottle wool) can be packed in to minimise gaps in insulation. The vapour barrier sits on top of the insulation to prevent warm, moist air that is generated inside the van from ever meeting the cold exterior of the van and creating damp. Finally, timber battens and cladding can be added to complete the insulation stack.



Theoretical heat loss calculation

To put into perspective just how important a good insulation scheme is, we have compared two theoretical vans. The two vehicles are both large vans with the same dimensions and construction, one with a bespoke insulation scheme and one without any insulation.

We calculated the time it would take for the two vans to drop from 18°C inside the van to the ambient outside temperature of a chilly 0°C. We also considered the impact of people as a heat source within the van. At rest, the average human produces around 100W per hour of heat. Depending on the activity, humans can comfortably sustain 300-400W, and in the case of very short bursts of energy, some people can output over 2000W!

The insulated van benefits from an insulation scheme of eurothane insulation board, an aluminium bubble wrap vapour barrier and wood cladding and flooring. The calculations also factor in the impact of windows and skylights on the thermal efficiency of the van. However, they don't account for any air infiltration through skylights and vents, and they assume the van is perfectly sealed. This would obviously not be the case in a real van, but insulation is the largest contributing factor to preventing heat loss, and so this is what we have focused on within the calculations.

The insulation thickness we have used for the insulated van has been varied throughout the van to account for typical thermal stratification (the temperature difference between the top and bottom of the van). Because heat rises, you're likely to see a 40% temperature difference between the floor and ceiling, so using more insulation on the ceiling than the floor is sensible. For the insulated van, we have also factored in that windows and skylights will be covered with thermal blinds.

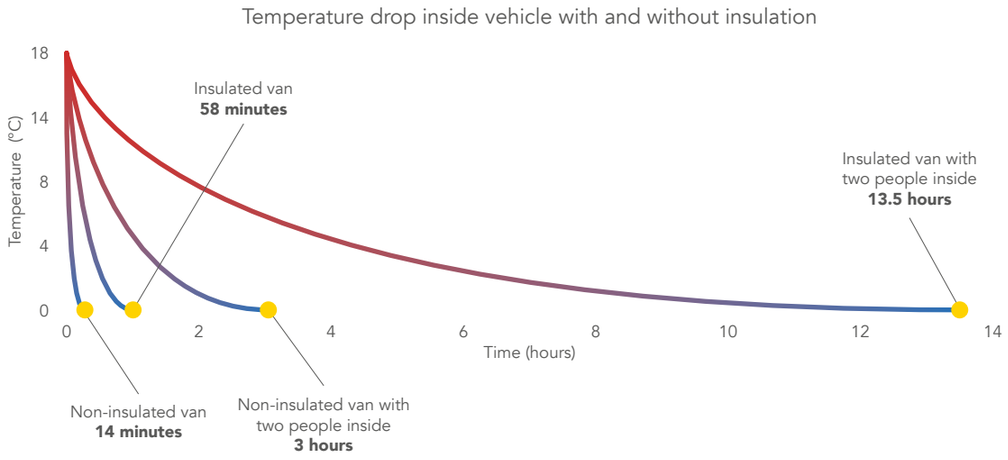
Based on these factors, the insulated van would take 58 minutes to drop from 18°C to 0°C, compared to only 14 minutes for the uninsulated van. Once you introduce two people at rest into the van, the radiant heat they produce increases the time taken for the temperature to drop. In the insulated van, the time would increase to 13.5 hours, and in the non-insulated, it would increase to three hours.

If reality, you obviously wouldn't want your van to drop to 0°C after 14 hours, as it would be pretty unpleasant! That's why most people who will spend any time in colder climates will typically install a heater. An insulated van containing two people like the one in our example would only require 0.1kW/hr output to maintain the temperature of the van, which is easily achievable by any heater.

Insulation recommendations

A common mistake people make when insulating their van is not distributing insulation to the most important areas. Because convection causes warm air to rise, any heat you generate in your van will rise and subsequently try to escape due to the temperature difference between the inside and the outside of the van. Therefore it's important you pack as much insulation into the ceiling as possible, prioritising this and the walls before the floor. You will often see conversions with 100mm of insulation on the floor and just 30-40mm on the ceiling, but switching this around will leave you with the same headroom and a big reduction in heat loss.

For those in warmer climates, using a radiative barrier next to the bodywork of the van is a great way to reflect heat away. It's important that you leave an air gap of at least 20mm for it to work as radiant heat only occurs through air or a vacuum and not through solids, so it will not work if you apply it directly against the side of the van. You can apply an additional vapour barrier next to the bodywork of your



van, or you can use an insulation material such as eurothane board, as this has a reflective material as its outer skin.

Sound deadening

The final consideration to complete the insulation scheme is whether you want to invest in sound deadening. Unlike a car, commercial vehicle manufacturers rarely use acoustic dampeners. It's seen as an unnecessary cost in new vans when typically the owner of the vehicle is not the one driving it, due to the majority being commercial fleet vehicles. Thankfully it's an easy process to improve both road and parked noise using materials to dampen the vibrations and absorb the sound.

Sound transfer occurs as a result of airborne and structural borne noise (raindrops on the roof, engine noise, tyre roar, etc). The sound wave strikes the exterior wall of the van and the pressure variations cause the wall to vibrate. This vibrational energy is transferred through the wall and radiated as airborne sound on the other side. Essentially, your van acts as a massive drum!

An empty van without sound deadening driving at 70mph is perceived as being three times louder than a car driving at the same speed. Employing sound deadening techniques should effectively enable you to achieve a similar sound level to that of a car. There are a few strategies to dampen both airborne and structural noise in your van, each of which will require you to apply the sound dampening material in different areas depending on what is most important to you.

Sound deadening material works by adding mass to the panels of your van, which reduces structural resonance and absorbs vibrations. Most dampening material for this application is typically made of a synthetic butyl rubber which is coated with an adhesive on one side and an aluminium top layer. There are several different options available but they all share similar installation logic of sticking the deadening material to the centre of each panel, filling roughly 30% of the area. You should be able to hear the difference straight away. Try tapping a panel, first without the material and then with - the tinny clunk is dramatically reduced.

If you're not too bothered about road noise but want some peace and quiet when you're in the back of the van, applying sound deadening strips to the walls and ceiling is a good start. The benefits of using sound deadening on the floor are not significant enough to warrant the expense when the source of the noise in this scenario is typically coming from the sides or above. The floor is also the most rigid area of the van, which is further strengthened by the significant amount of weight you will be adding to it, so it won't vibrate nearly as much as the walls or ceiling.

Installing an insulated bulkhead as a part of your van layout will dampen much of the noise coming from the rear of the vehicle, so if you are concerned about driving noise, you can concentrate your material placement within the cab. To do this you will need to remove the fascias on the doors, ceiling and floor so you can apply the dampening material directly to the metal surface of the van.

If you don't plan on installing a bulkhead as part of your van layout, you will need to consider other sound deadening options. Rubberised undercoating is an effective way of soundproofing the underside of your van, and comes with the added benefit of protecting against rust and debris. This can be achieved with rubberised spray cans and an afternoon under the van. Alternatively, several companies offer this service if you don't have a vehicle lift or fancy getting covered in rubber spray whilst wedged under your van!

OPPOSITE Ringo: "You may think I'm a van, but at heart I'm a submarine!" *@climbingvan*

Generally speaking, fitting narrower and softer tyres is the best option to reduce driving noise, but you need to remember you will potentially be driving a heavy vehicle in all sorts of conditions, so sound shouldn't be the only consideration. The noise from your tyres is created primarily from air getting trapped between the rubber tread and the road surface which causes the air to decompress, making a small popping sound. This happens multiple times each second, so it ends up sounding like a continuous hum coming from your tyres. A quiet tyre is expected to make around 68dB, while big chunky off-road tyres may sit closer to 74dB.

Floors and walls

In many ways, you almost have more choices for your campervan walls than you would in a house! Whether you want a cosy cabin on wheels, a clean and bright minimalist aesthetic, a soft and practical carpeted finish or anything in between, it's possible to mix and match cladding, ply and carpet to achieve your desired finish. We'd suggest looking on Instagram and Pinterest at lots of different vans to decide on the type of aesthetic you may want to go for to help inform your decision.

A benefit of cladding with ply is that it's the quickest method by far - you can use very large sheets of thin ply to attach to the walls of your van, fill any holes or gaps and then paint them to achieve your required aesthetic. Carpeting will likely take a similar amount of time, as you will be glueing auto carpet to your ply instead of painting it. The slowest by far is cladding, as each individual cladding strip will need to be attached to the wall, and you may also wish to paint your cladding afterwards.

You may have seen lots of photos on Instagram of empty vans fully clad, creating a lovely photogenic empty shell to work on. The reality is it may not be a good idea to clad your van as one of the first jobs you do. Although it's definitely easier, you'll be adding a considerable amount of extra weight to your van, and spending more money too. There's a lot of space, for example behind kitchen cabinets, that you don't need to clad, and by doing this job first you will be adding unnecessary weight.

Your flooring options are equally simple. We'd recommend you use a 12mm thick piece of ply on top of the floor insulation and then apply either carpet, laminate or vinyl flooring to finish. The decision once again is purely down to personal preference. However, it's worth remembering that hardwood flooring can be quite heavy so if you have a large van it's worth either only applying it in visible areas or sourcing something a bit thinner. Wood laminates can be applied straight on top of your van's insulation. There is no need for additional underlay as this is primarily used to prevent moisture from damaging the wood if it's laid directly onto cold concrete subfloors. For obvious reasons, concrete is not a recommended flooring option in any van conversion!

The floor can be laid once you have insulated, and will provide a stable and hopefully level platform for you to build from. As this cosmetic element of your build gets laid very early on, it may be wise to temporarily cover visible areas with cardboard and taped in place, this will hopefully protect your floor as you traipse in and out of the van with various supplies.

OPPOSITE Beth's beautiful build combines a natural cladded ceiling, parquet flooring and clean, ply lined walls. *@sheisthelostgirl*

Electrics

For many, the electrical system is the most daunting part of the build, and it's typically also the most expensive! Understanding the fundamentals of how electrical systems work will allow you to establish what equipment you need and how products interact with one another. The number of options may feel a little overwhelming, but we've broken everything down to help you understand it. The design chapter will include three example systems to help you visualise how everything works.

If you get to the end of this section and feel lost, don't worry, you have a few options. You can employ a professional to install your system, you can use a consultancy service to design your system for you, or you can buy an all-in-one solution. We'll explain more about each of these options at the end of this section.

How does electricity work?

Electricity is defined as the flow of electrons in a material. This is referred to as electrical charge, or 'current', measured in amps. Voltage is defined as the potential energy in a system, which is required to make the current flow. Think of it like a river. The height difference between the top of a mountain and a lake at sea level makes water flow downstream and fill the lake. The current is analogous to the litres of water in the river, and the voltage is like the height difference - without it, the river would not flow. You can measure the flow of current per hour by using the amp hour (Ah). Electrical power is measured in watts (W). All devices will have a power rating in watts to tell you the power consumption of the device.

The three are related using the electric power formula:

$$P = I\ V$$

Watts = amps x volts

Another electrical unit that's useful to understand is the ohm, which measures resistance in a circuit. When electrical current passes through a material, it reaches a certain resistance. Voltage, current and resistance are related to each other.

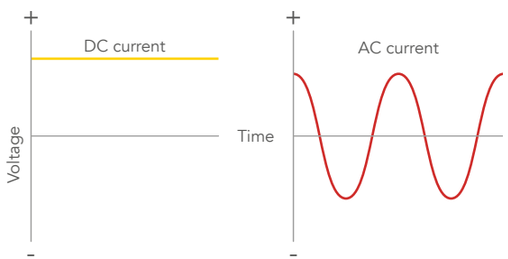
- When resistance is low, many electrons can move and so the current is high
- When resistance is high, fewer electrons can move and so the current is low
- When resistance is very high, no electrons can move and so there is no current

The resistance of a material determines how much current can run through it at a given voltage. This relationship is called Ohm's Law:

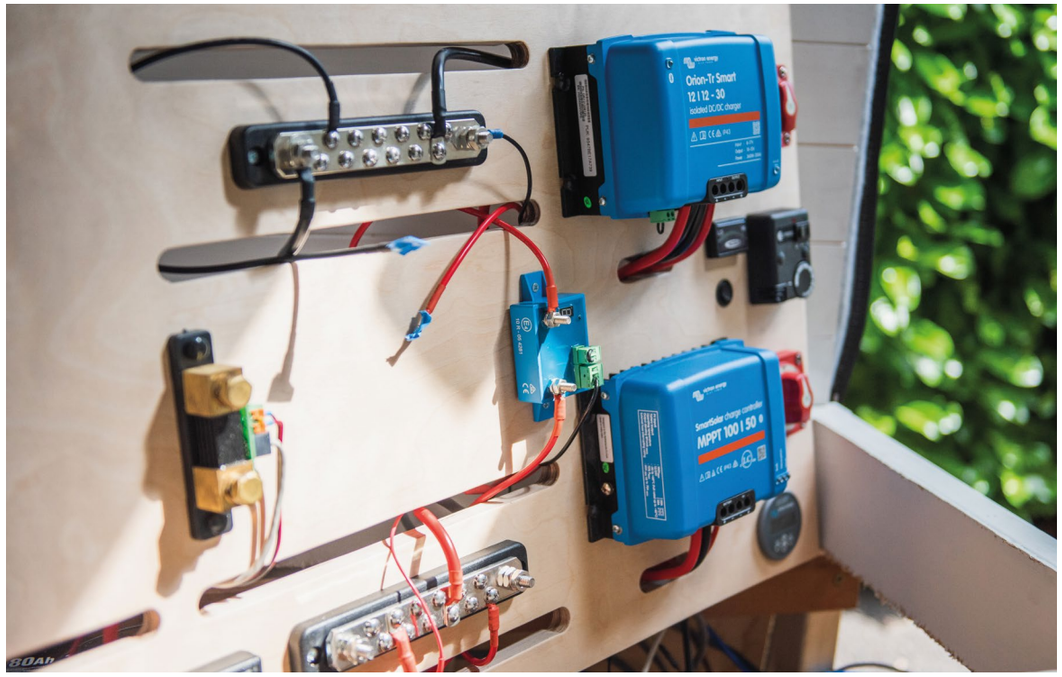
$$V = I\ R$$

Volts = amps x ohms (Ω)

Whilst mains electricity you find in a house is usually 230V (in most European countries) and has an alternating current (AC), the standard voltage of a car or leisure battery is 12V and has a direct current (DC). DC current is converted into AC current by using a current inverter. This is a device which takes the straight line of a DC wave and converts it into an alternating line of an AC wave. Without an inverter, you will not be able to charge any products that require an AC current.

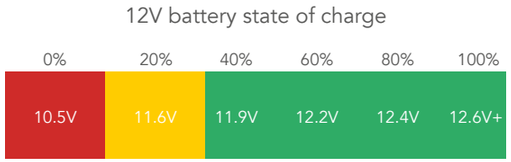


CHARLIE SAYS:
Sorry if this is giving you flashbacks to school Physics lessons; you might have rolled your eyes at this in the past wondering when it was ever going to be useful, but now that moment has finally come! It's important to understand the basics of how electricity works before going into detail on the different systems. Without understanding the basic principles, it will be difficult to design something that works and install it safely. It would be a bit like converting a campervan before you're able to drive!



12V electrics

Let's start with a simple 12V system - this is the voltage of a standard car battery, and uses direct current (DC) electricity. When you plug your phone into your cigarette lighter in your car to charge it, you are using 12V power, whereas when you plug your phone into the wall socket at home, you are using 230V alternating current (AC) electricity (in most of Europe, in other countries this voltage may vary). So if all you want to do in your van is charge your phone, run some lights and perhaps install a fridge, you can keep it simple and use 12V. Most appliances built specifically for a caravan or boat such as the Dometic fridge that a lot of people install in their builds are 12V for specifically this reason.



12V is the nominal voltage of the leisure battery. The nominal voltage just means the named voltage, which is a way of designating a specific voltage value to the battery. But what does that actually mean? It means that it's not the exact voltage of the battery - if you use a multimeter to measure the voltage across your leisure battery, it will give a reading higher than 12V if the battery is fully charged. You can use the exact voltage of your battery to find out its state of charge.

ABOVE The beginnings of our electrical system board, which holds all of major components and keeps the mass of cables neat and organised. *@climbingvan*

It's possible to install a 24V or even a 48V system by connecting your batteries in series instead of in parallel. However, in a campervan you'll most likely have a 12V leisure battery to charge your system, and most campervan appliances are 12V. Using a 24V or 48V system would mean you would have to increase the voltage to charge the batteries and decrease it to power appliances, which would be inefficient and is therefore not advised.

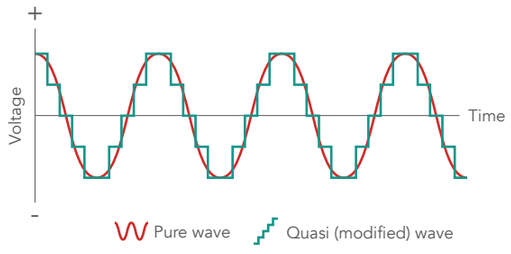
230V electrics

Things get slightly more complicated when you want to plug in a domestic appliance, such as charging a laptop or powering a hairdryer. These devices require more than 12V (e.g. a laptop charger will use somewhere between 20-25V) and usually have a mains plug connected, designed to plug into a wall socket in a house. To use these appliances, you will need to install an inverter or be connected to shore power (more on that soon). You can purchase a 12V laptop charger; however, these will not charge your devices properly as a laptop requires a higher voltage to charge. Therefore, we'd recommend you instead use one of the following methods of powering 230V appliances.

Inverters

An inverter converts the DC electricity from the leisure batteries into AC electricity, and converts the 12V input voltage to the desired output voltage depending on your country.
The two most popular types of inverter are:

- Quasi (modified) sine wave
- Pure sine wave

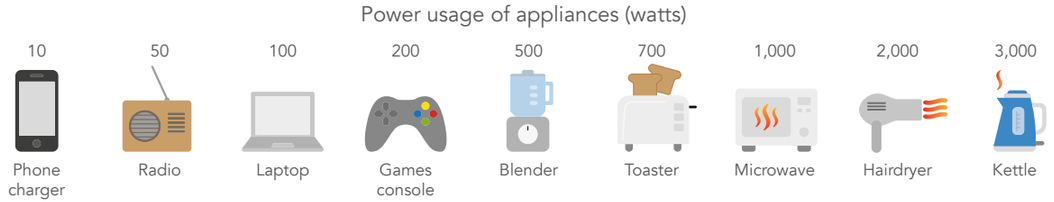


The quasi sine wave inverters create an approximation of the AC waveform found in household wall sockets, whereas a pure sine wave inverter exactly reproduces the AC waveform. Quasi sine wave inverters will be able to run basic electrical items such as kettles, hairdryers, laptops and blenders, but they'll struggle to run certain appliances such as sensitive electrical devices. It's therefore worth checking the appliances you plan to power before purchasing an inverter. The main benefit of a quasi sine wave inverter is that they are much cheaper because they don't require the complex systems necessary for creating a smooth wave.

The other factor that will affect the inverter you choose is its wattage. The wattage of the inverter needed will be dependent on how many appliances you want to power from your inverter at the same time. To work out which inverter to buy you will need to calculate your total expected wattage at any one time. It's not simply a case of buying the inverter with the highest wattage, as the higher the wattage, the bigger and more expensive the inverter will be, and a bigger inverter will also have a larger idle power draw (the power it uses when not in use).

Therefore it's important to calculate your own usage to decide which inverter to buy. We'd also recommend adding a factor of safety to your calculation to future proof your system. If you can afford to increase the wattage, this will allow you to power future christmas presents and impulse purchases!

When you're researching inverters, make sure you compare like for like. As well as the continuous wattage rating, an inverter has a 'peak power' rating that details the wattage it can sustain for a few minutes at a time. Cheaper inverter manufacturers tend to advertise this figure, whereas higher quality brands will advertise the continuous rating, and detail peak power separately (which can be up to double!).



We've included the typical wattage of some commonly used appliances at the top of the page to give you an idea of just how much power some products can draw!

Shore power

Shore power, sometimes known as mains electric hook up, uses a socket fitted to the outside of your van to connect to an electric hook up at a campsite, or even your own power supply at home. The socket is connected to a consumer unit, much like a domestic fuse box. This an important safety device to stop you from being electrocuted if there's an earth fault in the system. You can power your 230V devices using shore power via the consumer unit.

It's worth noting that most campsites have an electricity supply of 10A (2300W) or 16A (3680W). If you exceed this total wattage, you will trip the charging post and likely be charged to restore the supply to your pitch.

Batteries

Your batteries will likely be one of the most expensive single items within your van build. It can feel like there's an overwhelming amount of options, and it's easy to end up spending much more than you need to due to confusing information online. In the next few pages, we'll help you cut through the noise by using data to provide definitive answers.

Calculating expected battery usage

The amount of electricity you use directly correlates to the size of the battery bank and type of batteries you require, so you should work out your expected usage early on. To do this, make a list of all the appliances you will use in your van, and calculate the amp hours for each appliance using the equation:

Watts ÷ volts = amp hours

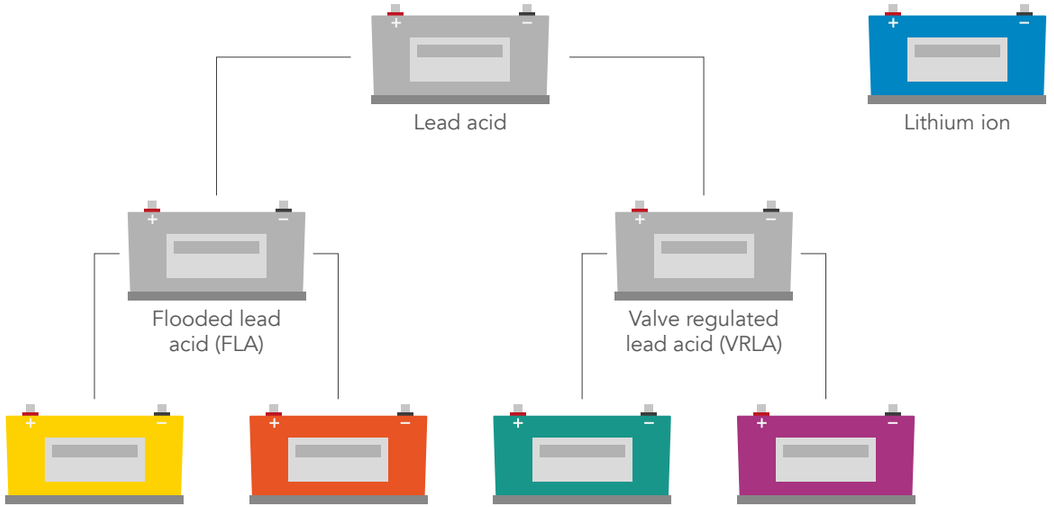
The voltage will be 12V as this is the voltage of your batteries, and the wattage will be the total wattage of each appliance. Once you have calculated the amp hours for each product, you will need to multiply by the usage (the total hours the appliance will be in use for each day):

Ah x usage (hrs) = Ah/day

Add up the Ah/day of each product to calculate your total daily usage.

Example daily usage

Appliances	Qty	W	Ah	Usage (hrs)	Ah/ day
Fridge	1	11	1	12	11
Laptop charger	2	61	5	2	10
Phone charger	2	10	0.8	7	6
Camera charger	1	53	4	2	9
Speaker	1	20	2	1	1
Spotlights	10	8	1	8	5
Fairy lights	1	3	0.3	8	2
				Total	**44**



When calculating the size of your battery bank, you will need to consider how you will charge your batteries, which will vary based on your charging method (we'll go into more detail on this later). You should ensure you have a big enough battery bank to last for at least two days at your daily power usage without charging. If you are planning on spending time off-grid and will be relying mainly on solar power, you may want to ensure you have enough power for three or four days without charging your batteries as a worst-case scenario.

It's also important to bear in mind that depending on the type of battery you choose, you will only be able to access around 50-95% of the total battery capacity (we'll explain why shortly), so you'll need to factor this into your calculations. In the example, if you were installing AGM batteries and you wanted three days of power without recharging:

44Ah daily usage x 3 days =
132Ah required capacity

As AGM batteries can only be discharged up to 80%, you should divide your calculated capacity by 80% (0.8) to calculate the total battery bank size required:

132Ah ÷ 0.8 = 165Ah battery bank

The value you need to divide by will vary depending on the battery type. You can use the lookup table below to figure out which value to use:

Usable capacity

	Flooded lead acid	AGM & Gel	Lithium
Usable capacity	50%	80%	95%
Divide by	0.5	0.8	0.95

If you are planning on spending a lot of time on a campsite with shore power, you won't need such a big difference between daily usage and total the amp hours of your battery bank. However, it's worth remembering if you do end up wanting to spend more time off-grid, you may need to increase your battery bank size, so it's always a good idea to think ahead and future proof your system. We'd therefore recommend you have the capacity for at least a couple of days power usagewithout charging. So, using the example daily usage in this scenario:

44Ah daily usage x 2 days =
88Ah required capacity

88Ah ÷ 0.8 = 110Ah battery bank

So now you know how to calculate the size of battery bank you will need, you can start to get your head around the conundrum that is the different types of leisure battery available! It may all seem a bit confusing, but we'll include a summary of our recommendations at the end.

Types of leisure battery

The most common types of leisure battery available are made using either lead acid or lithium ion, and there are several subtypes of lead acid battery available (opposite). Each type of battery has a typical lifecycle, which can be used to calculate the battery's expected lifespan based on a certain level of usage.

Glossary

Starter battery: A vehicle uses a starter battery to start the engine on ignition. These batteries are designed to deliver short, high discharge currents and are therefore not suitable for campervan electrical systems.

Leisure battery: A leisure battery is designed to provide a steady current flow over a long period, and can be discharged to 50-95% of the total battery capacity.

Depth of discharge (DoD): How much of a battery's total capacity can be accessed (e.g. a 50% DoD for a 100Ah battery would mean the battery could be discharged to 50Ah).

Lifecycle: The total number of cycles a battery can achieve in its lifetime at a given DoD.

Cycle: One cycle is complete when a battery goes from 100% to the specified depth of discharge (e.g. for a 50% DoD, one full cycle would discharge a battery from 100% to 50%).

Standard flooded lead acid

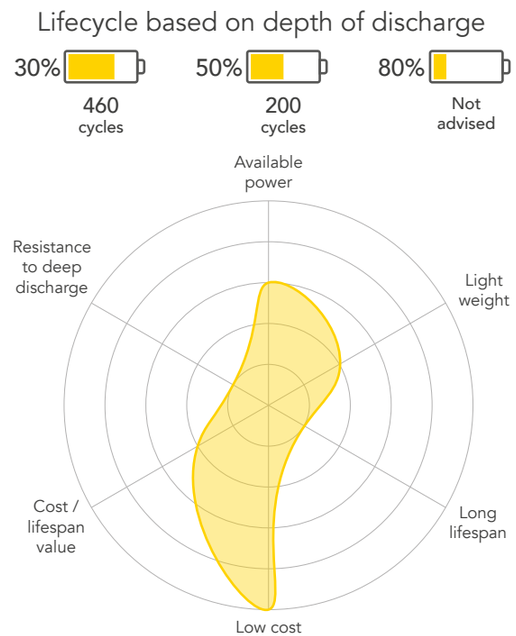
For a long time in the caravanning and boat world, the most common type of battery was the flooded lead acid battery. These batteries are 'flooded' with a liquid electrolyte (a substance that conducts electricity), which means they need to be mounted upright. They also need to be maintained regularly by topping them up with de-ionised water. When almost fully charged, flooded lead acid batteries produce hydrogen gas, and so it's important to mount them in a well-ventilated area.

PROS

- Low upfront cost
- Not as sensitive to overcharging

CONS

- Regular maintenance required
- Can only be mounted upright
- Heavy
- Permanent damage caused if battery discharged below 50%
- Risk of battery acid spillage



Sealed flooded lead acid

Sealed flooded lead acid batteries, sometimes referred to as maintenance-free flooded lead acid, work in a very similar way to their flooded lead acid counterpart. However, they are completely sealed, which means they don't need topping up and there is no risk of spillage. They're more expensive than standard flooded lead acid batteries, but are almost always used instead due to their maintenance-free attributes. The main downside of flooded lead acid batteries is that they can only be discharged by 50%.

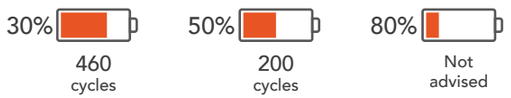
PROS

- Lower upfront cost
- No maintenance required
- Not as sensitive to overcharging

CONS

- Can only be mounted upright
- Heavy
- Permanent damage caused if the battery is discharged below 50%
- Relatively short lifespan

Lifecycle based on depth of discharge



Gel

Gel batteries use a thick paste which contains the electrolyte, meaning they can be mounted in any orientation and don't require maintenance. They are less sensitive to deep discharging - where flooded batteries should only be discharged to 50%, gel batteries can be 'deeply discharged' up to 80% (however they have an increased lifespan when discharged less than this). Gel batteries perform best in hot weather applications. However, they need to be charged in a very specific manner, and are extremely sensitive to overcharging, meaning it's quite easy to cause irreparable damage.

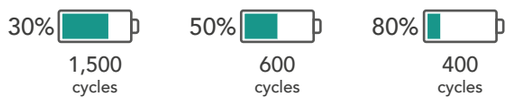
PROS

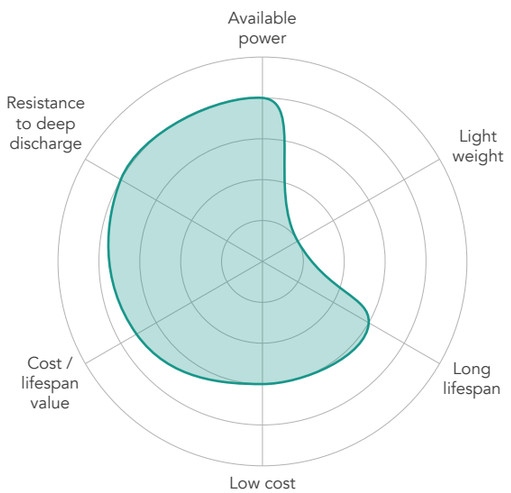
- No maintenance required
- Can be deeply discharged
- Best for hot climates
- Longer lifespan

CONS

- Higher cost than other lead acid batteries
- Very sensitive to overcharging
- Very heavy

Lifecycle based on depth of discharge





OPPOSITE Some impressively organised and tidy wiring, no mean feat in a van conversion! *@slowlywild*

AGM

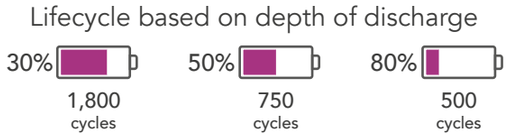
AGM batteries are a popular choice of leisure battery. They have a thin fibreglass mat containing the electrolyte so they can be mounted on their side, and require no maintenance. AGM batteries are only slightly more expensive than good quality flooded batteries. They are more sensitive to overcharging, however, like gel batteries, they have a longer lifespan and can be deeply discharged. AGM and gel batteries are often perceived as similar, however AGM batteries currently outsell gel batteries at a rate of 100:1, as they are much less sensitive to overcharging.

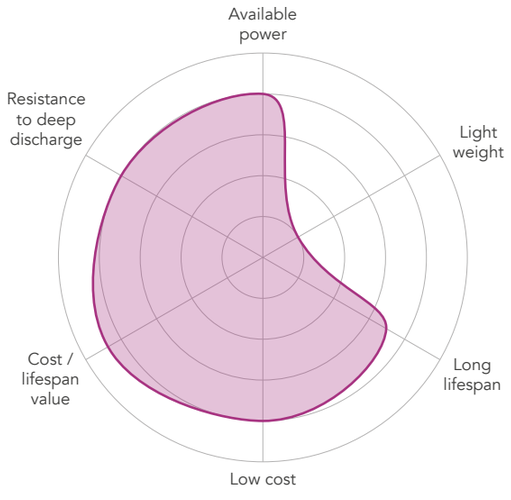
PROS

- No maintenance required
- Can be deeply discharged
- Best for cold climates
- Longer lifespan
- Best value lead acid battery

CONS

- Sensitive to overcharging
- Very heavy





Lithium ion

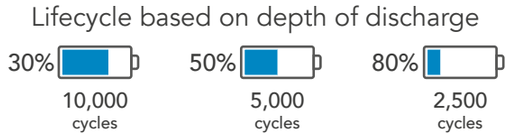
Lithium ion batteries have a much longer lifespan than any other battery on the market, and they can be very deeply discharged, which means you don't need as large a battery bank to access the same power usage. It's possible to discharge a lithium battery by 97% without damaging it. They weigh less than half of a lead acid battery with the same power capacity, and they're much smaller too. However, they do have a high initial cost. Lithium batteries do not perform well in cold climates as they cannot charge below 0°C, however heated versions are available to alleviate these issues.

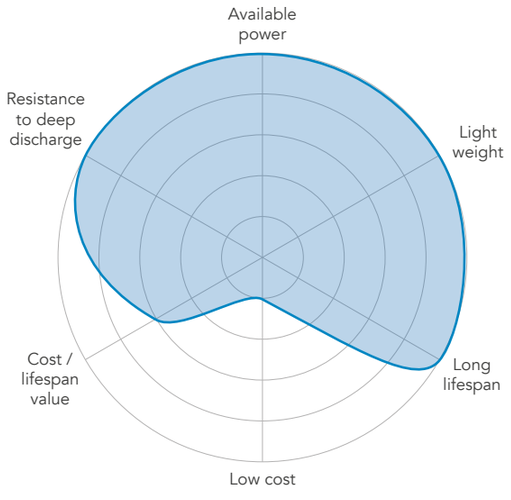
PROS

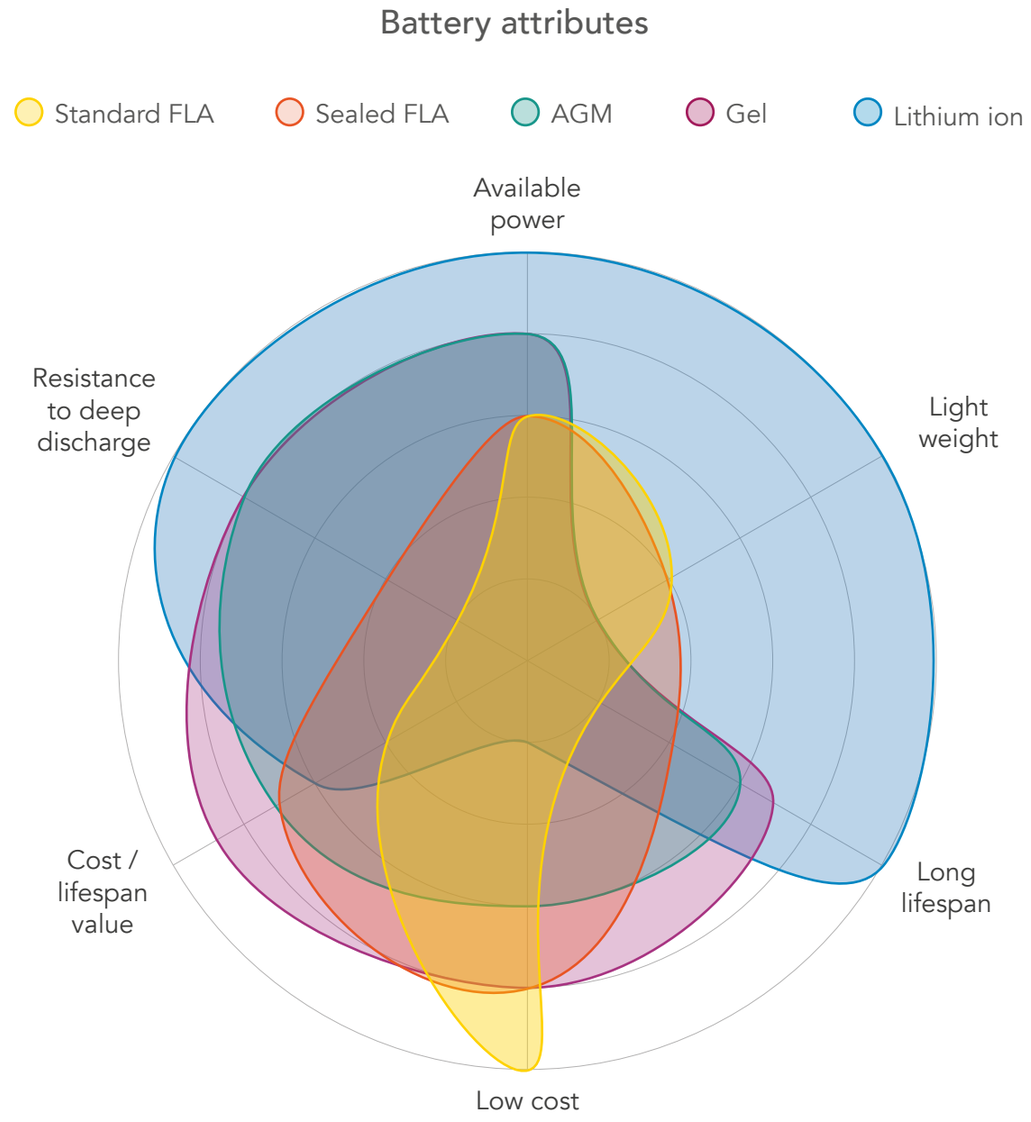
- No maintenance required
- Lightweight
- Can be very deeply discharged
- Extremely long lifespan

CONS

- Higher cost than other lead acid batteries
- Sensitive to overcharging
- Sensitive to cold temperatures



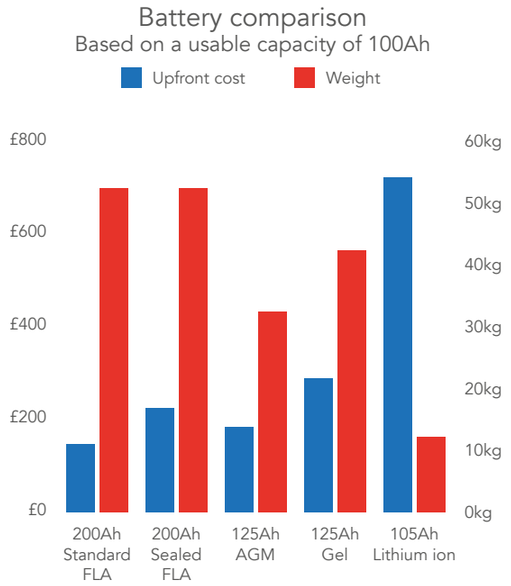




Battery comparison

You may be confused by the term 'usable capacity'. In the descriptions of each battery type, we included the lifecycle of a battery at three different discharge depths. Although you can discharge gel and AGM batteries down to an 80% DoD, if you plan on full-time van life, it's recommended that you only discharge them regularly by 50-65% to increase their lifespan.

However, as the lifespan of a lithium battery is so high, regularly discharging it by 80-95% will still give you a far longer lifecycle than what would ever be needed in a campervan scenario. This means that you can buy a lithium battery with a lower amp hour rating than its lead acid counterparts to access the same 'usable capacity'.



When looking at the graph above, it's interesting to see that the upfront cost of an AGM battery is actually cheaper than that of sealed FLA when looking at usable capacity. As AGM has triple the cycles of sealed FLA, this makes it the more cost effective choice. It also quickly becomes obvious that although there is some variation in cost and weight between the lead acid batteries, the outlier on both fronts is lithium. A lithium battery with the same usable capacity as an AGM battery weighs almost three times less. However, that weight saving comes at a premium, with the lithium battery costing over three times more than the AGM.

But price and weight are only half the picture. Before you can decide on the right type of battery for your application, you will need to know your daily usage (which you should have already calculated) and the frequency you will use your campervan. You can combine these to calculate your overall average usage, to work out the lifespan of each battery in years. You can use the values in the table to help you calculate your average usage.

Average usage

	High frequency Full-time van life	**Medium frequency** Frequent weekend & holiday trips	**Low frequency** Occasional weekend trips
Divide by	1	4	10

Example

You have previously worked out your daily usage as 44Ah. You will use your campervan most weekends and for longer holidays. To calculate your average usage:

44Ah daily usage ÷ 4 (medium frequency) = 11Ah average usage

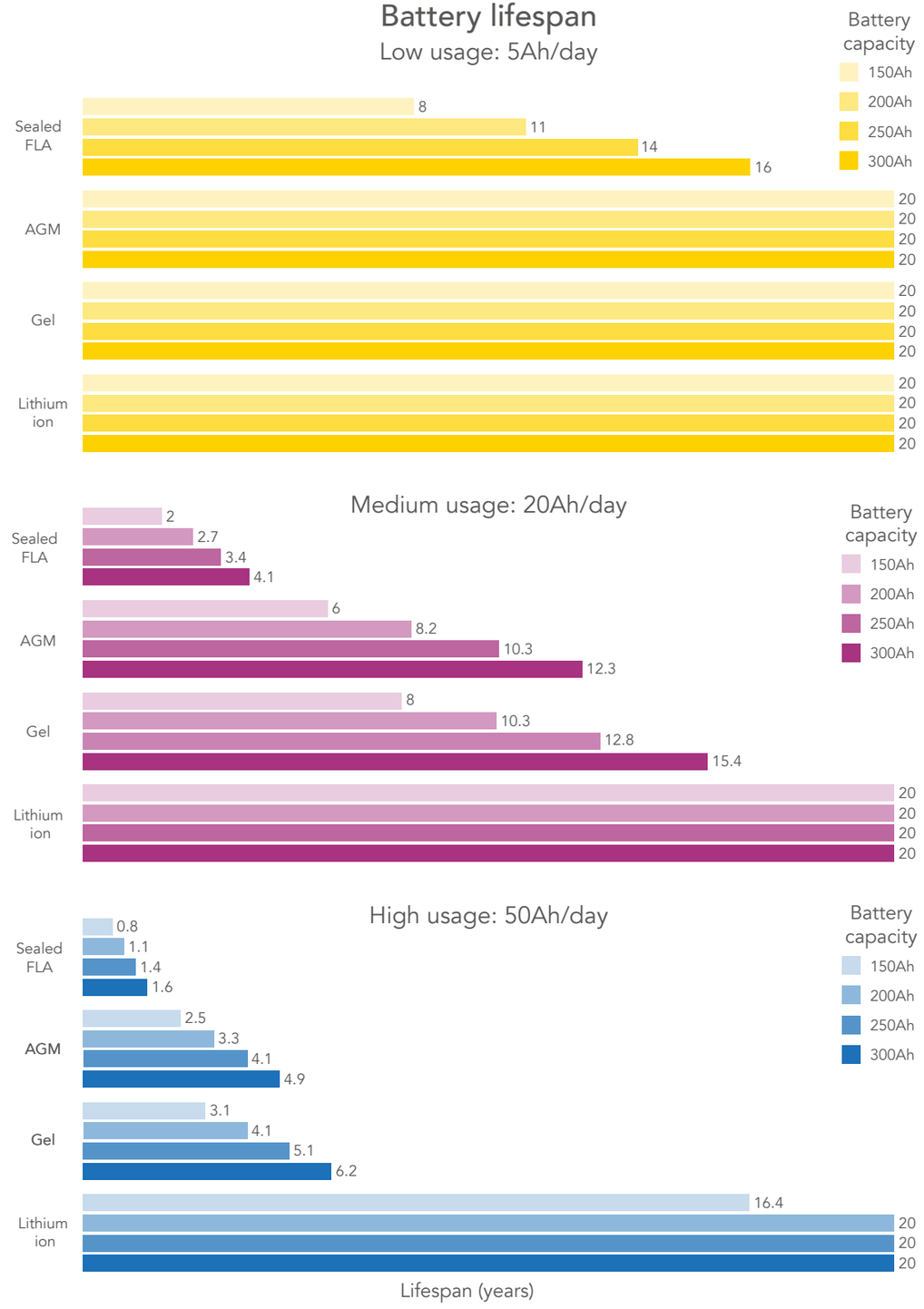
Once you have calculated your average usage, you can see which group you fit into:

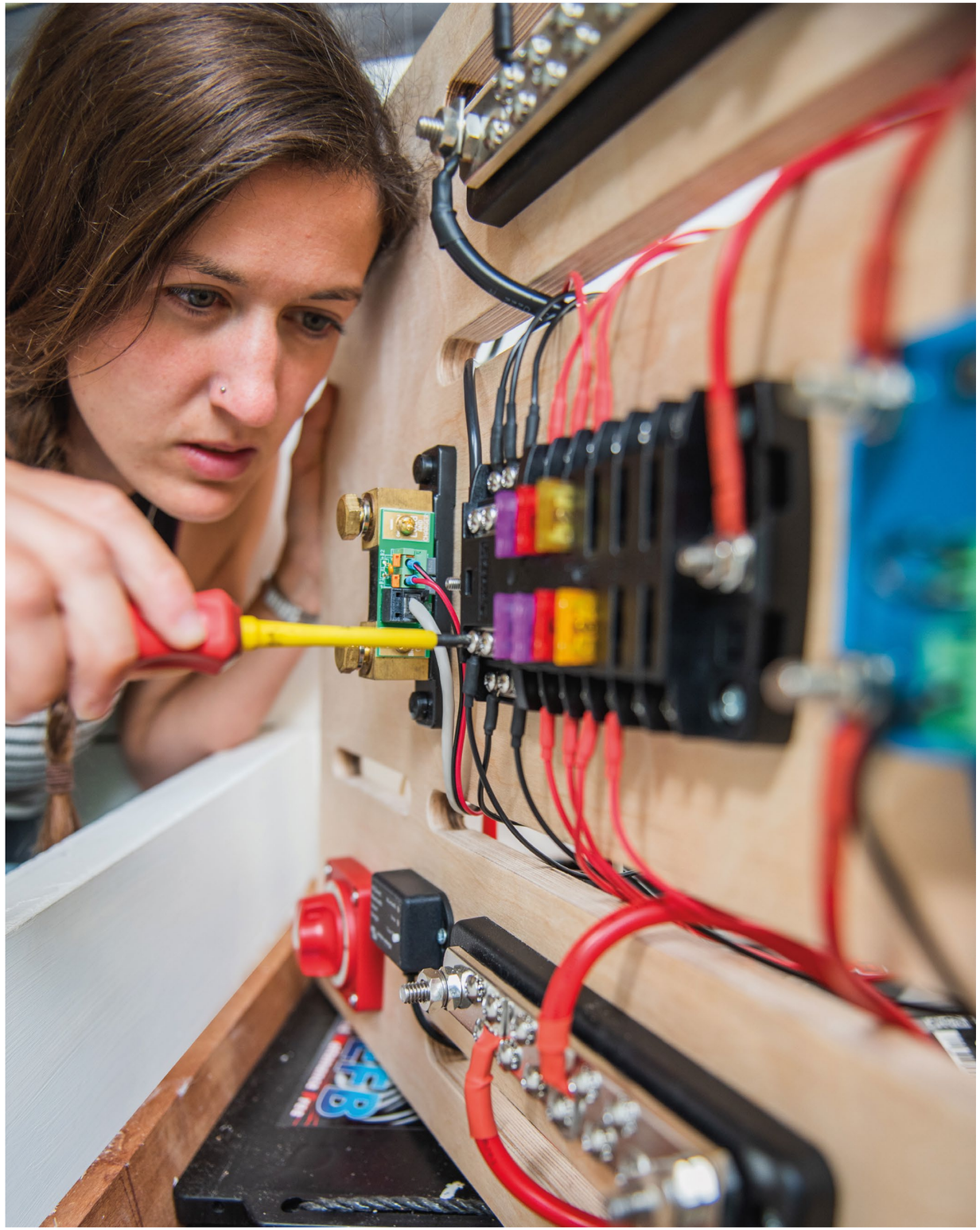
- High average usage = 50Ah daily usage
- Medium average usage = 20Ah daily usage
- Low average usage = 5Ah daily usage

If you sit somewhere between these values, pick the one you're closest to for the best approximation of your battery lifespan. Your average usage and your battery bank size can help you decide what type of battery will be most suited to your circumstances. Simply refer to the relevant battery lifespan graph for your usage level.

The battery lifespan graphs show the lifespan in years of each type of battery based on the level of usage and the size of the battery bank. The larger the battery bank, the longer the lifespan of the battery, as it will take longer to discharge the battery. Having a rough idea of how long you might use your campervan for at your average usage level will help you to decide the type of battery you should use.

Although the theoretical lifespan of some of these batteries is much longer than 20 years (in the case of lithium, it can be well over 100 years





depending on usage!), the graphs cut off at 20 years. This is because batteries degrade over time due to corrosion of the positive plate, which happens as a battery is charged. This is a slow but continuous process over the lifetime of a battery, and will eventually disintegrate the positive battery plates. It's therefore very unlikely that any battery would have a lifespan of more than 15-20 years.

Battery analysis

When comparing batteries, there are several attributes to consider. Although a flooded lead acid battery can have an adequate lifespan for some campervan applications, the upfront cost of an AGM battery with the same usable capacity is actually lower. This means it usually makes sense to opt for AGM over sealed FLA.

When pondering the question of different battery types, it's important to consider the likely lifespan of the vehicle itself, as well as your usage.

It starts to make sense to consider lithium batteries over AGM batteries when your usage will be high, such as with full-time van life, and you will keep your van for a number of years. In this instance, depending on the battery bank size, your batteries may need to be replaced after three to four years. If you can afford the increased upfront cost, in this scenario it would make sense to opt for lithium. Lithium may also be favoured in scenarios where the weight and space saving is important, for example if you're trying to fit your battery bank into a very specific space.

Battery recommendations

Flooded lead acid: Not recommended due to the required maintenance.

Sealed flooded lead acid: Not recommended due to the upfront cost being higher than that of AGM for the same usable capacity.

Gel: Not recommended for most applications due to the specific charging requirements and sensitivity to overcharging. May be relevant for campervans in extremely hot climates.

AGM: Recommended for most campervan applications with low to medium usage, or high usage if you are happy to replace the battery after a few years. Also the best choice for very cold climates.

Lithium ion: Recommended for high use applications where the van will be kept for several years and you don't wish to replace your batteries. Also recommended for those with very specific space and weight requirements.

CHARLIE SAYS:

It's important to note that when we have included figures for sealed lead acid batteries, these are for high quality batteries. There are many cheap sealed lead acid batteries on the market that do not perform as well as they claim, so you should source your batteries from a trusted battery manufacturer who produces high quality products.

Battery monitors

When you have spent so much money on your batteries, it's important to make sure you look after them properly. An important component of the electrical system is a battery monitor, which can range from a simple voltmeter costing around £10, to a much more sophisticated battery monitor. Battery monitors are key to ensuring you don't deplete your batteries below their recommended depth of discharge by providing an accurate account of the battery's state of charge.

Where a cheap voltmeter will only show you the voltage of your battery to a single decimal place, a more sophisticated battery monitor such as the Victron BMV-712 will be able to monitor the health of your battery to much

OPPOSITE Charlie putting her physics degree to use! *@climbingvan*

higher precision. As well as providing readings of voltage and current, it will measure amp hours used, the temperature of your battery, the exact percentage charge your battery is on, and a predicted time remaining until your battery bank is depleted if not charged based on your usage. It will also allow you to connect via Bluetooth so you can monitor your batteries via your phone. The Victron Smart Shunt also provides all of this information just via the app, without the addition of the screen.

It's important to be aware that with simple voltmeters, the voltage reading is heavily influenced by the loads on your batteries, such as charging via solar and discharging via appliances. When your batteries are being charged by the sun, the voltage reading on the voltmeter can exceed 13V. However, when the sun dips below the horizon, it can take a couple of hours for the voltage reading to level out and reflect the true state of charge. As soon as you switch on a light or plug in your phone, this will also start to influence the voltage reading. This is why a more sophisticated battery monitor is wise, as they monitor your power usage and use a number of other factors to accurately calculate your state of charge.

Battery protection

As we have previously discussed, batteries can be permanently damaged or have their lifespan significantly reduced if they are discharged below a certain level. Good quality electrical components can be programmed to protect both under and overcharging. However, for some parts of your system where this is not otherwise possible (e.g. 12V loads), it's a good idea to include a device such as a BatteryProtect. This allows you to define a cut off voltage at which the device will automatically disconnect the loads from your battery, helping to guard against depleteing them to dangerous levels.

If you are investing in a lithium battery bank, it's imperative that you protect it with a BMS (Battery Management System) which helps to prevent over and undercharging. Whilst some lithium batteries have a built-in BMS, others that don't will require you to install a separate module to protect against this.

Charging your batteries

Having a massive battery bank is useless if you're not able to keep them charged. There are several different options to keep your lights on and your beer cold! You are probably aware of solar power as a method of charging campervan batteries, but you may not be familiar with the concept of charging them whilst driving. You can use a device called a voltage sensing relay (VSR) or a battery to battery charger to harness the power from your vehicle's alternator as you drive around to charge your leisure batteries.

For those who will spend most of their time on campsites, you can also install shore power as mentioned previously. As well as powering your 230V appliances, it can also be used to charge your leisure batteries via a battery charger.

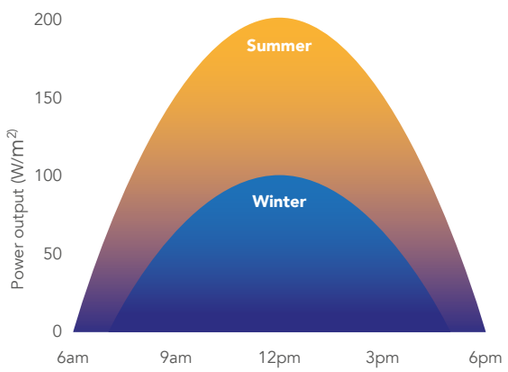
ABOVE The Victron app is incredibly useful for checking on your batteries after a long day working in the van. *@climbingvan*

Solar panels

Solar panels are an obvious choice for most van conversions wishing to spend time off-grid. A solar panel contains a group of photovoltaic cells made from a material such as silicon. When particles of light (photons) reach the solar panel, they knock the electrons within the silicon free, generating electricity. Solar panels are a great choice for van life because the sun is essentially an endless source of power, making them perfect for charging your batteries.

And the downsides? Although solar panels do still work if it is cloudy, they're a lot less efficient. On a hazy day where a thin film of cloud covers the sun, the efficiency will decrease to around 50%, and on a day with heavy cloud and rain, you're unlikely to get any power from your panels. The angle of the sun on the panels will also affect the power output of the panels, meaning you'll get less power from your solar panels in winter than you will in the summer, as the sun will be lower in the sky.

Solar panel output throughout the day



The solar panel output graph will give you an idea of solar panel efficiency throughout the day. When the sun is directly above your solar panel, you will get the highest output, whereas in the morning and afternoon when the sun is lower in the sky and hitting the panels at an angle, the output will be much lower.

Flexible versus rigid solar panels

When deciding on what panels to install on your campervan, you have a choice to make. There are two types of solar panels available: flexible and rigid.

Rigid solar panels are more traditional, and are typically made of either polycrystalline or monocrystalline cells. They tend to have an aluminium frame and a protective glass facade which protects them from damage and the weather. Rigid solar panels are mounted to the roof of your campervan using mounting brackets, and tend to be pretty efficient.

PROS

- Very efficient
- Resistant to damage
- Long lifespan

CONS

- Heavy
- Trickier to install

Flexible solar panels are lightweight, thin and bendable, making them easy to mount to your campervan roof. They're typically glued or taped to the roof of a van. As they have a low profile, they're generally not visible from ground level. This makes them a good choice if

you plan on building a campervan that you will use for a cheeky bit of stealth camping! They can also be useful if you have an older van with an undulating or very curved roof profile that might make fitting standard panels difficult.

However, the application of glueing the panels directly to the roof can cause problems. It's generally recommended solar panels are mounted with a gap between the panel and the roof of the van to keep the panel cool and avoid creating a heat sink, as this will prolong the life of the solar panel.

PROS

- Hard to see from ground level
- Lightweight
- Easy to mount on a variety of roofs

CONS

- Less efficient
- Prone to damage
- Generally shorter lifespan

If you plan on using solar power as your primary source of power, we'd recommend you use rigid solar panels, as they are more efficient, more durable, and usually come with a longer warranty. The only exception to this is if you put stealth camping as a top priority, or if you have a roof unsuitable for mounting a rigid panel to. It's more suitable to use a flexible solar panel if you are only using it occasionally as a backup power source, and you may wish to store them inside your campervan rather than permanently mounting them to the roof.

Calculating how many solar panels to install

The number of solar panels you install will directly affect how quickly your batteries are charged. To work out how many solar panels you will need to charge your batteries, you will need to use the equation:

$$Wh / W = h$$

Where:
Wh = Watt hours of your batteries
W = Total wattage of your solar panels
h = Hours to charge your batteries

To calculate the watt hours of your batteries, simply multiply the usable capacity in amp hours by 12 (Ah x V = Wh). This will give you the total Wh you will need to fully recharge your batteries from their lowest state of charge. As the total output of the solar panels can be affected by several factors, including the angle of the sun (i.e. time of day and year) and cloud coverage, you should presume that there will be a 40% loss in effectiveness in your calculations.

Example
To calculate the watt hour capacity of 250Ah battery bank with 200Ah usable capacity:

200Ah x 12V = 2400Wh

2400Wh x 1.4 (40% loss) = 3360Wh

Once you know how many watt hours would be required to recharge your batteries, you can work out how long it would take to charge them using a different number of solar panels. To calculate how long it would take to charge your example batteries using a 100W solar panel, simply divide the total watt hours needed by the wattage of the solar panel.

3360Wh ÷ 100W = 33.6 hours

As there is an average of 12 hours of sunlight per day in summer, this would take over 2.5 days to recharge the 250Ah batteries in the example. Repeating the calculation with a 300W solar array provides a more favourable recharging time.

3360Wh ÷ 300W = 11.2 hours

It would take less than a day to recharge the batteries from 20% full. If you plan on living in your van full-time, it's worth repeating the calculation for winter, where there are only seven hours of sunlight per day, and the sun is much lower in the sky (reducing power output from your panels to around 50% of what it would be in the summer). As this is the case, you will need to multiply your answer by two.

Example

11.2 hours x 2 = 22.4 hours

22.4 hours ÷ 7 hours = 3.2 days

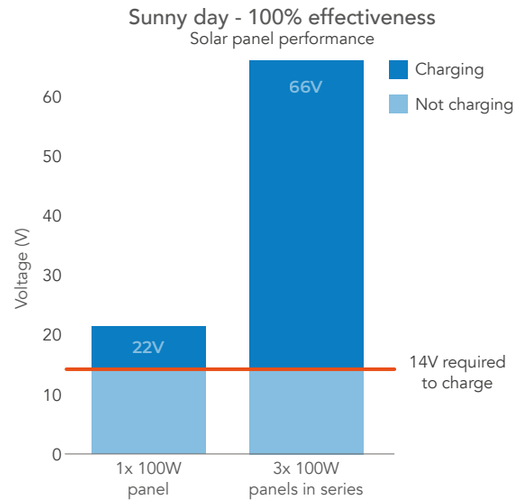
This highlights the importance of having enough solar panels, as a setup that will fully charge a battery bank from 20% to 100% in one day over summer will take almost three days in winter. Obviously, you're unlikely to discharge your batteries from 100% to 20% in a day (or if you are you probably need a bigger battery bank!), but if you're dealing with a lot of rainy days and aren't able to recharge often, when the sun comes out you will want to recharge your batteries as quickly as possible.

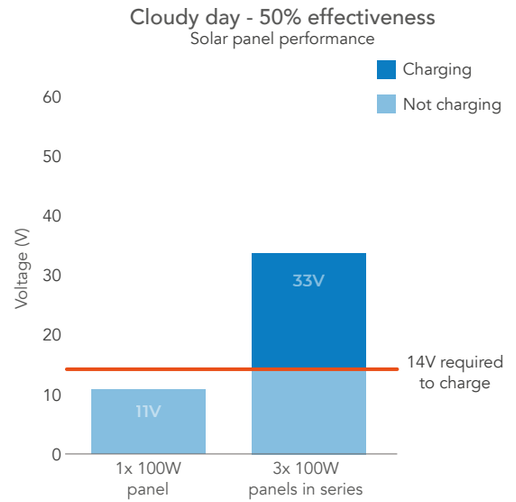
If you're only planning on spending one or two days in each area, you can use a VSR or battery to battery charger to charge your leisure batteries via your starter battery, and so you may not need as many solar panels. If you plan on spending a lot of time on campsites connected to shore power, you may only wish to have a single solar panel as a backup.

What's the smallest panel I can install?

If solar power will be your backup method of charging, you may be tempted to install a single 100W solar panel, as the majority of motorhomes do. However, there is a fundamental reason why this is not a good idea. If you live in a cloudy climate (such as the U.K. and much of Europe!), you will struggle to achieve the required voltage to charge your batteries on a cloudy day.

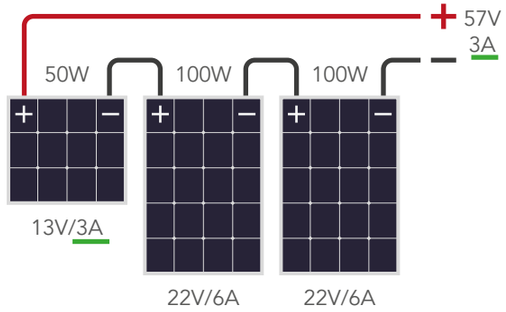
On a sunny day when your 100W panel is close to 100% effectiveness, it will output around 22V, whereas three 100W solar panels wired in series will output 66V. On a more overcast day when your panel is only 50% effective, it will only output 11V, where the 300W solar array will still output 33V. The issue here is that a voltage of around 14V is required to charge your batteries. This means that as soon as your solar panels are below 65% effectiveness, you will not gain any charge from a 100W solar panel. This is why we would always recommend you install a 200W solar array as a minimum.





Can I use different size solar panels?

Mixing solar panels with different ratings is inadvisable. When you connect different size solar panels, they're only able to draw the current of the lowest panel in the series. This means that the power draw of the panels is severely limited and you will not be able to achieve the combined wattage of the panels. The only way around this is to install an additional charge controller for each different set of solar panels, which would be a costly solution to an avoidable problem.



Example

In the solar panel diagram, the current is limited to 3A. This means the total wattage of the panels would be limited. To calculate the wattage, first work out the total voltage:

13 + 22 + 22 = 57V

Next, multiply the voltage by the current of the smallest panel to calculate the total wattage:

3A x 57V = 171W

But the total wattage of the panels should be:

50 + 100 + 100 = 250W

171W ÷ 250W = 68%

This means the panels would only achieve 68% of their potential power, which is massively inefficient. You should always try to buy panels of the same size to avoid this issue.

Wiring in parallel or series

Solar panels can be wired together in series or parallel. Deciding which option is more suitable usually comes down to where you will travel.

Parallel

When you wire solar panels in parallel, the total current increases and the voltage stays the same. The advantage here is that the currrent increase allows you to charge quicker, and if one panel is damaged, dirty or shaded, the others are not affected. The problem with wiring in this way is that you need powerful, uninterupted access to the sun to gain the benefits of faster charging.

.

If you live in a sunny climate with fairly limited cloud and poor weather, wiring in parallel is likely to be the best option.

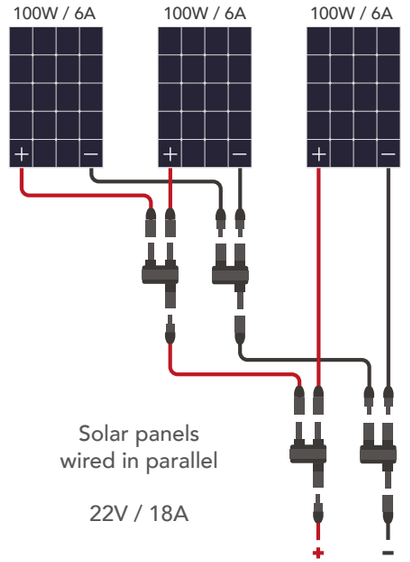
Series

When you wire solar panels in series, the voltage is added and the current remains the same. This allows you to access a much higher voltage input, and you can also use a thinner gauge wire as the total amperage remains low. However, if one panel is damaged or shaded, the output of all of the panels will be affected.

Crucially though, wiring in series will allow you to stay above the open cell voltage required to charge your batteries. If you refer back to the graphs on the previous page explaining voltage output for a 100W panel, a 300W solar array wired in parallel would have the same output as the single 100W panel. If you live in a cooler climate with frequent cloud coverage, wiring in series allows you to increase the overall voltage and ensure you gain charge in most weather conditions and throughout the year.

Solar charge controllers

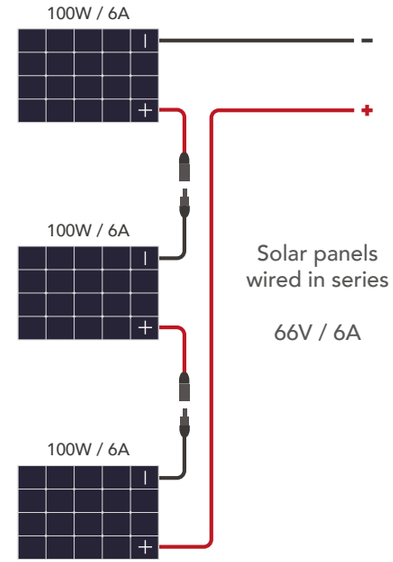
To use the power from your solar panels to charge your leisure batteries, you will need to install a solar charge controller. They regulate



the voltage from the solar panels and use it to charge your batteries effectively whilst preventing overcharging.

There are two different types of solar charge controller, PWM and MPPT. PWM chargers essentially act like a switch between the solar panels and the leisure batteries, drawing power from the solar panels just above the battery voltage. They're a low-cost option typically used for smaller systems where you may be using your solar panels to trickle charge your batteries, for example when the solar panels are a backup charging source to shore power. MPPT chargers are more sophisticated, drawing power from the solar panels at the 'maximum power voltage' (the voltage when the power output is greatest), which means they will charge your batteries faster.

If you are using an MPPT charger, you will need to work out what size you need for your system. If you are using a Victron Energy charge controller, their model names contain the maximum PV open circuit voltage and the maximum charge current. Other MPPT charge controllers typically only state the maximum charge current.



Example

The operating current of a 100W solar panel is 6A. If you have more than one panel and you're wiring in series, this will stay the same. If you're wiring in parallel, multiply this value by the number of panels. So if you have three panels:

6A x 3 panels = 18A

You will also need to factor in an additional 25% as a factor of safety. So:

18A x 1.25 (factor of 25%) = 22.5A

6A x 1.25 = 7.5A

The open-circuit voltage of a 100W solar panel is 22V. If you're wiring in parallel this will stay the same, but if you're wiring in series, multiply this by the number of panels:

22V x 3 panels = 66V

This would mean you would need an MPPT charger of over 7.5A and 66V for panels wired in series, or 18A and 22V for panels wired in parallel. So for this system, you would need the Victron 100/30 MPPT charge controller.

VSRs and battery to battery chargers

VSRs

A VSR (voltage sensing relay) can charge your leisure batteries via the vehicle alternator as you are driving. At one end they're connected to your leisure batteries, and at the other end, they're connected to your starter battery. They essentially act as a switch controlled by the voltage of your vehicle starter battery. They work by sensing an increase in voltage as you start driving, which closes the switch to allow your leisure battery to charge via the alternator at the same time as your starter battery. When you are driving, the voltage of your starter battery will increase to around 14V. Most VSRs will switch on when the voltage rises above 13.7V and start charging your leisure batteries. When the voltage drops below a certain threshold (around 12.8V) they will turn off again. It's a simple and inexpensive way of charging your leisure batteries.

However, there are a couple of issues worth highlighting with a VSR. It's only possible to use one if you have a starter battery and a leisure battery of the same type, so if you have a lead acid starter battery and a lithium leisure battery, it won't be possible to use a VSR. The other complication comes if you have a vehicle with a Euro 5 or Euro 6 engine. These vehicles have a 'smart' alternator which has their voltage controlled by the Engine Control Unit (ECU). This means that after the van has been on for a short amount of time, and if the starter battery is close to being fully charged, the voltage will drop well below 14V, which reduces fuel consumption and lowers emissions. This means that any vehicle with a 'smart' alternator can't use a standard VSR that relies on a constant high voltage whilst driving.

Euro 6 vans also have regenerative braking. As you brake, the smart alternator uses the kinetic energy from braking to charge the starter battery. This will generate a much higher voltage than you would otherwise see (15V+ rather than around 14V). AGM, gel and lithium batteries are sensitive to overcharging, and voltages above 14.4V, such as the high voltages seen from regenerative braking, can cause gas bubbles to form which damages the battery and dramatically shortens their lifespan. So what does this mean? If your van has a Euro 5 or Euro 6 engine, or you're installing lithium batteries, you won't be able to install a VSR.

Battery to battery chargers

A battery to battery charger (sometimes known as a DC-DC converter or a B2B charger) is more intelligent than a VSR. They take the variable voltage from the starter battery and output a stable voltage. They are also able to match the required charging profile of different battery types to fully charge your leisure batteries, which a VSR can't do. The downside of a B2B charger is that they're bigger and more expensive than a VSR, but ultimately this is the only suitable option for most van conversions.

Battery chargers

A battery charger charges your leisure batteries when you're connected to hook up. The device is simply connected to your leisure batteries and to the hook up via a consumer unit.

Battery chargers are available in a range of current ratings. The higher the rating, the quicker it will recharge your leisure battery. Simply divide your usable battery capacity by the rating of the battery charger to work out how long it will take to recharge your batteries.

Example

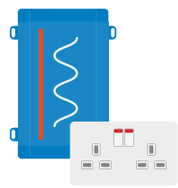
90Ah usable capacity ÷ 10A battery charger = 9 hours to fully recharge

As you're likely to be plugged into shore power overnight, you shouldn't need a battery charger that recharges your batteries quickly, just one that will recharge them fully over the period you're at a campsite for.

However, there is a complication to all of this. If you only want to use 230V appliances when connected to hook up, you can simply wire in plug sockets that will only work on a campsite. But if you want to use your mains appliances when off-grid, you will need to install an inverter/charger. The Victron MultiPlus is an inverter and battery charger in one, and uses a high-speed switch which can automatically switch your system from using shore power to your batteries. This means that whenever you're connected to hook up, your batteries will charge and your system will use shore power for any 230V appliances. As soon as you are no longer plugged in, your system will switch to using power from your leisure batteries.

The MultiPlus uses a pure sine wave inverter, and is available in a variety of sizes to cater to your electrical needs. This is sized in the same way as an inverter, by calculating your expected total wattage.

If you're unsure as to which setup to go for, refer to the table below with your usage.



Use cases

Exclusively campsites You will use hook up when available	**Mixed use case** You will occasionally use hook up	**Off-grid** You don't need hook up but use 230V
Battery charger & shore hook up	MultiPlus (inverter/charger) & shore hook up	Inverter

ABOVE Campervans are made for life on the road, so make the most of this and charge as you drive. *@vanlife.sagas*

Wiring components

Wires

Different parts of your electrical system will require different gauge wires. Earlier we talked about Ohm's Law, which defines the relationship of how much current can run through a material at a given voltage determined by its resistance. Voltage drop is related to the resistance of the material, where the resistance in the wire is caused by heat. The longer the circuit or cable length, the bigger the voltage drop. A voltage drop of around 2.5% is typically seen as acceptable within a DC electrical circuit.[9]

There are several ways you can prevent voltage drop in your circuit:

- Keep wire lengths as short as possible
- Ensure connections are tight (but not too tight)
- Check that all contacts are clean and don't have any corrosion
- Use high-quality cables, crimps and kill switches
- Use bus bars
- Follow wiring legislation

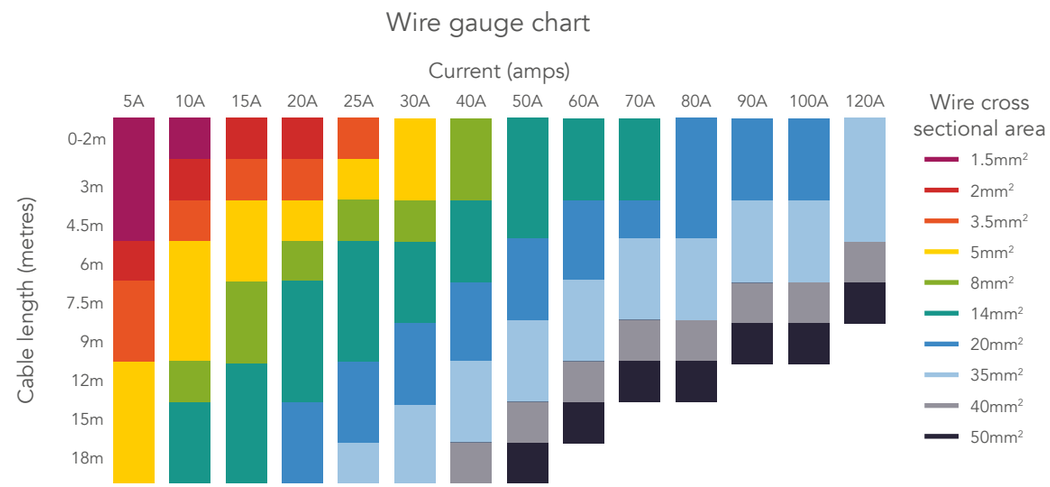
9 Leeftink, M., 2019. Wiring Unlimited. Victron Energy. Available at: <https://www.victronenergy.com/upload/documents/Wiring-Unlimited-EN.pdf>.

The other way to prevent voltage drop in a circuit across a longer distance is to use a larger gauge wire. To determine the wire gauge, you will need to use for your electrical system, you have to consider two things:

1. The length of the wire
2. The current passing through the wire

Once you know these two data points, you can use the wire gauge chart below to help you decide on the correct wire gauge. In Europe, wire gauge is measured in cross sectional area (mm^2) and occasionally in SWG, or British Standard Wire Gauge, not to be confused with AWG, or American Wire Gauge.

To calculate the length of wire you will need to design your electrical system, as you will need to plan how far each component will be from one another to calculate the length of wire needed. The measurement of length refers to both the positive and the negative wires, so you will need to measure there and back again. For example, if your fridge is 5m away from your fuse box, you will need to use a measurement of 10m for your calculation. It's also important to remember your wires will not be taking a direct straight line between components, so you will need to measure their exact path.



OPPOSITE When you are confident in your calculations and system design and you know how to connect all of your components, the electrics can turn from the most daunting stage of the build to the most satisfying! *@climbingvan*

A good way to do this to use a piece of string to replicate the path the wire will take.

To calculate the current passing through the wire you should check your appliances specification and technical details to find the current (given in amps). If it's given in watts you should divide by the voltage of the system (12V).

WARNING

If you do not size the wires for your electrical system correctly, you could cause an excess current, which can cause damage to appliances and create a fire hazard. Therefore it's advisable to add a buffer of around 25% when calculating your wire size. If you're unsure, it's better to be safe and opt for a thicker wire.

Although it may seem like a good idea to simply buy the thickest wire possible for your entire system, very thick wire such as those used to connect batteries is very heavy and harder to work with as it's less flexible than thinner wire. Wiring your entire van conversion with thick wire will add a lot of extra weight to your van and will also cost you loads! You will struggle to connect much thicker wire to your appliances due to connector sizes. Therefore, it's important to size your wiring correctly for each aspect of your system.

Example

Spotlights have a current of 0.25A each. The lights can be wired in parallel so they can be turned on and off with a single switch. There are 10 spotlights in total. The distance from the spotlights to the 12V fuse box is 6m.

0.25A x 10 spotlights = 2.5A

6m x 2 (positive and negative) = 12m

12m x 1.25 (25% buffer) = 15m

Looking up 2.5A and 15m on the table gives a wire thickness of 5mm^2.

Remember, this is the thinnest wire you can use for the application. Once you've worked out all of your wire gauges, it makes sense to buy a big roll of wire that works for most of your smaller components so you don't have to buy lots of rolls of different gauge wire. The only downside to oversizing your cable in this way is the small cost difference, but you will probably find you make a decent saving by buying one big roll to use for lots of appliances.

You should ensure you select the correct type of wire for the application you are using it for. All wires should be flexible, and should not have coarse strands.

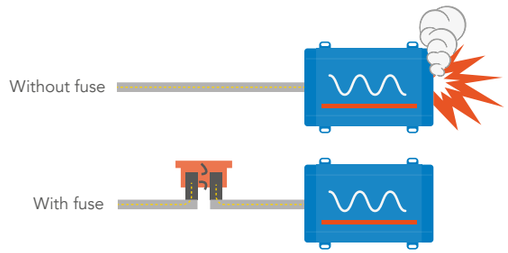
Wiring is available with a range of different outer insulation colours. Historically in the UK, all positive or 'live' wiring was installed using a red cable, and all negative or 'neutral' wiring was installed using a black cable. In 2004, there was an amendment to the British Standard for electrical installations, changing the colours that should be used for live and neutral wiring. In domestic settings, it is now required that brown cable is used for live wiring and a blue cable is used for neutral wiring. Similarly in Europe, the International Standard specifies blue and brown cable should be used for wiring as of April 2004.

However, in automotive and marine settings, black and red still tend to be used for wiring in 12V circuits. Red is used for the positive side of a circuit and black is used for the negative side of a circuit. Therefore, we have used red and black in all of our wiring diagrams when showing a 12V circuit, and used brown and blue when showing a 230V mains circuit.

As well as your positive and negative wiring, you will also need to ground all of your electrical components (we will explain how to do this in *Build* on page 224). This is typically done using yellow and green striped wiring.

Fuses

Fuses are an important part of an electrical system as they protect circuits from power surges. They create an intentional weak point within the circuit that will blow in the case of a surge in current, protecting your batteries and appliances from damage. 12V appliances are connected to the batteries via a 12V fuse box which uses blade fuses, whereas other electrical components such as an inverter and a split charge relay will need to be fused using a link fuse connected using an in-line fuse holder.



Fuses should be above the maximum current of the circuit (i.e. above the amp rating of the appliance) but below the amp rating of the wire you're using. You should ensure each positive wire is fused, except for a positive wire intersected by a kill switch, where you will only need to include one fuse rather than two. When a fuse is being installed on a circuit containing a battery, the fuse should be installed as close to the battery as possible.

Example

The spotlights from our previous example produce a total current of 2.5A going into the 12V fuse box. The wire gauge needed for these was 5mm^2. The amp rating of the cable is the number at the top of the table, so for this example, it would be 5A.

This means your fuse would need to be between 2.5A and 5A. A standard set of blade fuses contains a 3A fuse, so you could use this.

Consumer units

To protect your 230V components from a power surge you will need to use a consumer unit, sometimes referred to as a breaker box. This is much like the 'fuse box' you would find in a modern bricks-and-mortar house, and contains several RCDs (residual current devices) and MCBs (miniature circuit breakers).

An RCD uses electromagnets to protect a circuit rather than a fuse, using a special switch called a relay. The live and neutral wires are connected to the RCD, and when the circuit is working normally, the live and neutral wires produce equal magnetic fields which cancel each other out. In the case of a power surge, one of the magnetic fields becomes much greater than the other resulting in a net magnetic field, creating a current that opens the relay and breaks the circuit. Because the RCD uses an electromagnet rather than a fuse, once an issue has been resolved, the RCD can simply be switched back on rather than having to replace a fuse.

You will need to install a consumer unit if you are installing an inverter, and each appliance will need to be wired into the unit which is connected to the inverter. This will ensure each of your appliances are protected against power surges. You will also need to install a consumer unit if you are using shore power.

Kill switches

Kill switches are used to cut the power to a certain part of your system. You should install a kill switch on the positive wire of any main component going into or out of your batteries.

- Power coming in:
  - Solar charge controller
  - Battery to battery charger/VSR
  - Shore power
- Power going out:
  - Inverter
  - 12V fuse box
  - MultiPlus

Bus bars

Bus bars help with cable management, providing a common point to connect all of your cables to. You should connect a bus bar to your positive battery load and your negative battery load, and each component of your electrical system should be connected to your batteries via your bus bar. Bus bars have an amp rating, so you should ensure the one you buy is rated for the total amperage of your system.

Crimps and crimping tools

Once you know what gauge wire you require, you will need to connect everything in your circuit. There are two main methods of connecting wires in a circuit: crimping and soldering. Soldering requires a soldering kit and uses heat to join a wire to a connector using a substance called solder. Crimping uses a crimping tool and crimp connectors (little pieces of metal and plastic that fit over the wires). The crimping tool is used to crush the crimp down to connect it to the wire.

Crimping is the most common way of joining wires in the setting of a van conversion as it is an easy and repeatable process. The joins are generally more reliable (as over time the solder on a soldered joint can degrade), especially if you don't have any soldering experience.

Standard insulated metal crimps are used for thinner wires. These come in three sizes, and you can purchase a crimping tool that's compatible with them. You will also need to purchase a wire stripper to prepare the end of the wire. There are crimping tools available that also function as a wire stripper and cutter. Much bigger metal crimps are used for much thicker wires such as those you will use to connect your batteries. A hydraulic crimping tool is used to connect these to the wire.

Once a wire has been crimped, it's important to protect the connection. This can be done using heat shrink. A small plastic tube is be passed over the crimped connection and contracts when heated, hiding any exposed wire. You can use a specialist heat gun, or just a device such as a hair dryer to make the heat shrink contract. Alternatively, you can use electrical tape to protect the connection, although this will not be as protective as the heat shrink as it is liable to move. Therefore, it's best practice to use heat shrink.

ABOVE The crimp selection box; use what you need and pass it on. Just like a chocolate selection box, all the good ones go quickly! *@climbingvan*

Electrical appliances

Before you grab your toaster and kettle from your kitchen at home, it's worth understanding the ramifications of using products like these in a campervan. Cast your mind back to the power usage of appliances on page 56, where kitchen appliances generally had the highest energy consumption. While it might feel like a good idea to put a microwave in your van, the average modern microwave uses around 1000W. To power this, you would have to invest in a big, expensive inverter to power it and large batteries to deal with the power usage. Just 30 minutes a day of using a 1000W microwave would use 42Ah of power, which is a considerable amount for a single appliance!

It's a much better use of power to install a gas hob and oven, which only require a tiny amount of electricity to start them and then rely on LPG gas to run. Generally, it's advisable to rely on gas for cooking in a van rather than electricity as it is a much more efficient use of the resources you have available. One of the main electrical appliances most people will choose to include in their van build is a refrigerator.

Fridges

Arguably the most important appliance in your conversion is a fridge. Whilst for most other appliances you can simply include what you would use in a domestic setting, a campervan fridge is slightly different.

You might be wondering why you can't just buy a standard household fridge, but it's inadvisable for a few reasons. Household fridges run on 230V and will have a much larger power consumption than a compressor or 3 way campervan fridge. They will also be much heavier than a campervan fridge as even the smallest household fridge is much bigger than a 12V fridge. They aren't built to be constantly rattling around inside a moving vehicle, and so over time, you may find you have issues with hinges weakening, whereas a campervan fridge is built specifically to deal with constant movement. A small domestic fridge will also typically use four times as much power as a 12V compressor fridge.

An electric cool box, sometimes known as a thermoelectric cool box, uses a thermoelectric heat pump and a fan to transfer heat from the inside of the cool box to the outside using electric power, usually 12V. They will also be made of an insulated material so the cool box can be unplugged and maintain a cool temperature for around six hours. There are several types of electric cool box available, from very cheap models from outdoors stores that probably won't keep your food very cold, to much more sophisticated models such as the Dometic CFX range that can also function as a freezer and can get down to a chilly -22°C.

A compressor refrigerator designed for a campervan works in the same way as your fridge at home, except it will use 12V power rather than mains power, and will usually have been designed to have a very low energy consumption. They also come in a smaller size to fit within the limited space available, and many have a small freezer compartment to store some frozen goods. As well as the more conventional style fridges, it's possible to buy drawer compressor fridges to save on space, and top-loading compressor fridges.

A 3 way fridge, sometimes known as an absorption fridge or gas fridge, works similarly to a compressor fridge and can run on either LPG gas or 12V electricity. They're completely silent when running which is a big positive, as the compressor fridges are quite noisy, but they're also more complicated to install than a compressor fridge. Their performance also relies on the surrounding ambient temperature, so they may not be as effective in a hot climate.

Fridge comparison

	Electric coolbox	Compressor fridge	3 way fridge
Power source	12V	12V	12V or LPG
Installation complexity	Low	Low	Medium
Cost	£50-£800	£200-£1,500	£400-£2,000
Example	Dometic CFX3	Dometic CRX50	Dometic RM 5310

Electrical summary

Paying a professional

If you're struggling to get your head around the somewhat confusing world of campervan electrical systems, don't despair. The electrical system is one of the most common jobs outsourced to a professional, beaten only by window fitting.[10] A professional can fit the entire system if you don't want to tackle it yourself. The table will give you a rough idea of costs for three electrical systems with varying levels of complexity.

Electrical system install costs

	Parts cost	Professional supply & fit
Basic 12V system	£500-£1,500	£1,000-£2,100
High spec 12V & 230V	£2,300-£3,800	£3,000-£4,600
Shore power 12V & 230V	£2,500-£4,800	£3,200-£5,600

However, unlike other areas of your build, there is another option available if you don't want to incur the cost of someone installing your system for you but would like the assurance you have all of the right components and know exactly how to install everything.

Electrical consultancy

If you don't want to fully outsource your electrical system but you feel like you need some support, you can speak to a campervan electrical consultant who will be able to help you design your system. A consultant can understand your requirements, provide you with a schematic to work to and advise on the components you need. This option works well if you are happy to install your system yourself, but you would like additional guidance on exactly what to install and how to install it.

Most consultants will charge around £200 for a consultation and a schematic, and will also make a commission on the electrical products they sell you (but this shouldn't cost you any more than it would buying from elsewhere). This is a good way of gaining some extra confidence in your electrical system without having to pay for a professional install.

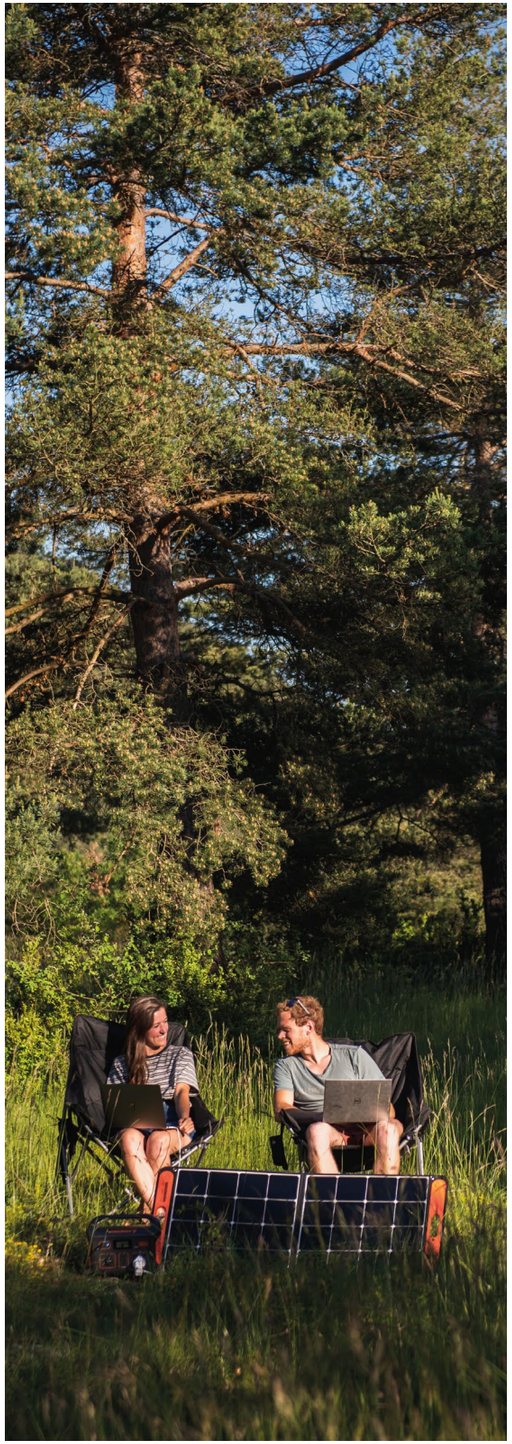
CHARLIE & DALE SAY:

Since publishing The Van Conversion Bible, we have developed an electrical system design service called Nomadic Energy. Many electrical consultants dramatically over-spec systems and charge an arm and a leg for a quote and a wiring diagram, and we wanted to be different. We have created the service that we desperately wanted when we started our own conversion, to make off-grid energy simple.

Rather than trying to sell the same system to everyone, we start by understanding your needs and requirements, and then use our custom algorithm to help us configure your perfect system. This means there's no guesswork involved and you can be confident you have a bespoke system that meets your needs.

10 climbingvan.co.uk. 2020. The Climbingvan 2020 Van Conversion Survey.

OPPOSITE TOP The Dometic CFX3 is perfect for storing lots of snacks for long adventures. *@climbingvan* **LEFT** A Dometic CRX50 stocked with all the most important supplies. *@drifterscampervans* **RIGHT** 3 way fridges make the most of gas as a power source. *@adventuresinacamper*



Instead of charging for your quote and wiring diagram, we include all of this for free when you buy your electrical components through us. All of the components we include in our quotes are price matched too, which means you don't need to spend extra money to feel confident that you have the right system and you know exactly how to install it.

We've already designed hundreds of systems, and just like the campervans they go into, every single one has been different. This highlights the importance of avoiding off the shelf 'kits', and instead installing a system that is truly bespoke to you and your van.

For more information, visit:
climbingvan.co.uk/nomadic-energy

All-in-one solutions

Alternatively, if your requirements for your system are much more basic, then an all-in-one solution may be worth considering. These consist of a battery, an inverter and a charge controller in one, and have both 12V and 230V power outlets. They can be charged via a mains plug socket, or by using portable solar panels. If you're converting a small van for weekend use and you only need to charge phones and perhaps a laptop, this can be a great option. The magic of a power bank is that they are plug-and-play.

This does have its limitations - if you wanted to install lights in your campervan, then you would need to plug these into the power bank each time you wanted to turn them on. This option won't work for everyone, but if you are looking for simplicity and wince at the idea of having to install your electrical system, this could be the answer.

ABOVE With a portable power bank you can take remote working to another level. *@climbingvan*

Layout construction

Construction methods

Choosing which method to use to construct units, walls and structures in your van will largely be influenced by your access to certain tools, your skill level and your patience! This section only aims to make you aware of the different methods, as later sections cover how to design and build your units in more detail.

Carcassing

The carcassing (sometimes known as framing) method of building units can be achieved in a couple of ways. One uses wooden battens to create a basic framework, which can then be clad with ply to hide the supporting battens, leaving a clean and strong structure. The other uses battens attached to a ply sheet as a support to connect other pieces of ply.

The carcassing method is useful for creating large storage areas or load-bearing structures, but it can be more challenging to create enclosed units as the carcassing can block dividing walls and panels. The only tools you'll need for the carcassing method are a drill, a mitre saw and a pocket hole jig to allow you to drill holes into the battens at an angle. Carcassing arguably represents the best balance of robustness, time and cost to create framework structures.

PROS

- Easy construction method
- Relatively quick
- Strong
- Doesn't require specialist tools
- Fasteners aren't visible

CONS

- Can be heavier than other methods
- Carcass limits storage space
- Hard to achieve standard kitchen unit aesthetic

Cabinetry

The cabinetry method is commonly used in freestanding storage and domestic kitchen units, and relies on cutting a trench (or dado if you're American) into the side walls. This allows the panels to slot together a bit like a jigsaw puzzle. Wood glue or PVA can then be used to fill the trench before all of the parts are clamped together. This is a strong way to connect all of the elements of the unit and gives you the best chance of achieving a premium feel.

However, it can also be time-consuming and is reliant on using a workbench, guides, a router and ideally a table saw to make each panel and create the trench cuts.

If you don't have a router there is an alternative method of cabinet construction. Instead of creating trench cuts, you can use clamps and battens to hold the ply in place and use small screws to connect the ply. It can be more time-consuming and not quite as strong, but it achieves the same aesthetic without needing access to a router and a workbench.

Once the cabinet is finished, it can be positioned on feet or rest directly on the floor. Using feet allows you to run utilities beneath the cabinets and make subtle height adjustments.

PROS

- High-quality finish
- Good strength to weight ratio
- No visible fasteners
- Space efficient

CONS

- Requires a router
- Time-consuming
- Challenging for the novice DIYer

Metal framing

There are a couple of different methods of metal framing you can use in your build, using either steel beams or aluminium framing. Telescopic steel beams, such as bed mid-beams (widely available from stores such as IKEA), can be used in conjunction with timber battens to create a sturdy bed frame at a cost-effective price.

Aluminium framing should be considered for creating modular structures. It's possible to buy products such as FlexLink which provide modular extruded aluminium components that can easily be cut to size and connected with simple fixings. This method is most appropriate either if you're looking to span a large distance with minimal support and material depth (as aluminium is stronger than wood), or if you intend on creating a modular layout where you want to move sections around easily.

PROS

- Easy construction method
- Very quick to build
- Very good strength to weight ratio
- Easily adjustable and good for disassembly

CONS

- Only appropriate for large structures and not storage units
- More expensive than softwood carcassing

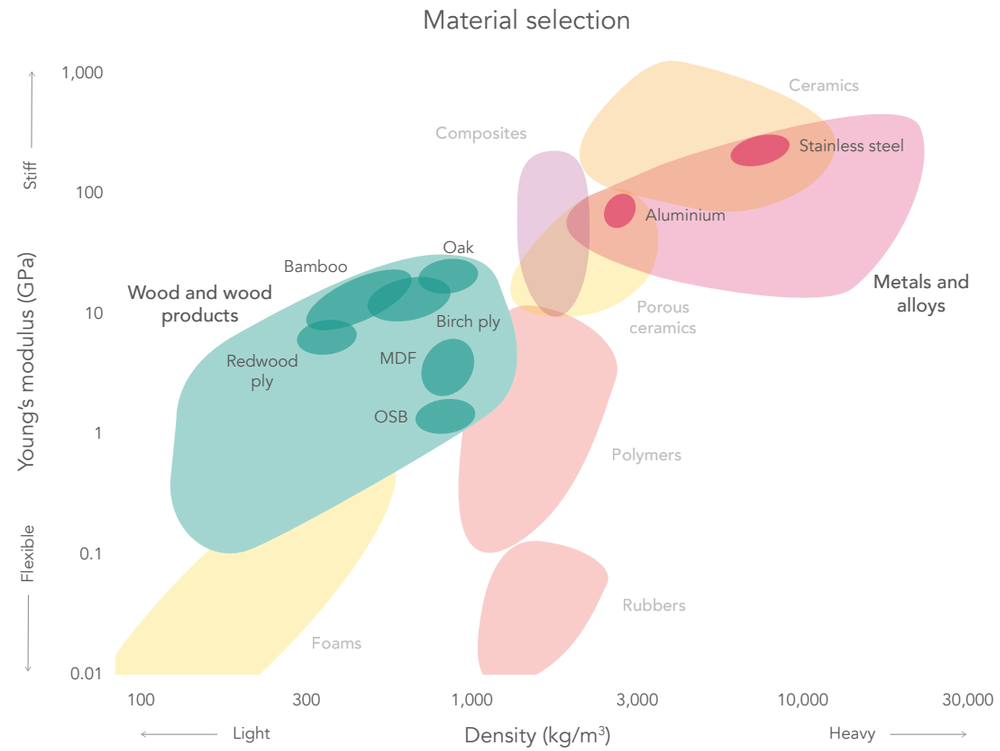
ABOVE The carcassing method is the quickest and easiest way of building units. *@dutchexplore* **OPPOSITE** We used the cabinetry method for our kitchen units to achieve a clean aesthetic and a strong structure. *@climbingvan*

DALE SAYS:
We used the non-router cabinetry method for our cabinets as we didn't have access to a router and a workbench. Although it was a little fiddly, it allowed us to create a light and space-efficient set of units with a good quality finish.

Materials

Deciding which material to use can have a massive impact on quality, weight and cost. We have created a graph illustrating the density and strength of various wood-based construction materials. Ideally you should be looking to use a very light and strong material such as those in the left-hand corner of the graph. Bamboo is a clear winner, but depending on where you are based it can be very difficult to source at a reasonable price. Birch ply also has a good strength to weight ratio and is readily available across the world at a reasonable price, providing you use timber merchants and not a generic DIY store. Pine also fairs pretty well and is probably the best value material if you are looking to create frameworks.

Ideally, you want to avoid the use of materials such as particleboard, MDF and OSB, as they have a poor strength to weight ratio. Particleboard and MDF will soak up water and other liquids like a sponge unless it's extremely well sealed on all sides and edges. Both are constructed using very fine particles so tend not to hold screws very well. Hardwoods should also be used sparingly as they are usually pretty heavy and difficult to work with!



Standard units and kits

Domestic units

It may be tempting to use domestic units from IKEA or other providers as they are great value and fairly well made, but they are also very heavy. When something is made for a domestic setting there isn't a weight constraint, and actually, weight tends to give a perceived quality, so manufacturers usually opt for cheap but heavy materials. When using domestic units you will also be constrained to just a few standard widths and depths and will have very little choice regarding height. You should also remember your van's walls are unlikely to be perpendicular to your floor, and therefore, units will need modifying to fit in the space.

Domestic units are typically constructed from modular 18mm MDF carcasses, which means you will end up with double thickness 18mm MDF between each unit. Despite MDF being the default choice for domestic applications due to its price and strength, it's 25% heavier than redwood ply relative to its strength.

So how much weight can I save building it all myself? An L-shaped kitchen can be built using standard 18mm MDF units or by constructing it using single skin 12mm birch ply. You could save a whopping 35kg by building it out of ply and achieve the same amount of storage. If weight isn't a concern for your build and you don't fancy the hard work of making your units then domestic units can be a great way to save time and achieve a high-quality finish!

Campervan units

Another option is to buy pre-built campervan kitchen units. Specifically designed for a campervan, they will mean you won't need to modify domestic units, plus they're much lighter and many have been designed in a van friendly way with clever storage solutions for smaller spaces. At the time of writing, it's only

TOP We built our kitchen units from scratch, saving vital weight (to justify our Belfast sink!). *@climbingvan* **MIDDLE** IKEA units are a great option if you are less concerned about weight. *@brownbirdandcompany* **BOTTOM** If you're converting a smaller van, you have the option to utilise pre-built custom cabinets. *@cambee_campervans* & *@robingoodladphotography*

really possible to buy units for small to medium-sized vans, and most have a caravan aesthetic.

If you are converting a Volkswagen Transporter, there are numerous providers of Rock'n'roll beds that convert from rated passenger seats into a bed with a simple sliding mechanism. These can cost in the region of £2,000 new and can be hard to come by second hand. Bespoke units are also available to cater for the sliding seat and bed functionality, but these are also very expensive!

We are aware of some van owners drafting in the help of professional carpenters or van builders to help with this stage of the build, which makes a lot of sense if you are trying to achieve a high level of finish and you can afford it! A good carpenter typically charges around £22 per hour, so expect to pay between £500-£1,000 for a bespoke kitchen depending on the size of your van plus materials and fixings.

Water

We've spoken a lot about keeping water out of your van, but it's also important to include a means of storing and dispensing water inside your van. The most basic systems may solely rely on a jerry can, whilst the most luxurious can include a full hot water system feeding an indoor shower. You should consider your requirements for your campervan as this will directly influence the type of water system you will install.

Sinks and taps

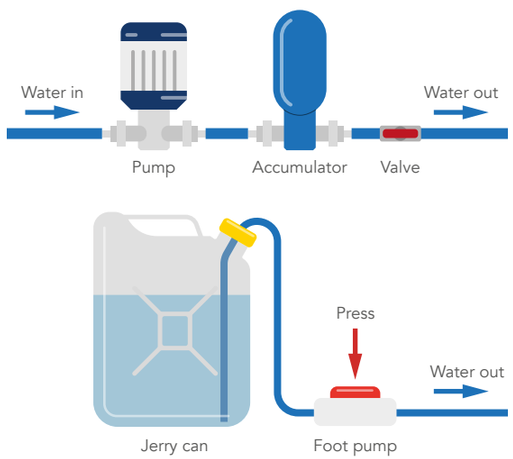
Installing a sink and a tap in your campervan is very simple. It requires water to be fed from the water tank to the tap via a pump, and water to be fed out of the sink via a waste pipe (and optionally into a grey water tank).

There are a range of caravan and boat style sinks and taps you can buy for your campervan, or you can choose to install a domestic sink and tap; if you do, you will need to ensure you buy the right connectors when you come to plumb in your water system. You could even make your sink out of a copper bowl and some pipe. It's worth thinking about the kind of aesthetic you're trying to achieve in your van as the sink and tap can be quite an eye-catching feature if you want to make it one!

Water pumps

For water to travel from your water tank to your tap, you will need to install a water pump. The most basic water system does not use a conventional pump, but relies solely on gravity. A gravity-fed system involves mounting your water tank above your water outlets so gravity can act as a natural pump and feed the system. It's worth noting water tanks are obviously quite heavy and so if you're mounting this high in your van, you will need to ensure you fix it securely in place!

The second option is a manual pump which is connected between your water tank and your tap and operated by hand or foot. When you pull up on the plunger, the pump will fill with water, and when you press down on the plunger, the pump will push the water into the tap. Manual water pumps are cheap and easy



OPPOSITE We made the sink the visual focus of our kitchen by installing a beautiful Belfast with a curved, matte black mixer tap and jungle green subway tiles. *@climbingvan*

to set up, so this could be a good option for those with a fairly basic setup who might not want to wire in an electric pump.

If you want the water system in your van to work in a similar way to your tap at home, you will need to install a 12V water pump. These pumps are installed between your water tank and your tap, and are also connected to your 12V electricity supply via a switch. When the switch is on and the pump has power, it will be in idle mode. The pump will be able to detect when you turn on your tap from the drop in pressure and turn itself on to supply water to your tap. 12V water pumps are fairly easy to install as they just need to be connected to your 12V fuse box via a switch and installed between the water tank and the tap. They're not very expensive, so this option is best for most people looking to have a slightly more sophisticated setup.

If you are installing an electric water pump, it's also a good idea to install an accumulator. Without an accumulator, the water flow from your tap will fluctuate as the water pump cycles. Accumulators balance the water pressure, delivering a smooth flow of water from your tap. This can save both water and electricity, and increase the lifespan of your water pump by reducing the cycling of the pump.

Water tanks

When choosing the location of your water tank, it's important to think about weight distribution. For example, if you have all of your electrics and batteries on one side of your van, it might make sense to install your water tank on the other side. We'll talk about this a little more later, but it's worth keeping in mind as you think about the different types of tanks.

If you are mounting your water tank inside your van, you can choose from a standard tank mounted flat or on its side anywhere in the van, or a wheel arch water tank which sits on top of your wheel arch. These can make good use of what would otherwise be dead space. For either of these options, you'll need to install a water fill point. You can install this either on the outside of your van, or on an internal structure.

Your other option is to mount your water tank externally to save on valuable space in the van. An underslung water tank is mounted to the underside of your van, and many have a fill point already installed meaning you won't need to install one on the side of your van. They are a good choice if you need a big tank and want to save space inside, but they are not recommended if you will be spending time in cold climates as the water can freeze!

Sizing your water tank

When deciding on the size of your water tank, there are a few main considerations:

- Refill frequency
- Usage
- Available space
- Weight
- Cost

If you plan on spending a lot of time on campsites or regularly moving from location to location where you'll be able to refill your water frequently, you'll be able to go for a slightly smaller water tank than if you're planning on spending several days off-grid. Once you have an idea of how often you might be able to refill, you should work out your water usage, which will be affected by factors such as whether you plan to install a shower, if you will wash clothes in your van or take them to a laundrette, and how frugal you are with your water.

Example

102L per week ÷ 7 = 15L per day

15L x 5 days = 75L

Example water usage

Task	Weekly usage
Drinking & cooking	60L
Washing up	12L
Showering/washing	25L
Washing clothes	5L
Total	**102L**

The other factors you should consider are the size, weight and cost of a tank. It seems logical to just install the biggest water tank you can find so you don't run the risk of running out of water, but a 200L tank will weigh over 200kg when full and will also take a up a lot of valuable space in your van, so it's important to work out the right size for your usage.

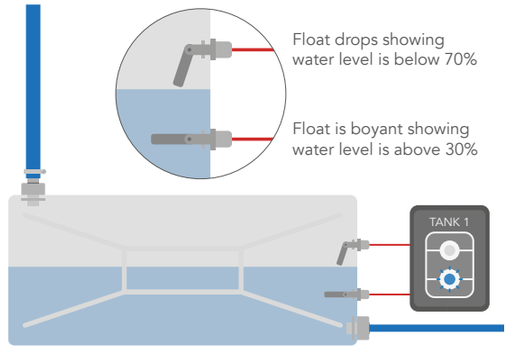
Water fill points

If you are installing an underslung water tank, it may already have a water fill point built-in, but if you are installing a water tank inside your van, you will need to mount a water fill point to it so you can refill your tank. Where you decide to install your tank will affect where you install your fill point. Wherever you mount it, it's important to ensure it isn't too close to your water tank, and is a fair bit higher too. This is to ensure when you're driving up a steep hill with a full tank of water, it can't leak back out of the fill point!

Water level indicators

Without having a way of checking your water level, you could quickly run into issues when staying somewhere remote. There are two obvious ways to approach measuring your water level - the high tech option of using water level sensors and the low tech option of having a visible gauge on the side of your tank. The visible gauge will only be an option if your tank is installed somewhere you can see it, and not hidden away somewhere. The idea is that if you have a transparent tank, you can physically see the amount of water in your tank. Although this is fairly low tech, it gives you a very accurate picture of how much water is in your tank.

The other more high tech option is to install some water level sensors in your tank. This involves cutting several holes in your water tank at set distances and installing sensors which are wired to LEDs. The sensors act as a switch - when the water level is above them, the switch is closed, meaning the LED lights up. When the water goes below the level of the sensor, the switch opens and the LED turns off. You can choose to install as many sensors as you like - the more you install, the more accurately you'll be able to measure your water level.



Grey water tanks

A grey water tank is installed below the outlet of your sink or shower and collects used water and will need to be emptied regularly. When considering whether to install a grey water tank, you should think about where you plan on spending most of your time. If you are going to spend a lot of time on campsites, not having a grey water tank and emptying your grey water straight onto the pitch is generally bad etiquette. If you plan on spending a lot of time stealth camping in cities it may also be a good idea to install a grey water tank to remain...

well, stealthy! However, if you plan on 'wild camping' in your campervan, you might decide not to install one.

If you decide not to install a grey water tank, you should ensure you aren't using any non-natural products that could damage the environment. You should ensure you use an eco-friendly washing-up liquid and soap made with plant-based ingredients which don't contain any chemicals so your grey water doesn't harm the environment you're staying in. We'd recommend doing this anyway as they're much better for you too! It's also a good idea to have a strainer in your sink to catch any food debris.

If you are installing a grey water tank, it's a good idea to mount it straight underneath your sink so the waste water pipe can go straight into it, and you have easy access for emptying it. If you're also installing an indoor shower, you may want to try and mount the tank equidistant from your sink and bathroom. The tank may also need to be mounted underneath your van so you can achieve a sufficient height drop between the outlets of both appliances into the tank. You'll also need to include a U bend below your sink or shower to avoid the smell from the grey water tank re-entering your campervan.

Showers

For some, a hot shower is an absolute must in a van. But this isn't the case for quite as many as you might think; only 20% of people planning a campervan conversion said an indoor shower was a prerequisite.[11] Including a shower in your build requires installing a means of generating hot water, and can also take up quite a lot of valuable space. If an indoor shower is firmly on your list of must-haves, you will need to build a shower cubicle or 'wet room', which you may also choose to use as a tiny bathroom by also including a toilet.

11 climbingvan.co.uk. 2020. Data from the Van Conversion Layout Configurator.

CHARLIE SAYS:
If you want the option of a shower without giving up space for a cubicle, you can create an outdoor shower setup. We have this in our van and it works really well if you're not too fussed about having a shower every single day, but you still want the option available. It's a good choice if you'll spend a lot of time in warmer countries; showering with a mountain view is nothing to complain about! You can create a basic setup by stringing a shower curtain across your back doors for privacy.

Hose and connectors

The most common hose used in campervan water systems is food grade water hose made from a polyester mesh and a PVC outer. It's important you source food grade hose, as other pipes can leach plastic chemicals into the water. This not only tastes bad, but at certain exposure levels, it's believed to be carcinogenic!

This hose is very flexible and easy to cut, which makes it easy to meander through your van without tools and complex joining methods. A wide range of barbed push-fit connectors are also available to let you split the water feed in multiple directions, provide an inline valve and connect directly to your appliances.

Hot water

Gas boiler

A gas boiler uses a gas burner to heat a tank of water. Once it's switched on, it will take around 15-30 minutes to heat the water and so requires some foresight as to when you'll need access to hot water, as it's inefficient to have it permanently switched on. It's also possible to buy gas boilers with an electrical element so you have the option of using electricity to heat your water quicker. This is only recommended if you'll be spending the majority of your time on a campsite connected to shore power as it will use a considerable amount of electricity.

OPPOSITE Ceri and Will's bathroom, situated in the middle of their van, combines a 'no poo' urine-diverting toilet and a shower to create a mini 'wet room'. *@tothemountainsnback*

Gas boilers have an inbuilt tank to store your hot water, typically around 10-13 litres in size. When you install a gas boiler, you'll need to connect it to a flue so any water vapour and carbon monoxide fumes can escape. This can either be positioned on the roof of your van, or as a vent on the side of your van depending on the make and model in question.

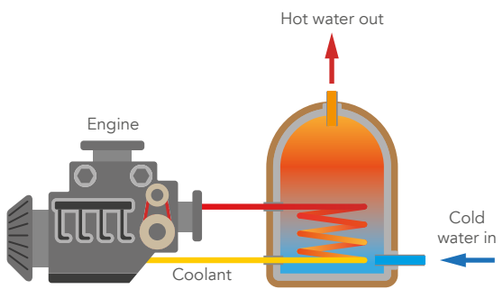
Combi boiler

A combi (combination) boiler derives its name from the fact it provides both hot water and heating. It works in a similar way to a domestic boiler. Combi boilers are connected to a hot water tank and will usually take 20-45 minutes to heat water, so you need to make sure they're turned on before you need them. They tend to be quite expensive, and they will require ventilation to an external flue. As with the gas boilers, it's possible to buy combi boilers that run on both LPG and 12V electric power.

Calorifier tank

Mostly found on narrowboats, a calorifier tank is an indirect water heater which doesn't have its own source of producing heat, relying on an external heat source to heat the water. It contains an internal pipe which is connected to the engine coolant system, and uses the heat from the coolant to heat the water inside the calorifier tank.

They don't require an external flue as they are not producing the heat themselves, but they do require tapping into your vans coolant system, making them a bit trickier to install than a standard boiler. The downside to a calorifier tank is the need to have a big tank to store enough water for your usage, as the water is only heated whilst driving.



Tankless water heater

A tankless water heater, sometimes known as a tankless or portable shower, instantly heats water using LPG gas as it travels through a pipe. Tankless water heaters are not recommended for internal use. We have one which is mounted in our boot space next to our back doors and we use it as an outdoor shower. Whenever it's in use, the back doors of the van are open so it's well ventilated. A tankless water heater is a good choice if you don't want to lose valuable space inside your van to a bathroom cubicle but still want the option of having a shower.

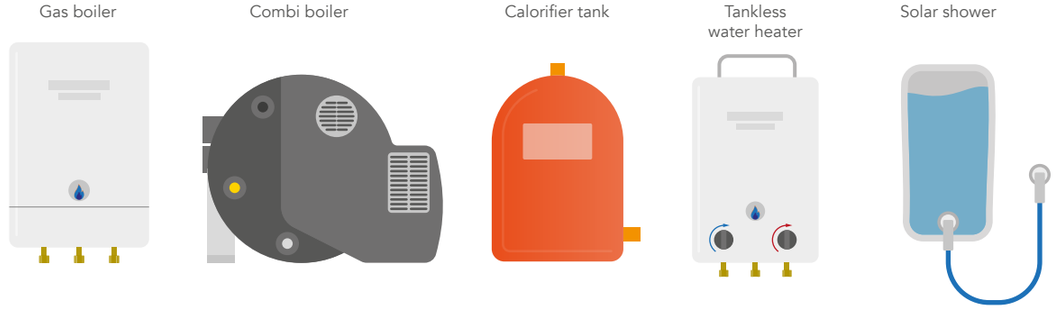
Solar shower

If you want access to a warm shower without the faff and expense of installing a boiler or water heater, a solar shower is a great budget option. A solar shower is a portable bag and shower head you can fill with water and sit on the top of your van so it can slowly warm up in the heat of the sun. They either use a gravity-fed system by sitting on top of your van, or a manual hand pump.

Toilets

Deciding whether or not to include a toilet in your build is a slightly contentious topic. Some people cringe at the thought of using a public toilet or squatting down in the woods, and so a toilet will be an absolute must-have, but others may feel it's simply not necessary. A toilet is a prerequisite for twice as many people planning a campervan conversion as a shower, with 39% including it as essential in their conversion.[12]

12 climbingvan.co.uk. 2020. Data from the Van Conversion Layout Configurator.



Water heater comparison

	Gas boiler	Combi boiler	Calorifier	Tankless	Solar shower
Cost	£400	£1,250	£200-£400	£150-£250	£5-£40
Size	Medium	Medium	Medium-large	Medium	Small
Complexity of installation	Difficult	Difficult	Very difficult	Medium	Easy
Power source	LPG (electric optional)	LPG (electric optional)	Engine coolant	LPG	Solar
Speed of hot water	30 mins	30 mins	1 hour per tank	Instant	3-6 hours
Example	Propex Malaga	Truma Combi 4	SureCal calorifier	Camplux 5L	10L Summit to Sea pocket

PROS:

- **Convenience** - you won't have to go outside when it's pouring down with rain in the middle of the night, or drive around searching for a public toilet after drinking your morning coffee!
- **Privacy and hygiene** - to some, the idea of squatting down outdoors where someone could stumble upon you mid-wee is horrifying, so a toilet is a must!
- **Emergencies** - if you're suddenly taken ill, instant access to a toilet can be important.

CONS:

- **Space** - depending on whether you opt for a smaller portable toilet in a storage box or a full bathroom cubicle in your van, toilets can take up a lot of valuable storage and living space.
- **Smell** - different toilet options will have differing levels of smell associated with them - portable toilets tend to have a chemical smell, whereas composting toilets have a slight earthy scent.
- **Faff of emptying it** - if you're going to commit to a toilet in your van, you will need to regularly find a spot to empty it, which unless you have a composting toilet, will need to be in a designated place due to the chemicals. Composting toilets are easier to empty, as the waste can be disposed of in a regular waste bin.

After weighing up the pros and cons, you can make an informed decision about whether or not to include a toilet in your build. If you do decide to include one, it's important to consider the type of toilet you will include.

Portable toilets

Portable cassette-style toilets are the classic option that many people choose for their campervan. You can easily fit them under a bench or in a big slide-out drawer, so they don't take up much room.

Portable toilets are made of two components: the upper part forms the toilet bowl and also has a water container for the flush mechanism, and the lower part is a removable waste tank, sometimes known as the cassette. Water is added to the upper water container so when the pump flush is used it works like a standard toilet flush. Water is also added to the removable waste tank along with some chemicals to reduce the smell from the toilet.

Due to the harmful chemicals in these toilets, they need to be disposed of properly at a chemical toilet disposal point which can usually be found on campsites or aires (European overnight camping areas). Installing a portable toilet will ultimately restrict where you can travel as you will need to find a 'dump' point every few days. To empty your toilet, you will need to take the waste tank to a disposal point, empty the contents and then give it a good clean out. All in all, not a particularly enjoyable process, and you will need to repeat this around once a week.

Composting toilets

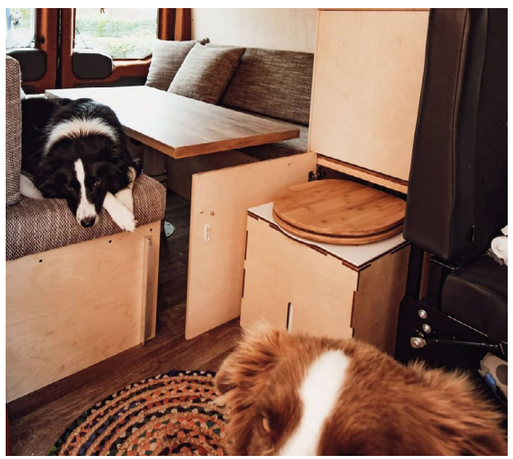
Composting toilets store liquids and solids in two different tanks, which reduces any associated smells, and they don't use any of the unpleasant chemicals used in portable toilets. The basic premise of a compostable toilet is that urine is stored in a small tank at the front, and solid waste is collected in a second tank at the back which has a plastic flap covering it when not in use. The solid waste tank contains a mixture of peat moss or coconut coir and sawdust, and dependent on the model of the composting toilet, you will either add a handful of the mixture each time you use it, or you will have a 'churning' handle to combine the waste and the coir, which minimises any smells. A lot of composting toilets also have a built-in fan which aids the removal of evaporating liquids and vents smells outside of your van, minimising any unwanted odours.

Men will need to make sure to sit down when they use a composting toilet as the urine tank is usually at the front of the toilet, and it's important to keep the liquids and solids separate to minimise any smells! The urine tank can be emptied outside, away from any water sources, in a discreet manner. The solid waste tank can be emptied by transferring the contents into a compostable bin liner and putting it on a home composting pile if you have access to one, or in a general waste bin. The urine tank will need to be emptied every two to four days and the solid waste will need to be emptied every three to seven days. This will vary based on the tank size.

The other option is to install a DIY composting toilet. Companies such as Kildwick provide components or entire kits so you can build your own composting toilet, which is useful as many pre-built composting toilets are quite large, taking up a lot of space in your van. Building a composting toilet means you can utilise the space you have available. Pre-built composting toilets can also be very expensive - the Nature's Head toilet is £1,000! A DIY composting toilet will be much more budget friendly, with the components needed coming to around £250.

If you decide against installing a toilet, you will need to ensure you are a responsible van dweller. Invest in a poo shovel so you can dig a hole that is 15cm deep and at least 50m away from any water sources. Any toilet paper should be packed out (taken away) and put in a rubbish bin. Coloured sandwich bags or dog poo bags work well for this purpose. And if you need a wee in the night, there's nothing wrong with a wide mouthed Nalgene bottle!

OPPOSITE Grab your shovel, and find a secluded spot in the bracken… *@climbingvan*



TOP A portable loo equals a poo with a view. *@briskventure* **LEFT** A Nature's Head toilet. *@nauticalnomads* **RIGHT** The Kildwick EasyLoo blends in with its surroundings. *@wir.ueberall*

Toilet comparison

	Portable toilet	Composting toilet	DIY composting toilet
Cost	£100+	£300-£1,000	£150-£300
Emptying experience	Not ideal!	Not too bad	
Frequency of emptying	Once a week	Liquids: 2-4 days Solids: 1 month	
Size	Medium	Big	Medium
Smell	Chemicals	Earthy	
Example	Dometic 972	Nature's Head	Kildwick EasyLoo

CHARLIE SAYS:
We originally didn't include a toilet in our campervan. We are used to wild camping and climbing in remote spots, and regularly have to cope without a toilet. However, as we are now living in our van full time, we have since decided to build a DIY composting toilet in case of emergencies. This means that if we can't find a suitable spot outside or a public toilet, we have a back-up.

Paying a professional

If you don't fancy installing your water system yourself, you can pay a professional van builder to take on the job for you. The specification of your water system or the specific task you would like them to complete will affect the cost.

Paying a professional

	Parts cost	Supply & fit
Underslung water tank	£150	£550
Tankless water heater	£130	£265
Boiler	£300-£1,400	£550-£1,650

Gas and heating

DISCLAIMER
We are not professional gas engineers. We hope the information is useful to you, but is not professional advice, it is intended as a guide only. Every campervan conversion is going to be different so please use this information only as a reference.

Gas has a plethora of functions in a campervan - allowing you to cook dinner, keeping you warm in the winter, heating water for a shower, and it can even be used to run your fridge! A lot of people are nervous about installing a gas system in their campervan as it's very flammable and explosive, but the benefits of a gas system far outweigh the complexity and cost of installation.

Of course, it's possible to build a campervan without a permanent source of gas and to just use a portable gas stove with camping gas bottles, but this isn't very practical for anything other than the occasional weekend trip in a smaller van. Most people will want to consider installing a gas system at least for their cooker.

In Europe, propane in the form of LPG (liquified petroleum gas) is commonly used as it's an efficient use of fuel that performs well over a range of temperatures. LPG is stored a inside a pressurised tank. Pressurising LPG both minimises the space required to store it, and acts as a pump to push it around the system.

All gas systems have both a low and high pressure side. The high pressure side of the system operates at 7,600mbar at 21.1°C and extends from the fill point through to the cylinder and finishes at the pressure regulator. Everything beyond the pressure regulator is classed as the low pressure side and operates around 30mbar with a max flow rate of 1.5kg/h. It's important when you're working with gas

that you note the unit of pressure (bar or mbar), as 1bar equals 1,000mbar.

In its liquid state, LPG weighs approximately half of the equivalent volume of water. It's naturally colourless which is why odour is added to it. The unpleasant 'rotten eggs' smell of gas makes it easy to detect in the case of a leak.

LPG can be dangerous. It's very flammable, and can also cause carbon monoxide poisoning. Carbon monoxide is produced by the incomplete burning of LPG gas. When you breathe in carbon monoxide, it enters your bloodstream and replaces the oxygen, causing carbon monoxide poisoning. Your gas system must be either installed by a Gas Safe engineer or fully checked by a Gas Safe engineer before testing to ensure the system is 100% safe and to avoid any dangers associated with LPG.

Tank types

LPG can be stored in a gas bottle mounted within your van, or in an underslung tank attached to the bottom of your van. For the internal gas bottles, you can either choose a bottle which is swapped for a replacement when empty, or a refillable bottle. If you are installing a gas bottle inside your campervan, it will need to be stored in a metal-lined box containing a drop out vent. There are several other requirements when installing a gas bottle covered in the design chapter.

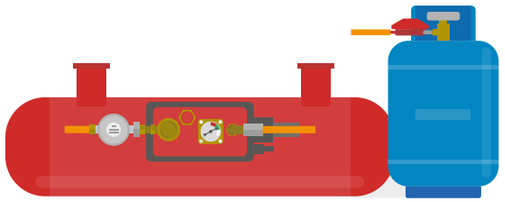
Replaceable gas bottles

If you live in the UK, you've probably seen the cages at petrol stations containing Calor gas bottles - these are the refillable gas bottles that can be used in your van. When they're empty, you simply take them anywhere that stocks them and swap them for a full bottle. It's not the most cost-effective way of buying gas, but it's the easiest system to install. The gas bottle will need to be mounted in a metal-lined box within your van, and as you will be removing the bottle when it's empty you will need to make sure it's accessible.

The downside to these bottles is they aren't so readily available in mainland Europe, and if you're planning on a long, several month trip rather than just a couple of weeks holiday, you may struggle to find a replacement.

Refillable internal gas bottles

Refillable bottles look similar to the replaceable bottles, but they have an attachment so they can be refilled at a petrol station that sells LPG. You can either refill them directly by removing them from your van and filling them up outside, or you can install an external fill point connected to the gas bottle so it can be refilled without removing the bottle.



Gas tank comparison

	Replaceable gas bottle & gas locker	Refillable internal gas bottle & gas locker	Refillable underslung gas tank
Cost	£160 *(£inc. 40 deposit)*	£270	£250
Cost to refill	£3 per litre	£0.64 per litre	£0.64 per litre
Size options	3.9-13L	2.7-11L	16-100L
Installation difficulty	Easy	Medium	Medium
Where can you refill?	Country specific	Most of Europe	Most of Europe

Refillable underslung gas tanks

An underslung gas tank is mounted on the underside of your van, and comes in a much larger variety of sizes than the internal bottles. You'll need to install an external fill point on your underslung tank so you can refill it easily.

DALE SAYS:
We installed an underslung tank because it saves valuable storage space. The installation was relatively simple and we're now able to store twice as much LPG as we otherwise would have been able to.

Gas system components

Gas fill points

If you are installing a refillable gas tank, you'll need to consider where to install your fill point. You should install it on the exterior of your van. If you plan on travelling to Europe in your van (or if you're based in Europe and plan on travelling to the UK), you will need to purchase an adapter for your fill point, as the LPG fill nozzles have different types of attachments in the UK and mainland Europe.

Hoses, tube and pipe

What's the difference between a hose, a tube and a pipe? And no, this isn't the start of a Christmas cracker joke! Hose is typically reinforced and flexible, whereas tube is more malleable, and pipe is rigid. As with many aspects of converting a van, there's no hard and fast rule as to the most appropriate option for your specific build and you may indeed use a combination of products here. You should ensure all hoses and pipes are capable of withstanding the pressures expected within both the high and low-pressure sides of the system.

Flexible hose

The two most common options of flexible hose are synthetic rubber and thermoplastic hose. They both typically feature an integral high tensile mesh to reinforce the hose and protect it from tearing. Flexible hose should not be used for permanent interior installations as it can degrade over time and is vulnerable to vibration and chafing.

However, they are the most common way of connecting internal gas tanks to non-permanent camping stoves as they allow you to easily move the respective elements around and disconnect them when needed. They're also used when connecting to tankless hot water showers as they are made for outdoor use and so need to be moved outside your van whilst in use.

WARNING:
Flexible hose should be used in applications requiring appliances and tanks to be moved whilst the gas supply is connected. It should only be used for short lengths of less than 75cm when flexibility is required to connect appliances that slide in and out of position.

Malleable tube

Semi-flexible copper tube is commonly used in van conversions and is also available with a PVC coating for added protection. The malleable tube comes in long reels and can be gently bent to meander around and through obstacles in the van without the need for connectors at every turn. We'd recommend you use a pipe bending tool so the pipe doesn't kink and create a weak point, or even worse, create a split in the pipe. Generally speaking, a safe minimum bend radius can be established by multiplying the outer diameter of the tube by three.

The other advantage of copper tube is it won't deteriorate over time and is resistant to vibration, which is important in a van that sees

excessive vibration when moving. It's also fairly resilient to damage, especially with the PVC coating in place.

Malleable PVC coated copper tube should be used throughout most van builds except in applications where connections or appliances need to slide in or out of position or shall be moved regularly.

Rigid pipe

Rigid copper pipe is the norm in domestic environments and is occasionally used in van builds. Unlike its more flexible brother, the rigid pipe should not be bent or flexed and needs angled elbow connectors to change the direction of the pipe. Each elbow will need sealing with a semi-permanent compression fitting, or a permanent soldered or brazed joint to create a rigid sealed connection.

The problem with using rigid pipe in your campervan is it's not being used in a rigid or static environment. Unlike a domestic setting, your van will vibrate and move around as you drive, and if the rigid pipe resists this movement and the vibrations are severe enough the pipe will develop a crack and leak. This is not something likely to occur quickly, and is very much a long term fatigue issue, but given the rigid pipe is harder to install and has a similar cost to flexible pipe, it makes sense to not use it in this setting.

Sizing your hose, tube and pipe

Once you know what hose, tube and pipe you need for your conversion, you need to work out what size to use. The aim should be to pick a size that won't restrict your appliances combined maximum flow rate which could limit the function or performance of the product. Whilst calculating this from scratch can be complicated, all you really need to check is the capacity of your pipe can meet the combined requirements of your appliances.

A gas system in a campervan will typically comprise no more than a boiler, a heater and a cooker. The combined capacity of these appliances could be up to 100ft^3/hr. As long as you are not using a combined pipe length of more than 16m, a ¼ inch or 8mm OD copper pipe will more than meet the requirements for your system.

If you intend to use any domestic appliances, they will likely be designed for 15-28mm pipe sizes as houses require a greater flow rate capacity due to the distance between and the number of appliances. This is easily addressed with reducers and connectors which allow you to transition between different pipe sizes.

Gas manifolds

A manifold is used if your gas bottle is feeding more than one appliance, and allows you to turn off the gas supply to a specific appliance. This is useful both at the point of installation to ensure there are no leaks, and also when you're leaving your van for long periods, as it's a good practise to turn off the gas connection to each appliance when it's not in use. It's a good idea to install your gas manifold somewhere easily accessible such as in your kitchen area, so that you can easily turn the gas on and off when not in use. If you're only supplying a single appliance with gas, you can turn the supply off directly from the bottle or using an isolator valve, so won't need a manifold.

Drop out vents

Drop out vents are an extremely important safety feature in any gas system. As gas is around three times heavier than air, in the case of a gas leak, any gas will sink to the floor. This means if you install a drop out vent, the gas should be able to escape from the van. You should install a drop out vent under any connection that could leak, so we'd recommend installing one at any of the following points:

OPPOSITE Cooking breakfast, sunlight streaming into the van, on our very first weekend away in a finished Ringo. *@climbingvan*

- Gas manifold
- Any connection between pipes
- Where your gas connects to an appliance

In addition to drop out vents, carbon monoxide alarms should be positioned next to potential leak paths, such as the manifold and in the primary living space.

Gas appliances

Hobs

If you plan on living in your van full time or spending as much time as possible in it, a fixed hob at the very least is sensible. A fixed hob or oven can be permanently connected to your gas system, allowing you to install a refillable tank and save money. If you're converting a smaller van, you may opt for a portable camping stove to save valuable countertop space.

There are caravan and boat two ring hobs available that take up very little space, and many options have a fold-down top to provide extra counter space when the hob is not in use. If you are converting a larger van, it's worth considering a domestic hob as these are usually cheaper than their caravan counterparts. They are very easy to install using an adapter and swapping to LPG nozzles which usually come with the hob, providing the hob has been designed for use with natural gas.

An electric induction or infrared hob isn't a viable option for a campervan, as the power draw for even a single medium-sized ring is between 1200-1800W. Some domestic induction hobs use 7000W for multiple rings running at any one time; this isn't worth entertaining!

Ovens

Fixed oven

Fresh bread, full roast dinner...believe it or not, it's all possible in a campervan. If you're an avid baker, an oven will likely be an essential in your campervan. However, the downside to installing an oven is that they take up what would otherwise be valuable cupboard space in your kitchen.

Omnia stovetop oven

The Omnia is a portable stovetop oven made of three parts. The steel base sits directly on a gas hob, and the baking pan and lid sit on top. Air is trapped between the steel base and the pan and lid, and heats up to cook your food. In theory, anything you would cook in a normal oven can be cooked in an Omnia.

The rounded shape means you can't fit quite as much in, but you do end up with doughnut shaped food which is quite fun! For some, an oven may be essential in their van, but for everyone else, the Omnia is a great alternative.

Oven comparison

	Fixed oven	Stovetop oven
Price	£400	£40
Ease of installation	Medium	Very easy
Ease of cooking	Easy	Medium
Weight	18kg	500g
Space required	Medium	Very low

Heaters

Returning after a long day out in the cold and sitting in a warm, cosy van is a great feeling. If you decide to install a heater, you have a few options. Heating is measured in kilowatts, which is the amount of power the heating source can output into your room in an hour. To heat a large van, you will need anywhere from 0.1-1.5kW from a heating source, depending on the external temperature, your insulation

TOP Ethan and Katelynn's dreamy setup means they can cook dinner with a different view every day. *@thehuntersvanlife*
BOTTOM The Omnia stovetop oven is incredibly versatile, negating the need for a permanent oven. *@vanderful_lerry*

scheme and the number of people inside the van. Heaters with greater power than this will simply heat the space quicker.

Before we delve into the various options, let's remove electric heaters from the equation! Electric heaters typically function in one of two ways, by using convection or radiation. Convective heaters use electricity to heat a highly conductive material and then use airflow to transfer that heat to the user or space.

If you wanted to achieve a comparable heating performance to that of a 2.1kW diesel or LPG heater from a convection electric heater, you would firstly need a 2400W inverter to manage the power requirements and if you had a 150Ah battery bank, it would run your battery down to 50% in less than 30 minutes! Radiant heaters use around one-third of the power for the equivalent heating performance, so although this is a slight improvement, it will still run a 150Ah battery down to 50% in less than 1.5hrs.

As you can see, electricity is not an efficient way of heating when off-grid as it uses a lot of power to produce heat, and therefore, it's not a viable option for heating a campervan. You may think if you intend on spending all of your time on a campsite connected to shore power you will essentially have a limitless supply of electricity and so in this instance, you will be fine using an electric heater. However, even in this case a lot of campsites limit their supply to 10A which will provide you with 2.3kW of power, so that would be enough to run only your heater and not a single other appliance in your van. This is why we have not mentioned electric heaters in our comparison.

Diesel heater

A diesel heater uses diesel to heat your van, either tapping into your existing fuel tank for its fuel source or by using an additional fuel tank installed internally, and the thermostat and the internal fan require a 12V power supply. The heater draws air from outside your van through an air duct, and an internal combustion process uses the diesel to heat the heat exchanger coils. Hot air is then blown into your van and heats the space.

Diesel heaters have low energy consumption and quickly heat the space in your van, although they can be quite noisy, particularly from the outside so they don't make you the most discreet person in the world if you're wild camping! It's possible to purchase diesel heaters that come with thermostats which can automatically turn the heater on when the ambient temperature drops below a certain point. This is useful for keeping warm overnight and not waking up to a chilly van in the morning!

PROS

- Heats up quickly
- Intelligent thermostat options

CONS

- Use more electricity than a gas heater
- Require tapping into the existing fuel tank or installing a second tank
- Standard models are very expensive
- Very noisy from outside
- Require regular servicing carried out by a professional

LPG gas heater

A gas heater works in a very similar way to a diesel heater but instead uses LPG as its fuel source for its heat exchanger. Gas heaters usually come with a temperature-regulating thermostat to maintain the ambient temperature in the van. Presuming you are installing a hob in your van, you can use the same energy source to power your gas heater which means you don't have to install an additional tank or worry about tapping into the diesel tank of your van.

PROS

- Heat up quickly
- Most come with intelligent thermostats
- Can use existing fuel source (as long as you're installing a hob already)

CONS

- Standard models are very expensive
- Require regular servicing carried out by a professional
- Can be noisy when in operation

Log burner

A log burner is a much more traditional way of heating your campervan. They produce heat by burning wood inside a stove which radiates heat and warms up the surrounding area. Log burners are the perfect way of having your own cosy cabin on wheels. You must only use dry wood in your log burner, as damp wood can generate soot and tar, blocking the flue.

It's much harder to control the temperature of a log burner than a gas or diesel heater. Once you light a fire, you have very few ways of controlling the heat output. In such a small space you may find a log burner gives off far too much heat. There's also no way of keeping it lit overnight unless you get up every couple of hours to add wood, meaning it's not a good option if you want to wake up feeling cosy!

PROS

- Much cheaper upfront cost than other heating options
- Very easy to maintain
- Cosy and atmospheric
- Quiet (and sound lovely!)

CONS

- Take a while to heat up
- Hard to regulating temperature
- A lot of insurers will not insure against fire damage from log burners
- Higher risk of carbon monoxide issues

ABOVE There's nothing cosier than enjoying the heat from a crackling fire on a wet and stormy day. *@jakecoleman* & *@rochelleallen* **OPPOSITE** It doesn't quite have the charm of a log burner, but when a diesel heater has the power to keep you toasty and warm, you'll love it like a baby! *@onthefreeside*

Heater comparison - fuel prices January 2021

	Diesel heater	Gas heater	Log burner
Cost	£100-£800	£500	£100-£400
Fuel source	Diesel	LPG gas	Wood
Output / hour	2.9kW	2.2-2.8kW	2-4.5kW
Fuel usage / hour	0.1L	0.1L	1-2 logs
Fuel cost / hour	£0.15	£0.06-£0.18 *Refillable vs. replaceable cylinder costs*	£0.00-0.33 *1m³ bag of logs = £100. Free if you find your own logs, but they need to be dry!*
Ease of installation	Medium-hard	Easy	Medium
Example	Eberspacher Airtronic	Propex HS2000	Cubic Mini Wood Stove

Boilers

If you want a hot water supply in your van, it will more than likely use your gas supply to heat the water. We have covered the different options in detail in *Water* on page 94.

Paying a professional

As installing a gas system can be nerve-wracking, it's one of the most common jobs outsourced to a professional. We have detailed some costs from van builders for installing different types of gas and heating systems.

A van builder who can install your gas system will be Gas Safe registered, so you know your system will be 100% safe. If you do decide to install your gas system, you still need to have your system checked by a Gas Safe engineer before it's commissioned.

Paying a professional

	Parts cost	Supply & fit
Diesel heater	£500	£685
LPG heater	£500	£685
Gas tank and locker	£270	£350
Underslung tank	£250	£775
Oven	£200-£500	£350-£650
Hob	£100-£300	£250-£450
High spec gas system	£800-£1,200	£2,000-£2,400

THREE

Design

Planning → **Define** → **Concept** → **Develop** → **Build**

Planning — Learn what's required to convert a van and investigate the possible methods of achieving your aspirations

Define — Understand what you need to create the perfect van and what layout and systems will make it possible

Concept — Explore all of your ideas and establish what is and isn't possible through sketches and scaled models

Develop — Generate detailed plans to inform the build through challenging your design and integrating systems

Build — Create the van of your dreams with the understanding and confidence gained from the design process

How to design your van

When it comes to designing your van, where should you start? Whilst sketching layouts may seem like the obvious first step, there's more to consider before picking up a pencil. The design phase is the pivotal moment in your van's development, where cost, complexity and build time could spiral if you're not careful.

There are many different approaches you can take when designing a campervan, but we believe the most effective way is to adopt the user-centred design process. This is an approach used to break down a large project into logical phases, focused on meeting the needs of the user throughout. It will ensure you spend time taking your campervan layout from a few scribbles to a fully matured design. The user-centred design process provides the foundations for the middle three pillars of our van conversion process, and will make up the core sections of this chapter.

Define

Determine exactly what you need from your van. Don't try to come up with any solutions, simply define your requirements. You should refer back to them throughout the process, so you can ensure your layout meets your needs.

Concept

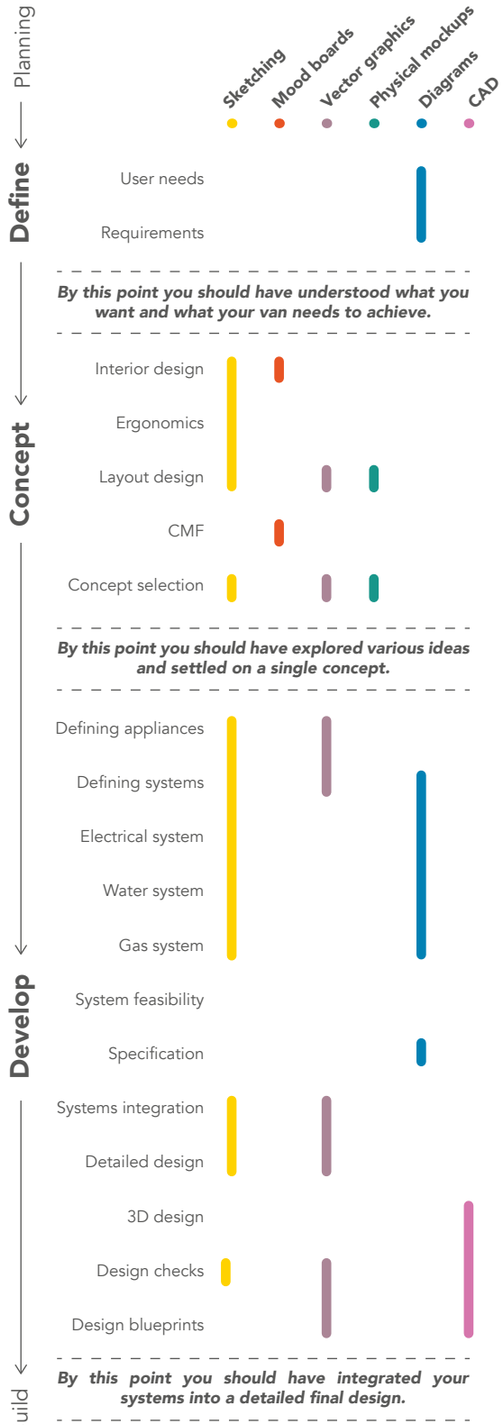
Explore ideas for your campervan layout, using paper sketches, graphic design programs and even physical models. Use mood boards to establish your interior design preferences, and combine the two to help you decide on a concept. Refer back to your requirements throughout this process to ensure your chosen concept meets your needs.

Develop

Develop your concept by defining your electrical, water and gas systems, and create schematic diagrams for each. Generate more detailed layouts and ensure your final design meets your requirements. Integrate your systems and your layout to produce a final 'blueprint' you can refer back to throughout your build.

There's a lot to consider throughout the design process, so we've created a timeline to illustrate this. Each phase is broken down into sub-tasks, which form the sub-sections of this chapter of the book. At the top of the timeline are the various tools that can help you complete each task (don't worry, these will be explained later). We recommend you design your van following this timeline, using it as a reference point throughout the design process. At the end of each of the Define, Concept and Develop phases, you should ensure that you have completed all of the sub-tasks before moving onto the next phase.

A good design process is not linear, and it's normal to repeat stages several times before you're ready to proceed with your build. You should constantly check you're still achieving your user needs and requirements, make adjustments as needed, and ensure your layout and aesthetic preferences are compatible with each other.



Ignoring the design process or rushing it will likely mean you end up with fundamental problems with the functionality, quality or usability of your finished van. If you don't spend enough time planning and designing your van, it's likely you won't be happy with the result or achieve your required functionality and finish.

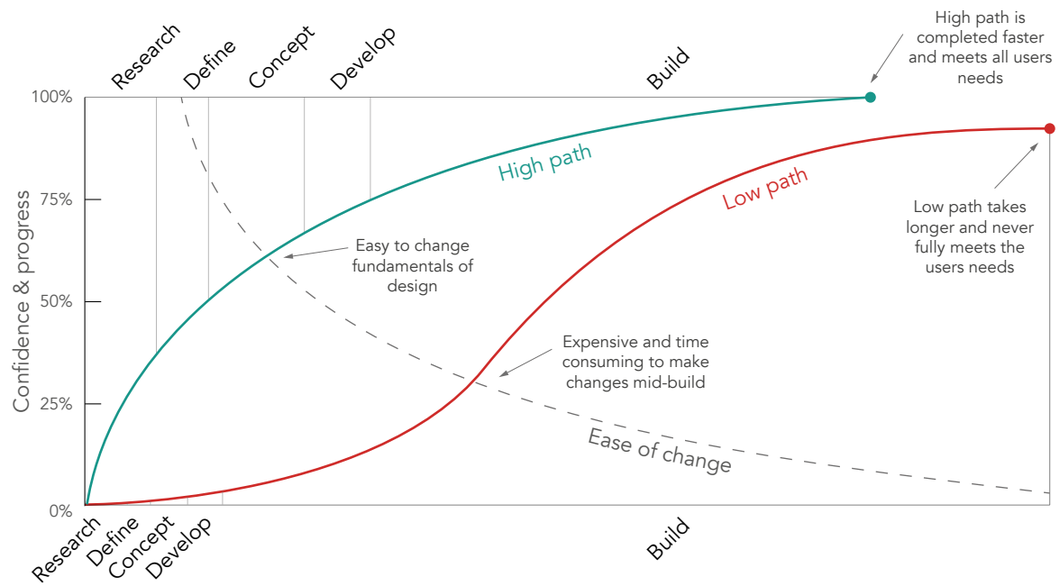
So many people fall into the trap of cracking on with their build straight away, only to realise a couple of months after finishing their van, that it doesn't actually meet their needs. They're left with the choice of living with something that doesn't work, or selling it and starting again. We even know of someone who realised halfway through their build that they couldn't fit everything they needed into the size of the van they bought and ended up selling it mid-build to start a new one! Ideally, you should design your layout and systems before you buy a van to mitigate this risk, allowing you to change vehicle if it transpires you need something of a different size, performance or cost.

The graph on the opposite page shows the possible routes your project could take depending on how thoroughly you work through the design stage.

The low path

- If you only spend a couple of hours planning and designing your van, you'll likely follow the low path. You'll start the build early but risk costly changes towards the end when it's hardest to make them.
- You'll be learning as you build and will be under pressure to solve lots of interconnected challenges on the fly.
- You're unlikely to meet all of your needs, and the total design and build time will likely be longer than the high path.

CAVEAT:
If you're experienced and have built vans before or already have a good understanding of a



particular phase, all of that prior knowledge can be used again so you won't need to spend as much time in the concept and develop phase.

The high path

- You're off to a great start - simply by reading this book you're already following the higher path and will have efficiently gained invaluable knowledge to start your build.
- You'll save countless hours by immersing yourself in planning and design, ensuring you avoid costly mistakes whilst building your campervan.
- Spend an adequate amount of time planning and designing before your build and you'll dramatically reduce your risk of mistakes, and make the build and overall project time shorter.

Another slippery slope is simply copying someone else's layout and systems. This can save you a lot of time but you have to be confident that A) they carefully considered their layout and requirements and B) you have very similar needs and requirements.

Building a campervan gives you the freedom to break away from the one-size-fits-all motorhomes and allows you to tailor something specific to your needs, so don't be afraid to deviate from the norm.

DALE SAYS:
The iPhone is a great example of a single product that manages to meet the needs of a whopping 728 million users.[13] Apple gives its customers the power to customise their device by downloading the apps that are most important to them, rather than trying to dictate a single set for everyone to use.

The physical phone in many ways is like an empty van: carefully designed to be as reliable as possible and non-controversial in its appearance. But the empty vessel can be tailored to its owner's needs. Sure, every iPhone user will have some apps that are the same, but it's rare to find two homepages that look

13 Statista. 2017. iPhones in use worldwide. Available at: <https://www.statista.com/statistics/755625/iphones-in-use-in-us-china-and-rest-of-the-world>.

the same. Even if they contain common apps, they're often laid out very differently, as each person will position what is most important to them in a different way...much like a campervan.

Design time vs build time

So how do you know how long to spend designing when you don't know how long your build will take? (Try and say that five times fast!) We used data from the Climbingvan 2020 Van Conversion Survey to establish the reference graph below.

To work out how long you should spend planning and designing your build, multiply your forecasted build time by 20%.

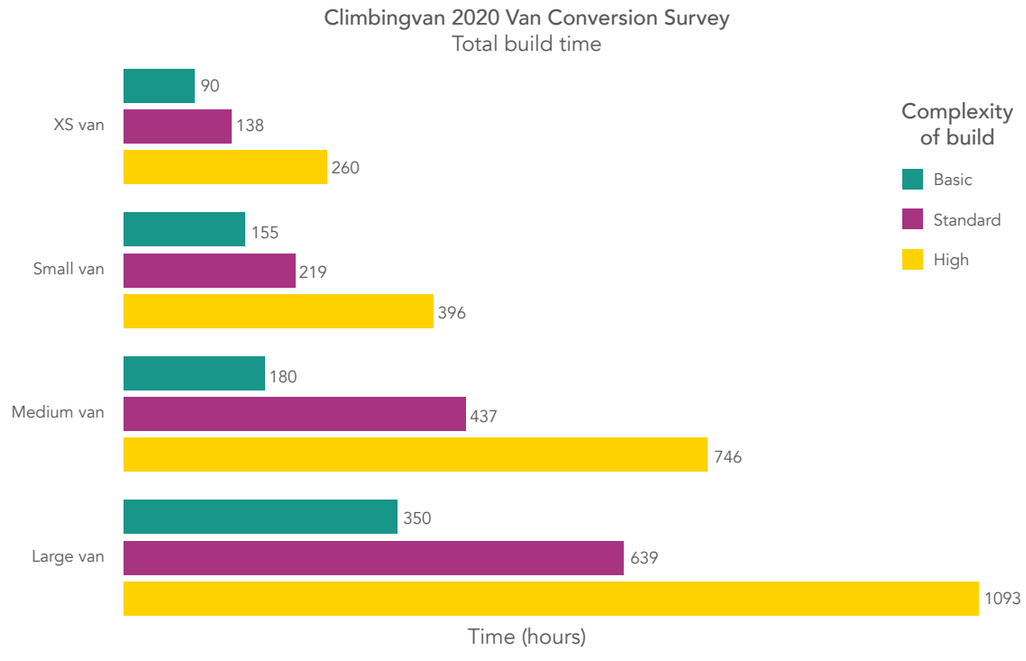
Example
To calculate planning and design time for a medium-sized van with a high finish:

746 hours x 0.2 (20%) = 149 hours

746 + 149 = 895 hours total

These timings assume you have limited DIY experience and haven't built a van before. The time also doesn't include any tea or coffee breaks, and is based on the combined hours of two people working on a build (e.g. 1,000 hours for a large, high spec and finish van equals two people working on a van for 500 hours). If only one person is working on the van, you will probably find your total is slightly less than that indicated in the chart, as it's unlikely the combined time of two people will be as efficient as a single person. You will both need to have a clear vision of what you're trying to achieve and an equal willingness to learn and get your hands dirty.

However, you will also find many jobs simply aren't possible on your own, so training up your partner, friends or kids is a good plan.



OPPOSITE Jacqui and Laura's well designed Sprinter layout combines practicality with a cosy aesthetic. Their layout worked so well for them that they used the exact same design for their second campervan! *@brownbirdandcompany*

You may think if you don't have any previous DIY experience that converting an entire campervan is much too big an undertaking, but it's important to remember everyone has to start somewhere!

It is also important to note the timings are average values and so they will only act as a rough guide as opposed to a definitive amount of time. Cast your mind back to the case studies in Planning, where Jo spent 1,800 hours on her build. Although she has a medium-sized van with a standard finish and system spec, she painstakingly sanded every piece of reclaimed timber and made every cushion cover, which meant her build took over four times longer than the average!

Define

The key to building the perfect van doesn't need to rely on vast amounts of experience, money or luck. We know van owners who have gone through several van builds and still don't have something they're happy with. Despite now being very competent builders, they've struggled to identify exactly what's required from their layout and systems to meet their needs. This is extremely expensive and time-consuming, and not a recommended approach!

The previously mentioned user-centred design process is a design philosophy which aims to address the needs and desires of the user. This ensures that the end product (your van) meets your needs and requirements, which is ultimately the sign of a successful van build. To do this you will need to define your user needs and requirements, and generate a specification. But how does it all work?

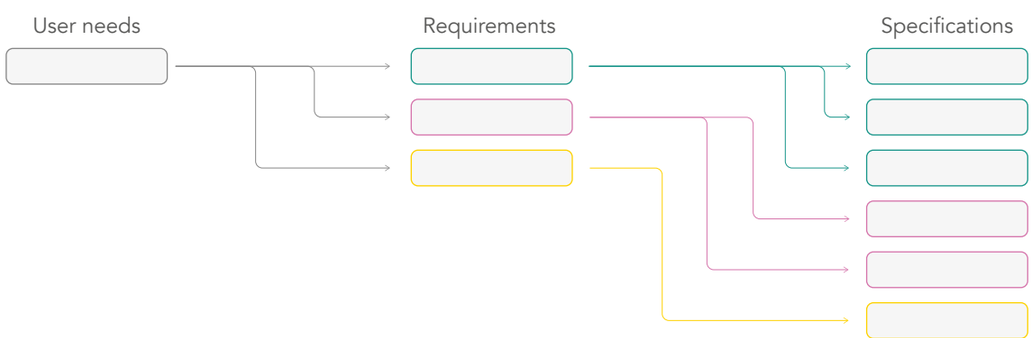
User need: A user need focuses on high-level goals rather than preferences. Goals are the things you must have, whereas preferences are things you may want or like.

Requirement: A set of requirements provide further detail to each individual need.

Specification: The specification provides the exact details of the solution to each individual requirement.

These definitions are slightly different to how they're usually explained, but we have defined them in this way to simplify them for the van conversion process.

The process flow diagram exemplifies a single user need, and the relationship of the requirements and specifications to that user need. When defining the requirements for your campervan, you will need to follow this process flow several times for each user need.



User needs

To define your user needs, start by writing down a basic list of things you need from your van. Ideally, no two needs should overlap, and they should cover everything your perfect van would include. Your user needs can be organised into four groups, which we have loosely based upon Maslow's hierarchy of needs:

Physiological: (food, water, excretion, sleep, air and shelter)
- "A place to store, prepare and cook food."
- "Hot and cold running water."
- "A place to sleep."

Safety: (personal safety, health and storage of possessions)
- "Space to store possessions and equipment."
- "Safe environment to spend time."

Social: (meeting with friends and relaxing)
- "An environment to socialise and relax in."

Work: (connectivity and a comfortable environment)
- "A comfortable working space."
- "A means of connecting with the outside world."

Requirements

The next step is to write out a list of requirements within each user need. These requirements should detail all of the things you will need to make the user need possible but without going into the nitty-gritty of specifying the exact method or products needed to achieve it. An example would be "The van should maintain a warm internal temperature in cold weather conditions". When you're thinking of requirements for a specific user need, try thinking about the following three groups to generate content. We have included a couple of examples for each group.

Usability
- "The van should have a bed big enough for two people to sleep comfortably."
- "The van should have enough room to stand upright in."

Tasks
- "The van should have a pull-out table to use a laptop and work on."
- "The van should have a sink with running water big enough to wash up in."

Environment
- "The van should stay cool in warm conditions."
- "The van should block unwanted noise."

ABOVE Dale the designer hard at work. *@climbingvan*

Specification

The final step is to write out a detailed specification. This will list the equipment or functionality needed to achieve your requirements. Each requirement will realistically need one or more specifications to fully define what you need, but doing this before you have started drawing layouts and developing your design and systems will be tricky. You should leave the specification column blank for now and we'll revisit this later in the design process.

Below is an example set of requirements and the specification for a single user need to give you an idea of how to write them.

DALE SAYS:
All of this may sound a bit dull, but it is important. Once your van build is complete you may remember this section fondly. Hopefully, that's because you built something you're really proud of which meets all of your needs, and not because you skipped the boring bit, started building straight away, and are currently regretting it!

Example table of requirements

User need	Requirements	Specification
Provide a comfortable place to sleep.	The van should maintain a warm internal temperature in cold weather conditions.	2kW LPG heater with thermostat
		Insulation: bottle wool, insulation board and vapour barrier
		Thermal blinds
	The van should stay cool in warm conditions.	400x400mm skylight to maintain ventilation
		See insulation stack for radiant heat deflector
		Air conditioning unit
		Side windows for ventilation
		Sound deadening material
	The van should have a bed big enough for two people to sleep.	Full length double mattress
		Double mattress bed slats
	The van should allow natural and artificial light to be controlled.	Electrical system to provide power for 12V spot lights
		2 way switch to control two sets of lights from two locations
		Integrated blinds for windows and skylights

OPPOSITE Charlie and Josh's Mercedes Vario has a cosy bedroom with stunning panoramic views. *@wandering_home_*

Concept

Design tools

Most design processes for physical products rely on prototypes to scrutinize a design at different stages, and provide an opportunity to troubleshoot it. As this simply isn't viable for a one-off van conversion, instead you should critique your layout and design using a few different tools to ensure it will meet all of your requirements.

There are a range of design tools you can use to plan and design your van, but using them at the right time is the important part. Refer to page 113 for an overview of when each tool can be used throughout the process.

Design tools

Phase	Design tool	Design maturity
Concept design	Sketching	Brainstorm initial ideas, basic layout development and design details.
	2D graphic design software	A selection of initial concepts have already been sketched and can now be digitally modelled to scale.
	Physical mock-ups	A scaled concept has been selected and sizes need to be verified.
Design development	Diagramming software	Create initial systems architecture diagrams for electrical, water and gas systems.
	2D graphic design software	Integrate systems architecture diagrams with your layout.
	Detailed sketching	Small complex details are refined through sketches.
	3D CAD	You're confident in your layout and your systems look viable, but you want the peace of mind that everything fits in a 3D environment.

As a general rule, you want to use the more basic tools at the beginning of the design process. As you gain confidence in your design, you can gradually transfer it to more and more complex design tools to refine the details. The biggest mistake you can make in the design process is committing to 3D design tools or CAD (computer-aided design) too soon.

It's easy to get distracted creating a fancy looking CAD model, and you could easily end up spending vast amounts of time on a design that doesn't meet your requirements. Although CAD is an exceptionally useful tool, it's often time-consuming to make significant changes, making it easy to dismiss them and stick with the original design even if it's ultimately not right for your requirements. This is referred to in the design industry as 'ugly baby syndrome' or less politely, 'polishing a turd'.

2D design tools

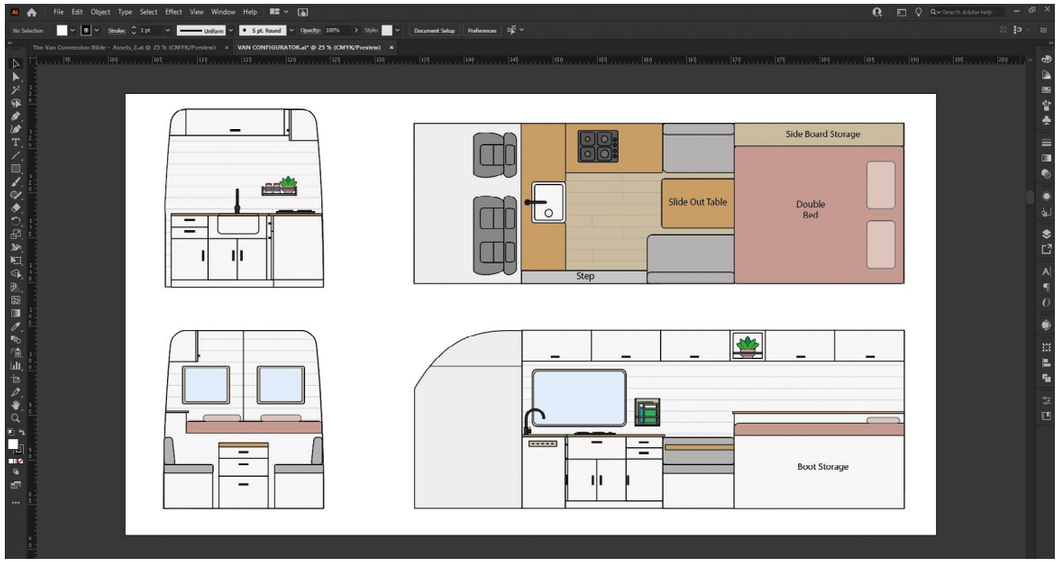
Sketching

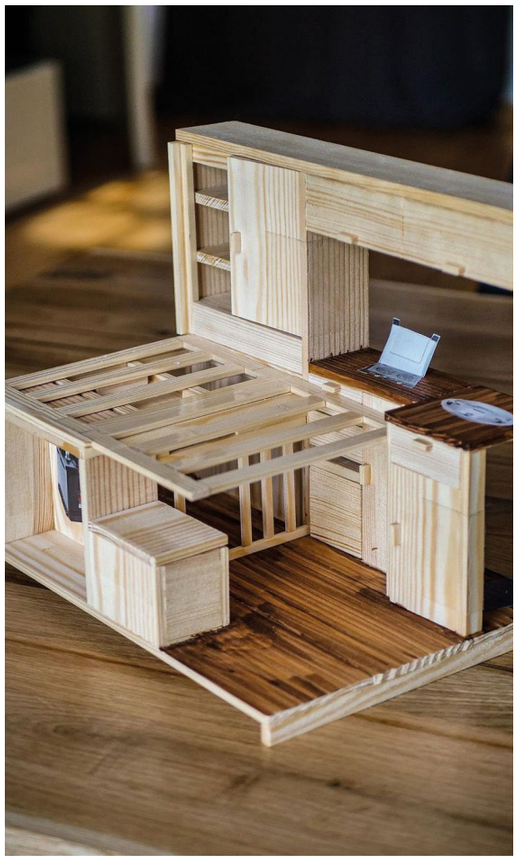
Arguably the best way to design your initial concept layout is with a pen and paper. Even if you're not great at drawing, the important thing at this stage is to generate a large number of ideas so you're confident you have explored all of the available options. No other tool is as quick to help you explore your early ideas and to iterate at the beginning of the design process. Sketching should be used throughout the entire design process as an aid to solving challenging areas.

Graphic design software

Graphic design software, commonly known as 'vector graphics' software, is used by designers, engineers and architects to digitally draw shapes and structures, creating scaled representations of real-life objects. This is essentially a fancy version of Microsoft Paint! There are several different graphic design programs available.

ABOVE See, we told you the hard work was in the planning and design! Lisa taking a well deserved break (and dreaming of her finished van!). *@travelution_*





TOP Design it, prototype it, make it! For us, Adobe Illustrator was *the* most useful tool when design our van. *@climbingvan*
LEFT & RIGHT Building a miniature model of your van is one of the best ways to visualise your dreams before they become a reality. *@igor.explores*

Graphic design programs are some of the most powerful tools for van converters to plan their build. They allow you to create a layout to scale, using shapes to represent beds, units, equipment, and really anything else you can think of! Producing orthographic (top-down), section (cut through) and detail (highlighting an area of complexity) views can be useful to check a floor plan layout works from all orientations.

There are several graphic design programs you can use, many of which are free.

Adobe Illustrator - *£19.97 per month*
Illustrator is a graphic design program developed by Adobe, and is the most established program of its kind. We used Illustrator extensively to design our van, and to produce the content of our van layout configurator tool.

Vectr.com - *free*
Vectr is a free graphics program used to create vector graphics easily and intuitively. It's a simple yet powerful web and desktop cross-platform tool that lets you bring your designs to reality.

PowerPoint or Google Slides - *free*
PowerPoint and Google sheets can be used in much the same way as the aforementioned pieces of software. Set your paper size a little bigger than the size of your van and work at a 1:10 scale (drawing:van). By using simple shapes and lines you can quickly map out a potential layout and copy the slide to create an iteration.

Constructing a virtual van layout is simple. Using basic shapes and lines, features can be combined and grouped to represent an item, which can then be moved around in a 2D plane until everything fits. Once the basic elements have been created, you can make a copy which will allow you to modify and refine your design whilst capturing your progress.

The ability to create a copy and easily make changes is the reason this relatively low fidelity tool is so powerful at this stage of the design process. Once you learn the basics, you will also find you can use these tools to solve more complex challenges such as mechanism design (defining the movement of an object) and producing system diagrams.

Setting your paper size to A2 (420 x 594mm) and working with a 1:10 scale (drawing:van) should allow you to fit a large van onto the sheet at scale, letting you quickly define shape sizes by dividing the actual size by 10.

Paper-based 2D design

If you would rather avoid computer software, it's still possible to develop your design to scale using a ruler or using graph paper (with 1cm squares). It's just a little slower to make changes and iterate in the same way that you can with vector graphic tools.

Physical modelling

If you already own a van at this stage, using a combination of masking tape and cardboard boxes to construct a lightweight representation of a potential layout is a good idea to help assess the size and position of each item. You should either draw or create layouts by another means first so you can spend more time refining a layout which shows promise before putting time into creating a physical model. If you haven't bought your van yet you could even make a model van out of a cereal box!

Basic modelling techniques are employed by designers, engineers and architects all the time, as it's the quickest way of creating a physical 3D object that's cheap and easy to modify. It's important to remember you're not aiming to produce a beautiful sculpture, you just want to work out if everything is going to fit and create a practical living space.

Interior design

Before you start drawing layouts and refining details, it's a good idea to consider the interior design of your van, which means thinking about colours, materials and finishes. This will help you set an aspirational target to work towards as you design your layout.

We wanted to achieve a clean, Scandi vibe in our van so we chose to include a lot of exposed wood. This meant we bought high-quality birch ply for visual areas, and attached it from one side to avoid any visible screws. It's little details like these that are hard to do on the fly and will work much better if you plan ahead.

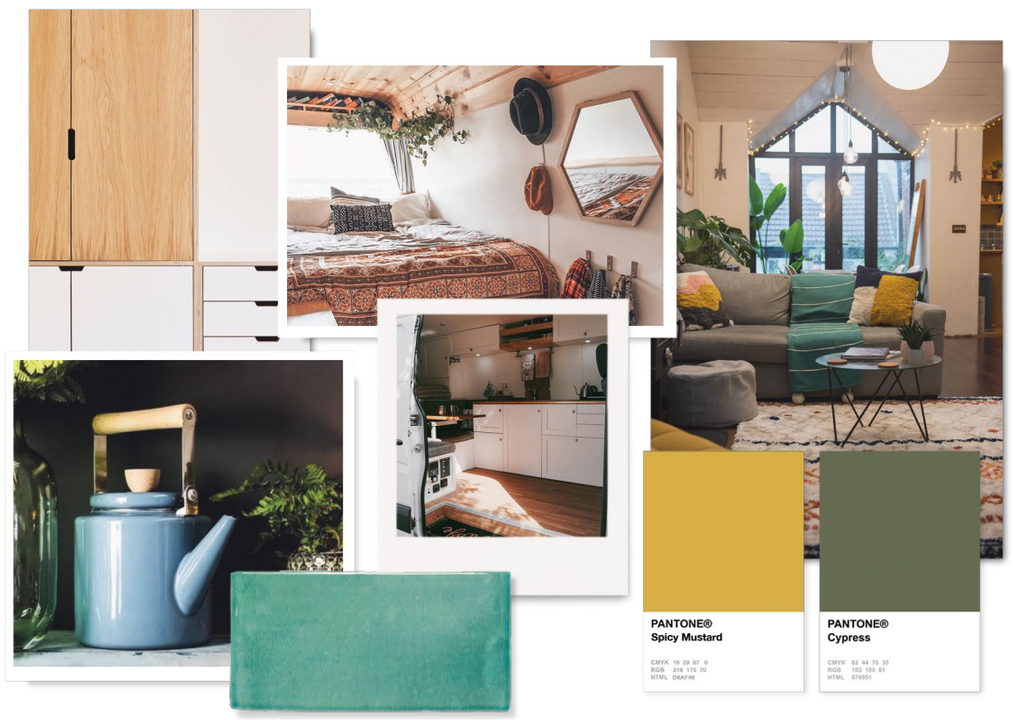
Mood boards

Mood boards are a great way to set the visual direction of your project, especially if you're building a van with someone else. They don't need to be made of magazine cuttings, nor do they need to be static - using video alongside pictures is a great way to define your vision.

Using Pinterest is perhaps the easiest way to do this so you can quickly pin content to virtual boards to help organise your ideas. Initially, you'll probably want to pin hundreds of things, but it's worth making a more concise version to refer back to when designing and building your van.

Here are our top tips for creating a genuinely useful mood board!

- Source ideas from houses, art, anywhere - not just vans!
- Try to cover design styles, colours, materials and finishes on the same mood board.
- Ideally, the whole board should have a common theme, for example, Scandinavian minimalist or log cabin.
- The mood board doesn't need to show specific layouts or van models, just concentrate on the internal aesthetics.
- Don't just source your content from Pinterest, install the 'Pinterest Save Button' extension so you can add content from Instagram and other websites too.



ABOVE Our moodboard included campervans we loved (@we_who_roam and @lifeultralight), as well as details of our bricks-and-mortar home, and some of our favourite colours and materials. *@climbingvan*

Opposite is the mood board we created before we bought our van - we even included some pictures of our house as we were keen to create a home away from home.

Layout design considerations

Vangonomics

Vangonomics, or van-ergonomics (the study of people's interaction with their surrounding environment...in a van!) is a really important consideration when designing tiny living environments. Thankfully designing ergonomic spaces is actually pretty simple, as the key measurements such as the height of seats and countertops and the widths of doorways are all the size they are for good reason - they tend to cater for fifth percentile female (fairly small) to 95th percentile male (pretty large).

Ergonomics extends beyond the physical size of objects we interact with, it also covers the relationship of one object to another and the user. For example, having your kitchen counter at a standard height might restrict you from opening your van window. Much of ergonomics is common sense, but taking the time to question each aspect of your design with ergonomics in mind will help you to resolve conflicting demands and limit frustrating user interactions.

If you sit outside the 'norm' (fifth to 95th percentile), now is your chance to build something bespoke that actually fits around you. If you're seven foot tall, build a bed that's long enough to keep your feet warm at night, or if you're four foot tall, build a lower kitchen countertop so you can finally chop your vegetables without a stool!

Below are our top tips to achieve vangonomic excellence:

1. Measure objects around your home that are comfortable for you and copy the dimensions where possible.
2. Will your intended van allow you to stand up? Remember the floor and ceiling insulation and cladding or ply will eat into some of this space.
3. Can you comfortably fit in the bed? This is probably the most important consideration.
4. If you plan to have a fixed bed, check if you can sit up in bed with the space you have available.
5. Don't cram too much in! Try and keep 600mm width of floor space as a minimum to allow you to move around comfortably.
6. Make sure to add angled backs to any seating to ensure they're comfortable.
7. Try to adopt standard kitchen unit heights, depths and widths where possible to allow standard appliances to easily fit inside.
8. If you intend to work in your van, try to factor in a desk or table with seating so you don't have to work from bed or at the kitchen counter all day!

The kitchen

The three most important elements of your kitchen layout are the cooker, the fridge and the sink. A good kitchen layout will allow you to easily move between the three and still provide enough space so that if you're cooking alongside someone else, you won't constantly be knocking into them. This is no mean feat in a small van! Kitchen designers typically create a "work triangle" between the three areas so no

two areas overlap which allows two people to cook together without interruption.

Thinking about the items and food you typically store is helpful as you can group these logically (e.g. cans, spices, pots and pans, etc) and see what size area you will need to fit it all in. Ideally, you want to limit tall storage areas; you can't stack items like you would in a normal kitchen because they're somewhat prone to falling over as you swing the van around a corner or hit a speed bump!

The bedroom

When it comes to the bedroom, you have two big decisions to make:

1. Are you short enough to sleep across the width of your van (or happy going foetal)?
2. Do you want a fixed or fold away bed?

A double bed measures 135cm x 190cm, so you have the potential to save 55cm of van living space if you can put your bed across the width of the van. This is half the length difference between your typical medium and long-wheelbase van, so opting to have your bed across your van could allow you to base your build on a smaller vehicle. Different van manufacturers have different internal widths for similar-sized vans, so it's important to check the internal width of any vans you look at if you're opting for a widthways bed.

It's also important to factor in the thickness of standard insulation and cladding or ply, as this will reduce your total width. It's possible to only add minimal insulation around the foot and head of the bed so you can gain more room, but you might find yourself feeling a little chilly in winter if you haven't got adequate insulation around your head and feet! You won't be able to fit a standard double mattress across most vans, so you will need to either chop one down or purchase foam cut to the exact size you need. Sideways beds also tend not to fold away as it limits your available storage options. Going lengthways for some will be essential, as fitting across the van simply won't provide enough room. If that's the case you will need to decide which of the following options best suits your needs:

Fixed bed design

Typically suspended off the van floor to allow for permanent storage below the bed, the fixed bed option works well for larger vehicles and people with large equipment such as bikes who need the extra storage below. Refer to *Layout construction - Fixed bed* on page 249 in the build chapter for design plans.

Convertible sofa bed design

Besides the fixed widthways and lengthways beds, the convertible sofa bed is the other popular option for larger vehicles. Whilst it does require rearranging the bed twice a day, it offers superior flexibility and the opportunity to accommodate more people for social occasions. This arrangement is often teamed with a central table that can be connected to the floor and stowed in the benches when not required. The downside to this arrangement is that storage space is confined to the space below the seating. Refer to *Layout construction - Convertible sofa bed* on page 250 in the build chapter for design plans.

Folding sofa bed design

Often referred to as Rock'n'roll beds, a folding sofa bed typically hinges in three places to allow the bed to fold up into a bench seat. Some Rock'n'roll beds are rated to carry passengers and feature three-point seat belts, but if you intend to buy one and want to carry passengers you should ensure it has passed the M1 strength and anchorage requirements of EC 76/115/EEC and you install it as per the manufacturer's guidance.

If you want to build a folding sofa bed, this cannot be used to carry people whilst driving. You may recall riding in the back of

OPPOSITE TOP LEFT Dom and Marie's sofa bed provides oodles of living space. *@vanlife.sagas* **TOP RIGHT** A fixed bed equals an enormous boot space for all of our climbing gear. *@climbingvan* **BOTTOM LEFT** Stef and Niko's custom Rock'n'roll bed. *@avancalledfred* **BOTTOM RIGHT** Amy and Steven's cosy cabin-esque van featuring a pull out bed. *@thiscabinvan*

a campervan as a child, free to roam around whilst your parents were driving, but since October 2007 the law has changed, and now all passengers in a campervan require seatbelts (whether forward, rearward or sideways facing). Vehicles built before this date are allowed to carry unrestrained passengers in them while travelling, providing the vehicle is not overloaded...however, for obvious reasons this is not a good idea!

Due to the complexity of the moving parts being very specific to the dimensions of the vehicle, we haven't included this design in the build chapter. If you want to include a folding sofa bed in your van, we'd recommend borrowing design and constructions ideas from pre-built options available online.

Sliding sofa bed design

The lengthways sliding sofa bed arrangement is a popular choice for self-converters of smaller sized vans as they allow you to quickly flip between seating and sleeping modes and are fairly easy to construct. They also offer ample easily accessible storage beneath the static side of the bed. We'd recommend using two 'daybed' mattresses as their combined width is typically around 1600mm, just 100mm less than an empty VW Transporter's width, allowing just enough room to fit insulation and wall cladding.

At the time of writing, IKEA offers a foam daybed mattress called MALFORS which match these proportions and are compatible with a range of mattress protectors and covers which would save you custom tailoring everything yourself. Refer to *Layout construction - Sliding sofa bed* on page 251 in the build chapter for design plans.

If you have children or pets, you will also need to consider their sleeping arrangements. It's worth remembering to design something that will keep up with their ever-changing needs!

The bathroom

For some, a toilet and shower aren't necessities and so not everyone will have a bathroom in their van (or their 'bathroom' may consist of a bottle and a shovel!), but there are a lot of people for whom a toilet and shower are an essential feature.

If you are considering installing a toilet and shower in your build, you may need to design a 'bathroom' area. The system you plan on including will affect what you need to design. If you only want to include a toilet, you may not need to design a separate bathroom that will take up a lot of space. Instead, a lot of vans will have seating that has a removable top or a slide-out bench where a portable toilet or a DIY compostable toilet can be stored. However, if you wish to include certain types of toilet such as the Nature's Head composting toilet, these are much bigger and so you may need the additional space that a cubicle will provide.

If you are installing an indoor shower in your campervan, you will almost certainly need to include a bathroom in your design. We have seen a couple of builds that include an indoor shower without a bathroom, using a shower tray inside a seat with a shower curtain hung from the ceiling. However, we don't think these are very practical, and you will most likely end up with a rather wet van and condensation issues!

You can base your shower cubicle around a standard shower tray, or you can build a custom floor which will allow you to create something more bespoke. Some builds combine their shower and toilet into a single bathroom; there are pros and cons of doing this. It's definitely the best use of space to combine the two, and as mentioned earlier, certain toilet models will struggle to fit elsewhere.

You will either need to ensure the toilet is made of waterproof material and sealed so water from the shower will not fill up the toilet,

OPPOSITE Muriel and Julius's layout is a great example of using a tambour sliding door to utilise valuable space. *@twoandavan*

or you could install a portable toilet that can be removed when the shower is in use. If the toilet is not removable, you may find the lack of space makes it awkward to shower, or you need to design a much bigger bathroom to accommodate both.

The other choice you will need to consider when designing your bathroom is the type of door you use. Whilst some people opt for a simple shower curtain, it may not look very nice and you could potentially end up with water and condensation escaping into your van. A couple of alternative options would be to install a door covered with the same waterproof coating you will use in the rest of your bathroom, or a tambour sliding door. This is a good option as you can install it on the corner of the cubicle, meaning you don't use valuable space on one side of the bathroom having to keep it free for a door.

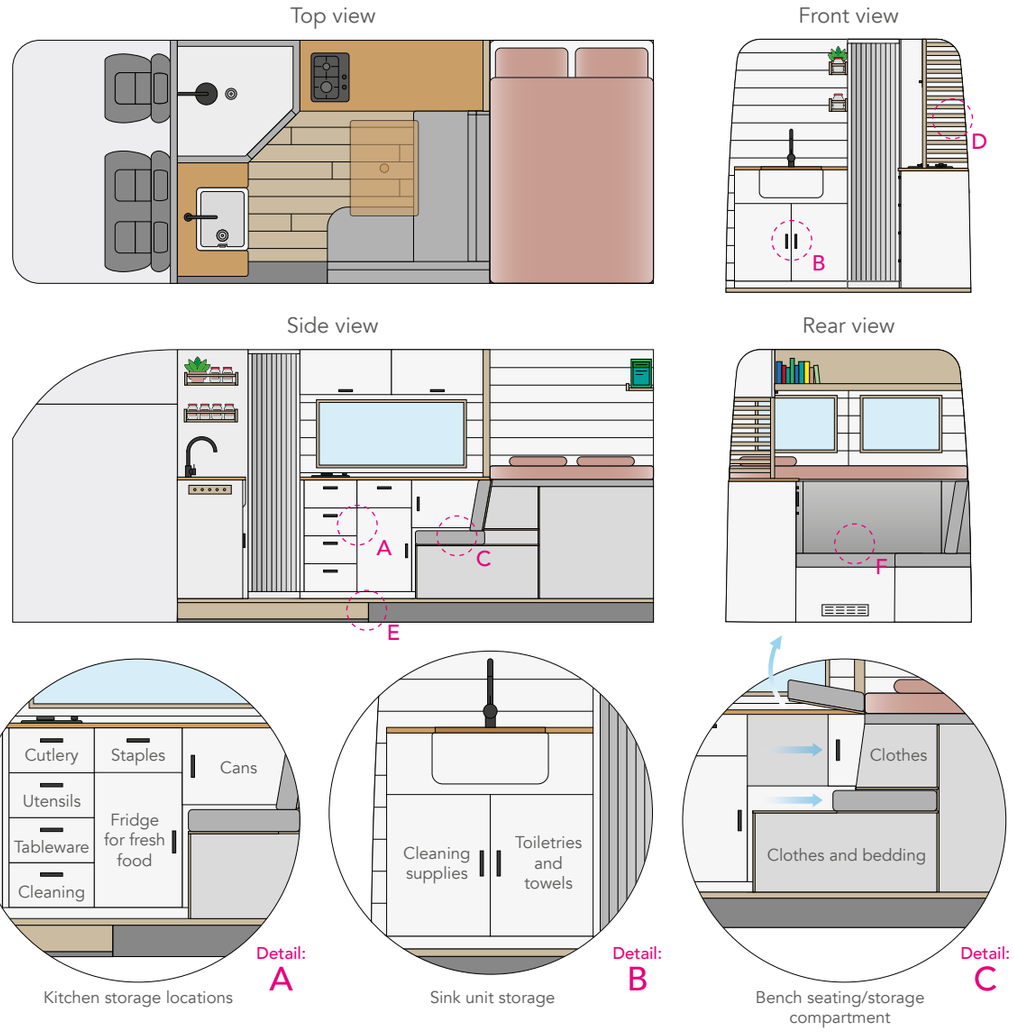
It's a good idea to install a skylight in your shower cubicle to quickly remove humidity, This will allow your bathroom to act as a 'wet room' to dry out wetsuits or waterproofs.

The garage

It can be easy to overlook the boot space and forget to account for certain items' heights and lengths, and how you can access the space. We have listed some key considerations:

- Bike height, length and quantity - will they fit into the boot without being dismantled, will they need adjusting to fit, or are you best installing an external bike rack to save on internal space?
- Length of sporting equipment (surfboards, fishing rods etc.) - will they need to extend through the boot space and into the living space to fit?
- Gas and water tanks - will you mount them in the boot spac, or will they be attached to the underside of the van, or mounted in a different area within the van?

You should make sure to design your boot space so it's as usable as possible. Whether you use a combination of boxes and hooks, or you build drawers and dividers within the space, think about what items you will be storing in there and how you can maximise your storage space. If you have a fairly low bed height, it may



ABOVE Raynor and Madison's garage features impressive bike storage functionality. *@rayoutfitted*

be worth considering the addition of a sliding floor to make accessing items easier. This can be achieved by adding two heavy duty linear rails which will act like draw runners for your sliding floor.

Generating van layouts

Once you have defined your requirements and you have your mood board at the ready, you can start to think about what this might mean for your layout. Keep your list of requirements to hand to make sure your design ticks all of the boxes.

The best way to start designing van layouts is with a pencil, ruler and paper. Because you're designing a small space, it's important to consider the size of each element, so draw a van shaped rectangle at 1:10 (paper:van) scale on A3 paper to get started. You can start to add units and other important items roughly to scale into your layout. You will want to generate and iterate lots of different layouts until you start to find a theme in the layouts you like.
Once you have found a few different potential layouts, you may want to consider converting your sketch into a 2D vector graphic so you can iterate each design more quickly, whilst maintaining the size constraint. Make sure you keep each potential layout so you can compare, copy and combine designs.

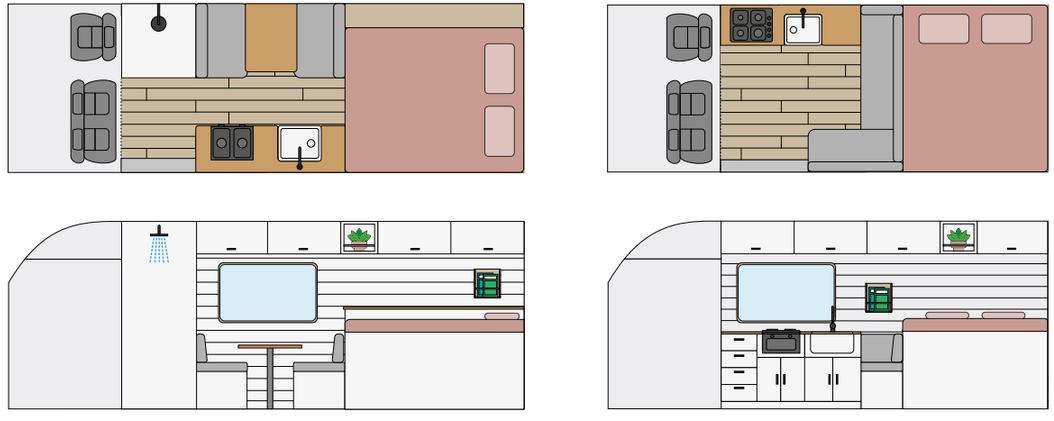
Campervan layout configurator

We've created an online campervan layout configurator which uses your requirements to match you with your perfect van layout (like the example below)! You can use this tool to help you come up with some layout ideas, or hopefully, it might match one of the layouts you have already come up with!

Remember, the layout configurator should just be used as a starting point to help generate ideas, and you may need to tweak the layout to work for your requirements, or even come up with something completely different. However, if the prospect of designing your own layout is too daunting, we'd recommend adopting one from the layout configurator.

Colours, materials & finishes (CMF)

Once you have your designs in a vector graphics program, you should refer back to your mood board and apply the colours, materials and finishes (CMF) to your layout. You should try to balance the distribution of CMF in the most pleasing way possible, so you may need to change aspects of your layout to achieve this. This will also help you plan which aspects of your build will need to be made from more premium materials and which can be cheaper and subsequently painted or covered.



OPPOSITE Anni has done an amazing job of mixing lots of colours, materials and finishes to create a complementary interior. We love the volcanic orange, the neutral whites, and all of the different textures. *@travelingbybus*

Ordering material samples for floors, walls, countertops, soft furnishings and other areas will also be very useful and give you confidence early in the design process that your choices complement each other and you will end up with a beautiful van.

Selecting your van layout

Hopefully by this stage, you will have developed lots of layouts, but if you're struggling to choose which is the best option to actually use for your van, there are a few simple checks you can make to aid your decision:

1. Using your design requirements document, assess each design against your requirements and see if they will achieve everything you want.
2. Debate the remaining layouts with family and friends to get a fresh perspective to identify positives and negatives you may not have previously considered.
3. Would any of your designs be considered new or unique? Often the simpler layouts, with less moving elements and different states for varying uses are more successful. It's easy to create a layout that seemingly achieves everything by moving everything around, but in reality it can end up feeling compromised and frustrating to live in.
4. Are you confident in your ability to achieve your proposed vision? Cast your mind back to the triangle of cost, quality and time - does it seem feasible your design will allow you achieve your desired balance?

Develop

Attributing additional design time to the development phase will make integrating all of your systems with your layout much simpler, and help to weed out any oversights in the concept phase by completing the following exercises:

- Systems architecture - *creating detailed diagrams for each of your systems*
  - Electric
  - Water
  - Gas
- Integrating your systems and your layout - *combining your systems diagrams with your conceptual van layout.*
- Detailed layout design - *refining your conceptual van layout to ensure it works with your systems, and adding detail such as measurements and build notes.*

Defining your systems

There are a few methods of defining your systems. We'd recommend following a similar design process to that of your floor plan layout.

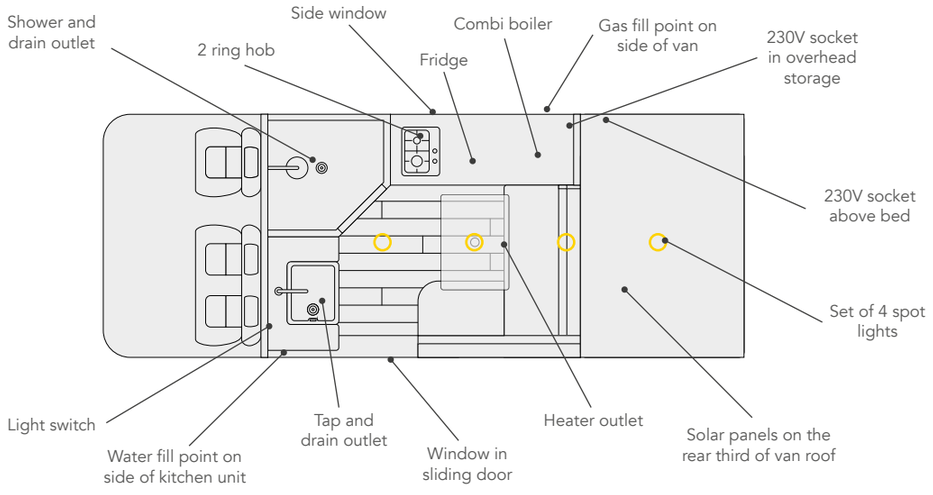
Defining and locating your inlets, outlets and appliances

Once again it's time to call on your requirements document where you will now need to define the exact specification of each appliance, inlet and outlet. You may also want to reference the planning chapter to help make your decision. We've included a table with some example appliances, inlets and outlets you may want to include in your van build.

Once you have defined your appliances, inlets and outlets, you will need to determine their respective positions in your van. Whilst you will probably want to space some outlets such as plug sockets evenly throughout your van, light switches will likely be positioned at the entrance of your van. You may wish to include a 2 way switch so you can turn your lights on or off from a different location such as your bed. At this point, the aim is to map their rough position, but you don't need to include specific measurements. These can be established either at the van blueprint stage or when you start marking out all of your critical dimensions in your actual van.

Appliances, inlets & outlets

Appliances	Inlets	Outlets
Fridge	Gas fill point	Lights
Oven	Water fill point	Kitchen tap
Hob	Shore power	Shower head
Heater	Windows	12V sockets
Boiler	Skylights	230V sockets
TV	Vents	Light switches
Air conditioning	Solar panels	Exhausts



ABOVE You can't beat playing with colour swatches and material samples to help you blend your CMF with your layout design. *@wandathevan*

It's worth noting the gas system has some very specific guidelines you need to consider. Fill points need to be at least 500mm away from any flue or vent, and a flue needs to be at least 300mm away from opening windows to prevent exhaust gases from re-entering the van.

Once you have established what you want to include and where it will be positioned in your van, you can start determining how these all connect to each other and what else is required to ensure everything works.

FACTORS TO CONSIDER:

- If you want to have lights over your bed, you might want to make these dimmable or wired independently so you're not blinded by bright lights at night.
- Creating efficient air circulation in your van is important to keep the moisture levels and odours at acceptable levels! Having an air inlet at one end of your van and an outlet at the other (ideally over your cooking area) is a great way to reduce condensation in your van.
- Putting a skylight above your bed may allow you to stargaze at night, but it's also likely to make your bed a little draughty, as many skylights aren't sealed well and have poor insulative properties. This is an especially important point if you intend to have a high fixed bed.
- Many layouts include overhead storage down one side of the van, changing the visual centre of the ceiling relative to the centre of the van. You may want to consider offsetting skylights, vents and light fittings to align with your internal ceiling centre, especially if you're specific about visual details like this.
- It's important to consider where your windows will align with internal structures such as countertops and beds, as this may influence where you position them.

Systems diagram creation

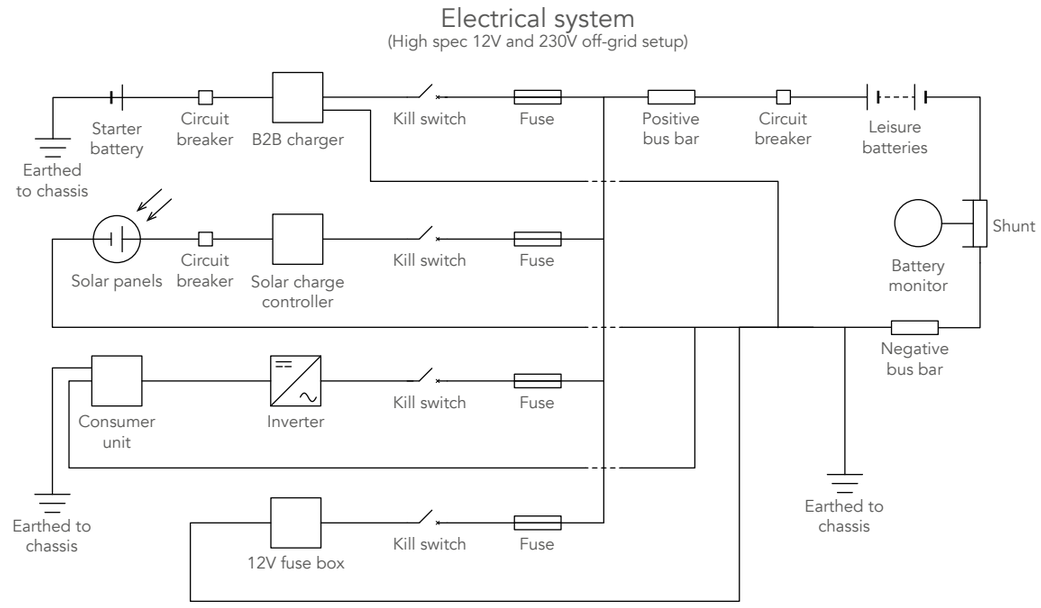
When looking at the different systems in the next section, we have provided three examples of different setups in an illustrated form to make them easier to understand. Unless you're a bit of a wizard with illustration software, producing something to this level of detail for your own build simply isn't necessary. Instead, you will want to create a simplified system diagram, which can be done using a range of different software, or simply using a trusty pen and paper. Ultimately you're trying to record:

- Key components with positions of all inputs and outputs.
- Lines depicting wires, pipes and hose that connect between components.
- Important connectors, fittings and fuses.
- The system plans can remain separate but try to indicate any interdependencies.
- The diagram doesn't need to be laid out in the position it would be in the van.

We'd recommend the following software to create your system plans if you wish to refine any pen and paper diagrams:

- **Visio:** You may already have access to this with some windows computers, it even comes with system icons built-in so you can drag and drop fuses, switches and other components quickly and easily.
- **Draw.io:** Is an online and free version of Visio and works in much the same way, it's slightly clunkier to use than Visio but that's the price you pay for not paying!
- **Graphic design tools:** By now you may be pretty handy with your chosen graphics design tool, so nothing is stopping you from creating your system plan using this.

We have included an example from each of the electrical, water and gas systems to show you what these might look like. These will relate to one of the three examples within each section.



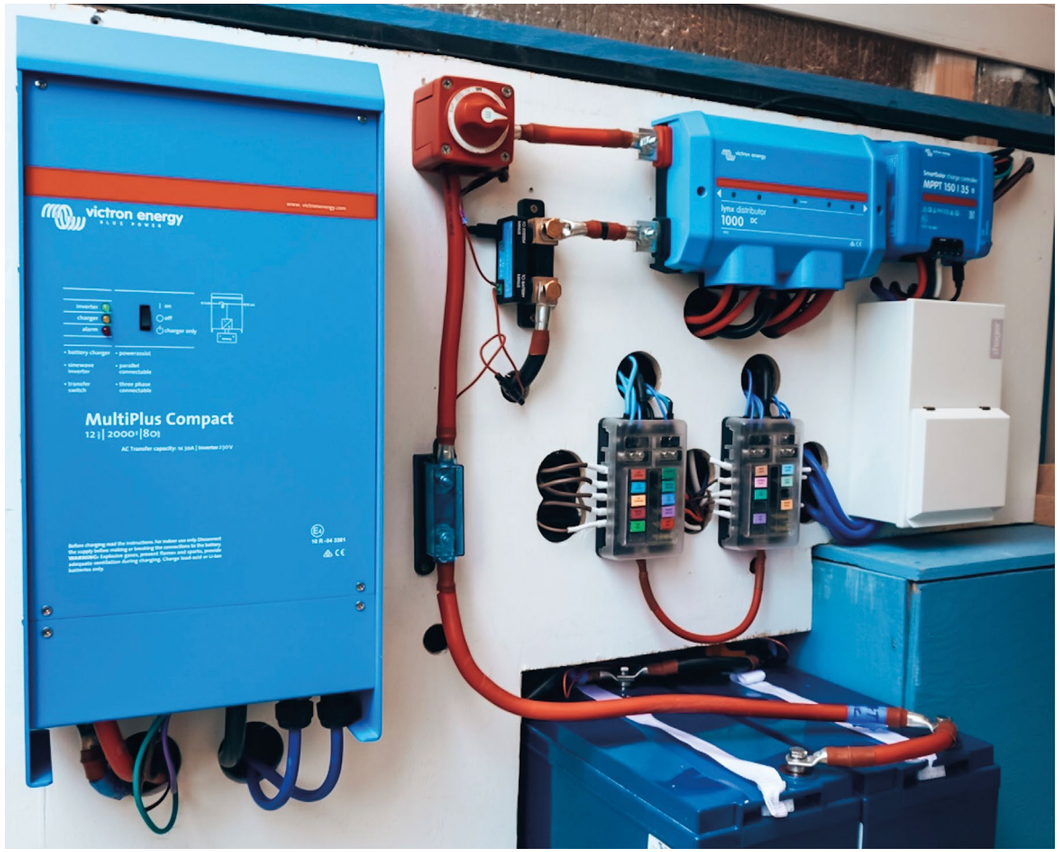
Electrical system

To define your electrical system, you will need to decide exactly which components you wish to include in your build. You should think back to Planning to decide what size batteries you will need and how you will charge them, as well as what system output you will need to power all of your appliances.

Once you have listed the components for your system, you can start to draw your wiring diagram. You will need a kill switch on a positive terminal of any main component going into or out of your leisure batteries. You will need to fuse each positive wire except for positive wire that's intersected by a kill switch, where you will only need to include one fuse rather than two.

You will only be able to specify the exact size of the fuse you need once you have established the length of cables you will be using, which will be covered in systems integration.

We have included three example electrical systems based on a basic 12V off-grid setup, a high spec 12V and 230V off-grid setup, and a 12V and 230V shore power setup for those spending most of their time on campsites. These should give you a good idea of how to connect different components and appliances within your system to help you create your wiring diagram. However, it's important to remember to size your all of your components, fuses, wires, bus bars etc. for your own needs and requirements.



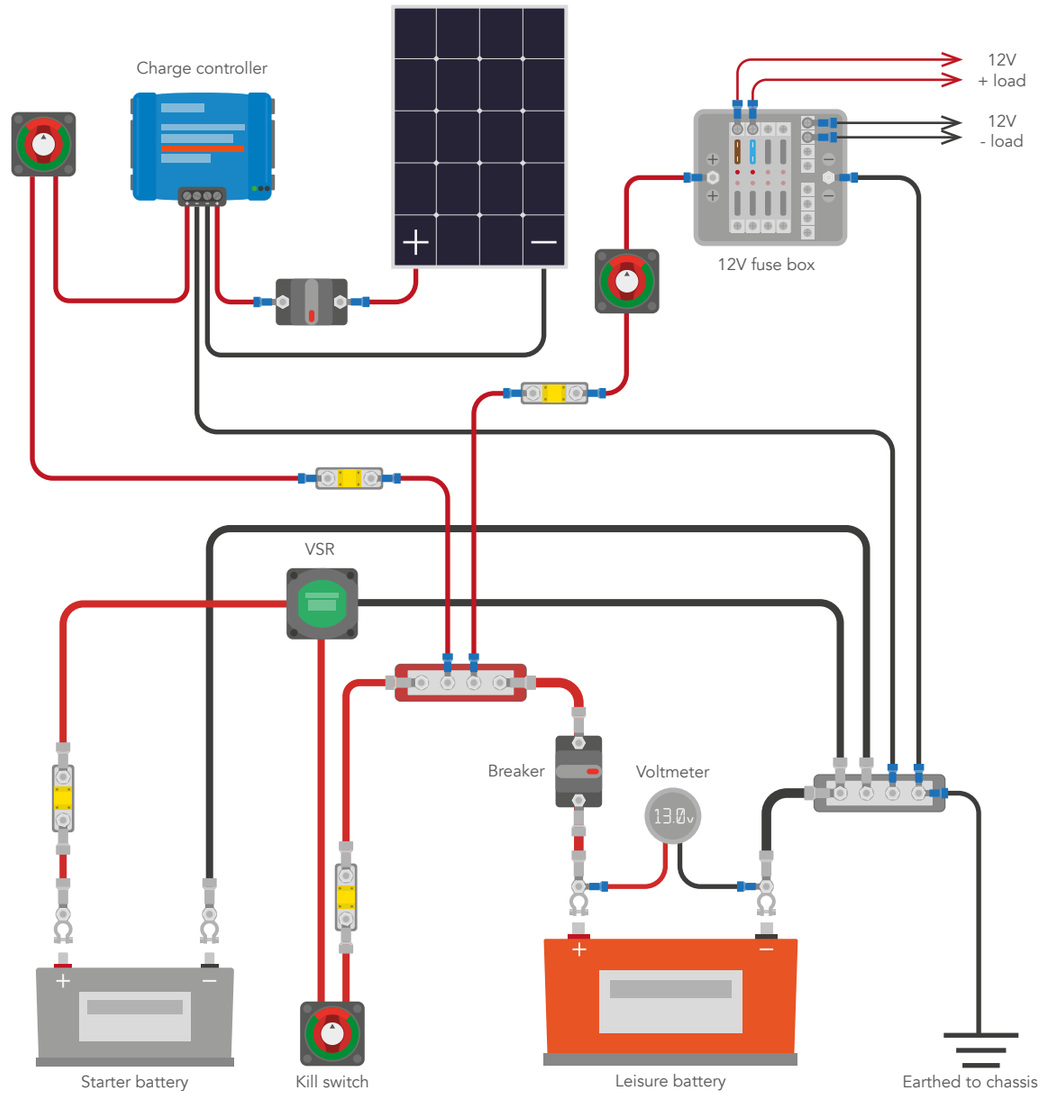
ABOVE A high spec electrical system including a Victron MultiPlus, two 12V fuse boxes and a Smart Shunt, which allows you to monitor your battery from a phone. *@city2_vanlife*

Basic off-grid setup

A basic 12V off-grid setup works well if you are planning on weekends away in your campervan. This setup would allow you to charge your phone and power your lights and perhaps a fridge, charging your batteries using solar power and your vehicle's starter battery as you drive. A basic setup would allow you to monitor your battery capacity using a simple voltmeter.

Main components

- 150Ah AGM battery
- 75/15 MPPT charger
- 200W solar panel
- 12V fuse box
- Voltmeter
- VSR

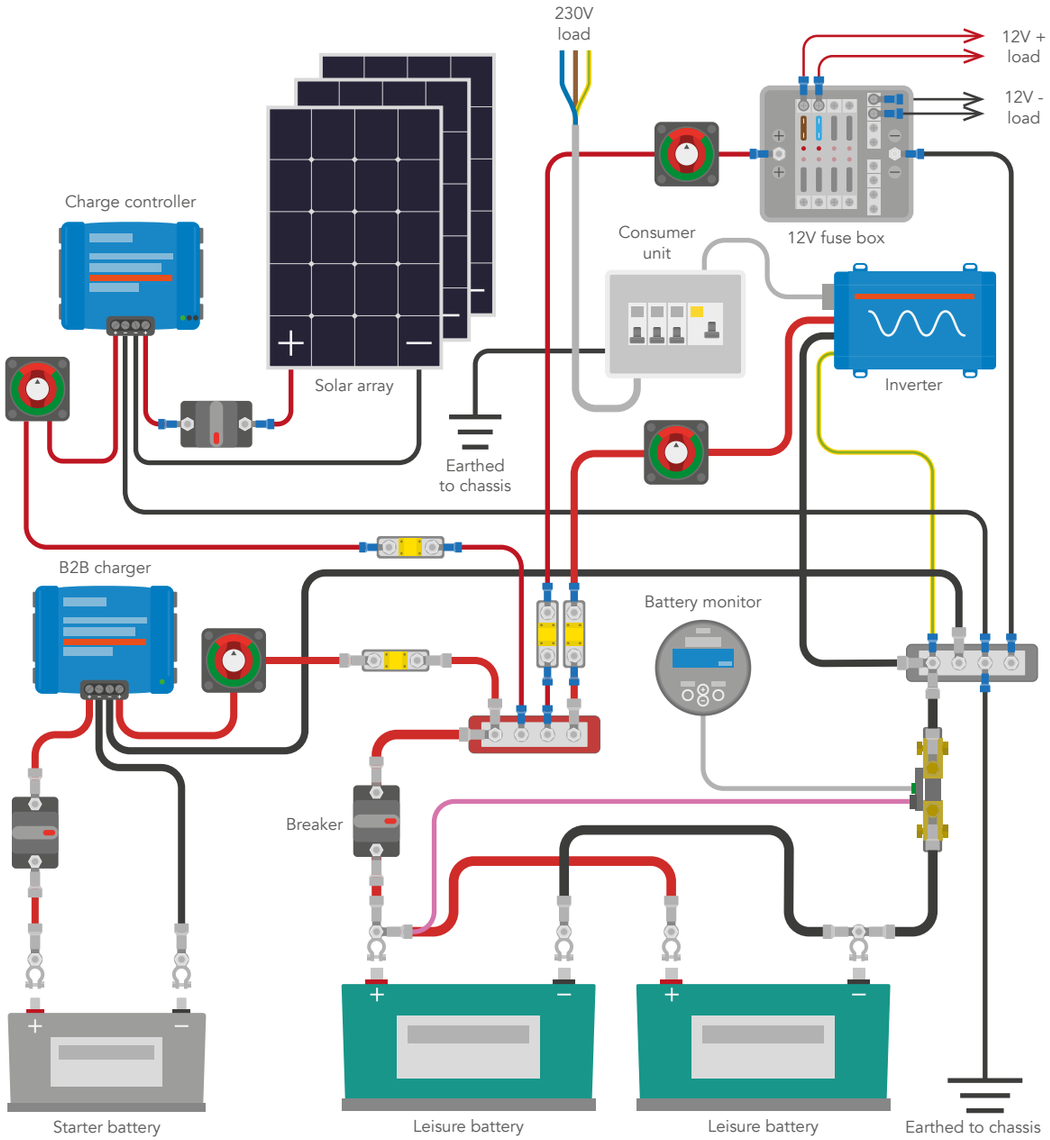


High spec off-grid setup

This setup is perfect if you're planning to live and work in your campervan, spending your time in remote spots. It would allow you to power laptops and cameras, and charge your batteries using solar power and your vehicle's starter battery as you drive. The high capacity batteries and large solar panels would ensure you don't run low on power.

Main components

- 350Ah AGM battery bank
- 100/30 MPPT charger
- 3x 100W solar panel
- Battery to battery charger
- 12V fuse box
- Battery monitor
- Inverter
- Consumer unit

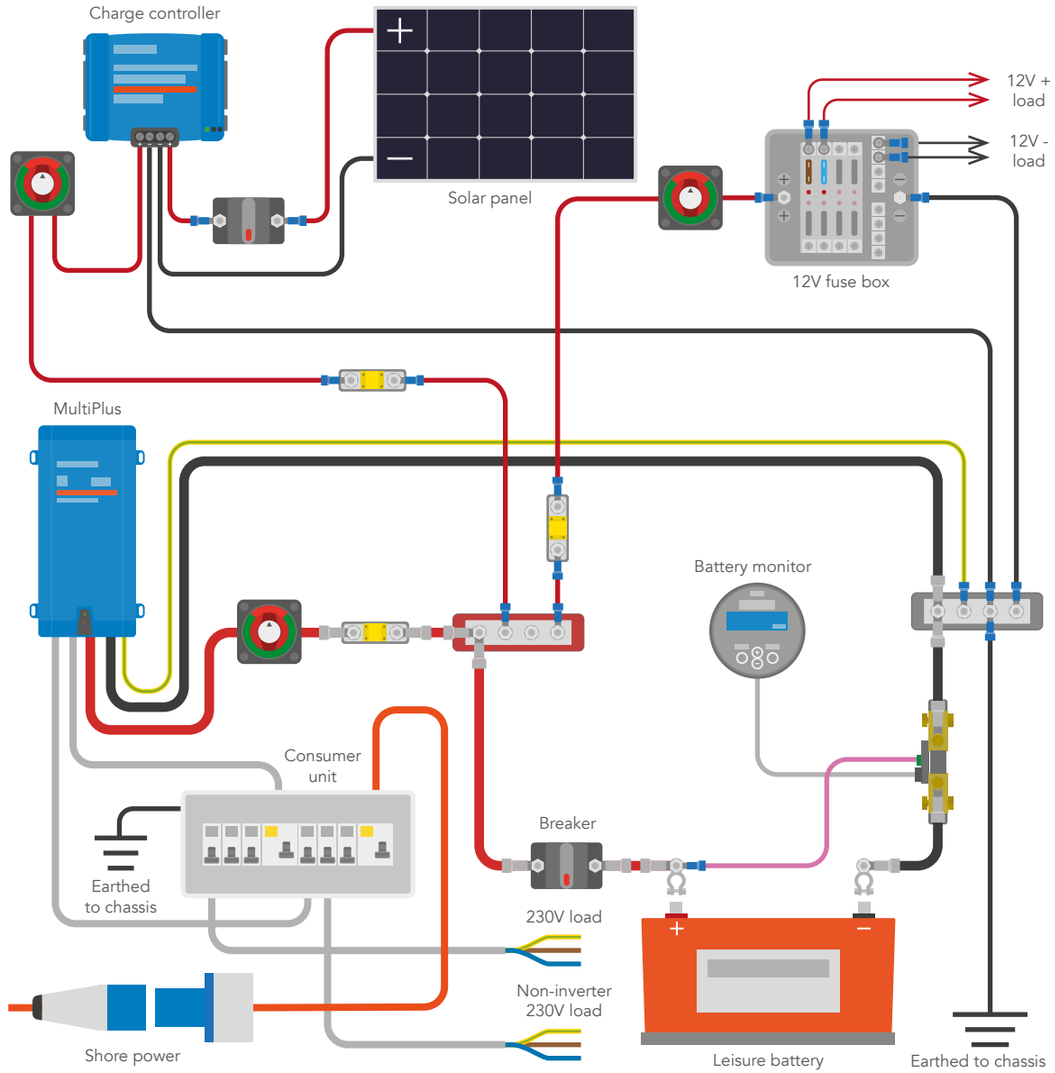


Shore power setup

This shore power setup is a good option if you're planning on spending most of your time on campsites. It allows you to charge your batteries using shore power on a campsite, and also has a small solar panel as a backup power source. The larger inverter will allow you to run lots of appliances at once, and you'll be able to monitor your battery capacity and performance in detail using a battery monitor and shunt.

Main components

- 120Ah AGM battery
- 75/15 MPPT charger
- 200W solar panel
- Shore power hook up
- Consumer unit
- MultiPlus
- 12V fuse box
- Battery monitor



Water system

After having battled with your electrical system design, you'll be glad to hear the water system is much less complicated! In fact, there are only a few key factors to consider before you start drawing out your water system diagram.

- How will you store clean water?
  - Portable tank or jerry can
  - Fixed internal tank with fixed fill point
  - Fixed underslung tank with fixed fill point
- What appliances will you need?
  - Tap and sink
  - Shower head
  - Boiler
- How will you transfer water from the tank to the outlets?
  - Foot pump for cold water only (manual)
  - 12V pump
- How will you dispose of grey water?
  - Direct outlet
  - Fixed internal grey water tank
  - Fixed underslung grey water tank

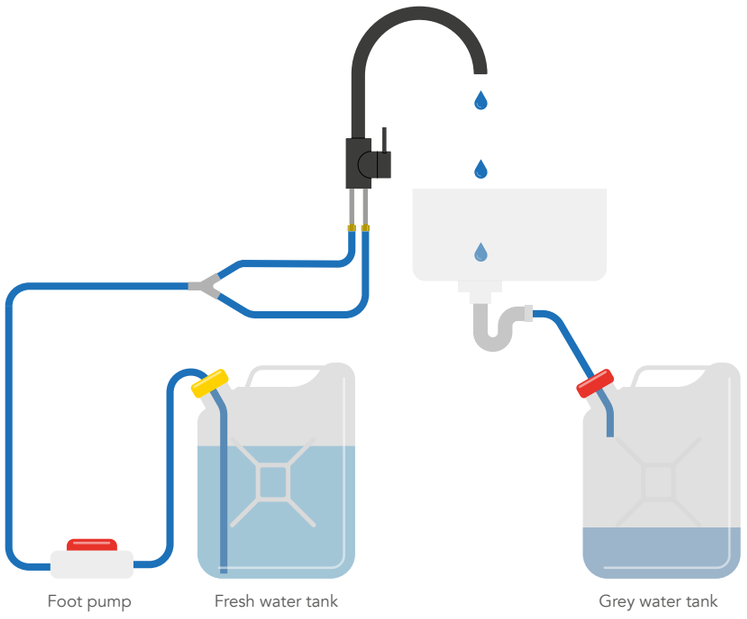
The next few pages cover three example water systems which include manually operated running water, powered cold water and on-demand hot water systems. Each system example should give you a good idea of how to connect different components and appliances within your own system, even if certain details are different from your intended system design.

Basic cold water system

The basic system is the best choice if you're looking to keep things simple. Its simplicity removes the need to connect it to your electrical system, as water is supplied to the tap via a simple foot pump. Both the fresh water and grey water tanks can be removed from the van to be refilled.

Main components

- Fresh water tank
- Manual water pump
- Grey water tank
- Tap - cold water
- Sink

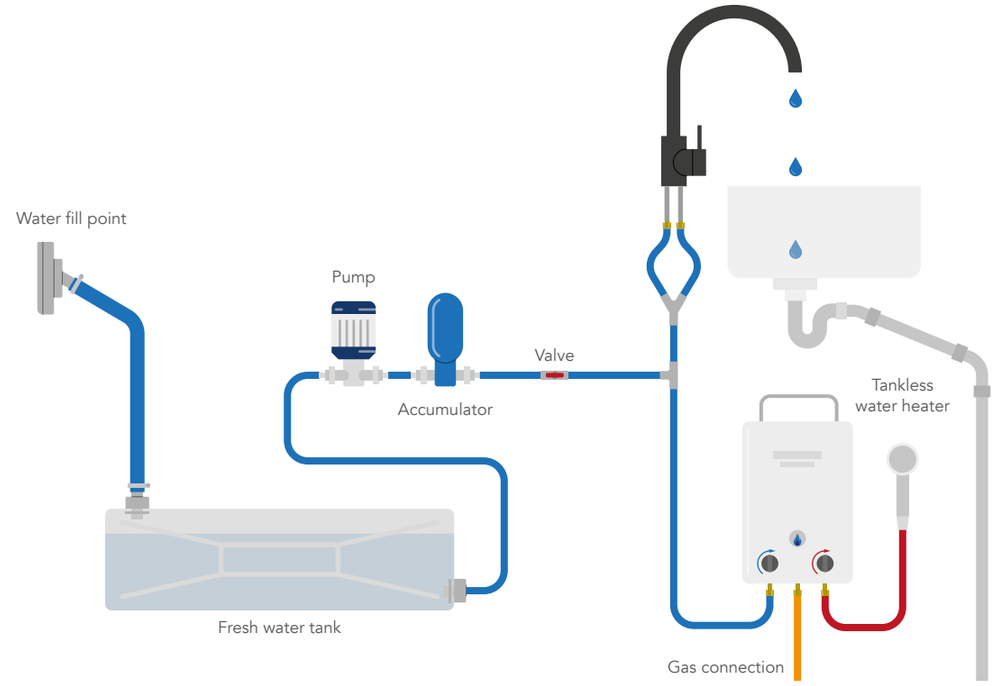


Standard cold water system

The standard system is the option most people will go for if they aren't installing an indoor shower. It features an electric water pump to supply water to your tap, and an accumulator to ensure your system is quiet and water flows smoothly. The water fill point will allow you to easily refill your tank, and the tankless water heater will give you the option of a nice, warm outdoor shower.

Main components

- Water fill point
- Fresh water tank
- Electric water pump
- Accumulator
- Tap - cold water
- Sink
- Tankless water heater



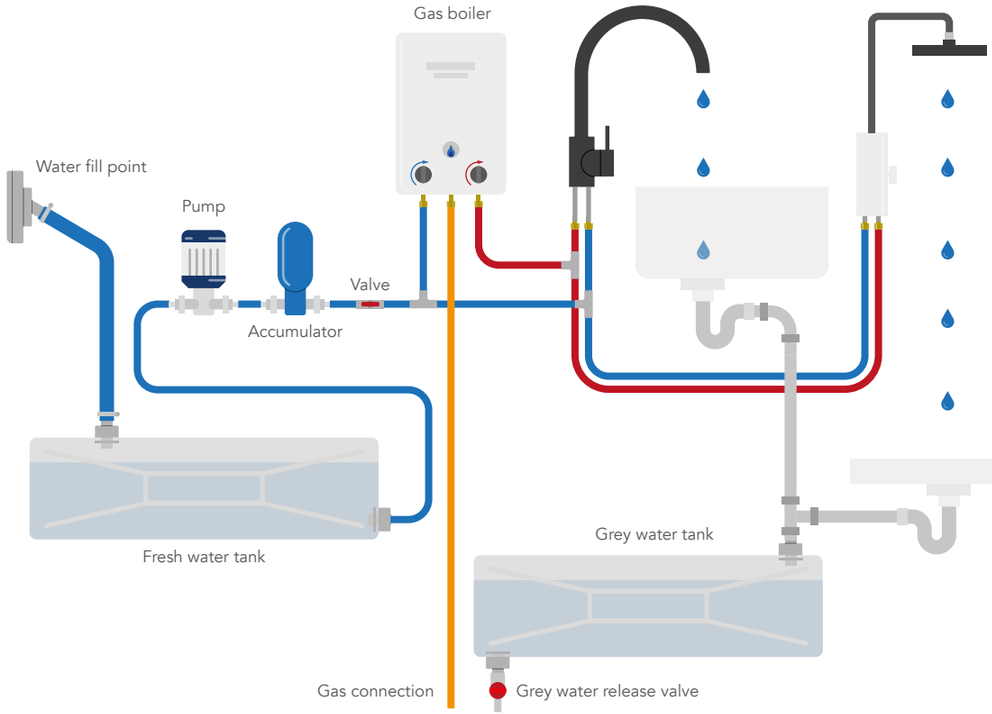
ABOVE Remember the colour swatches and material samples from a few pages ago? Well, this dreamy van was the end result! *@wandathevan*

High spec hot water system

The high spec system is the luxury choice, perfect if you're installing an internal shower. It uses a boiler and an electric water pump to supply both the shower and the tap with hot water on demand. The accumulator ensures that your system runs smoothly, and the water fill point makes it easy to fill up your tank.

Main components

- Water fill point
- Fresh water tank
- Electric water pump
- Accumulator
- Boiler
- Tap - hot and cold water
- Sink
- Shower
- Grey water tank



Gas system

Defining your gas system is unfortunately slightly more complex than just picking appliances and running some pipe - it needs to be designed and installed in a specific way to perform reliably and keep you safe.

Your gas system needs to be designed in accordance with the British Standard BS EN 1949: 2011 +A1: 2013, the 'Specification for the installation of LPG systems for habitation purposes in leisure accommodation vehicles and accommodation purposes in other vehicles' (a bit of a mouthful!).

Whilst this standard does not directly apply to self-conversions, it does detail some sound guidelines to follow. Legally you are allowed to undertake the gas work within your own vehicle yourself, providing you aren't intending to hire your campervan out, or to sell the van as a business. If you are intending to hire your vehicle out, then the person or business undertaking the work must be registered with the Gas Safe Register, or be suitably qualified to undertake the work.

If you are installing an internal gas tank within your gas system, it cannot be larger than 16kg. It will need to be stored in a sealed metal lined locker, secured at both the top and bottom, and the locker will need to be able to withstand a fire for up to 30 minutes! The locker will need to contain a drop out vent that's at least 2% of the floor area, and the gas cylinder cannot obstruct it. If you're reading all of this and wondering how on earth you will manage to build this, you will be pleased to know you can buy a pre-made box that meets all of the necessary requirements.

Whatever type of gas tank you are installing, you will need to ensure it has the following:

- An automatic cut off function that can't be filled above 80%
- Level indicator
- Manual shut off valve
- Pressure relief valve
- Overflow regulator

Below are three system examples of differing complexity. They should help you to understand how to connect components and appliances, so even if they don't exactly match your own system design, you can adapt them for your own requirements.

To aid the process of designing your gas system diagram, you can follow this process:

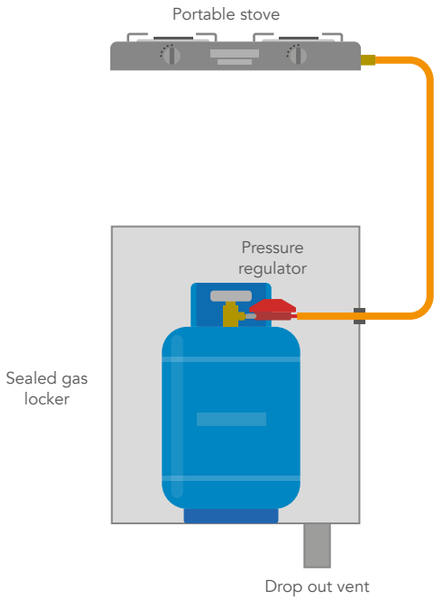
1. Define all appliances and work out their connection type.
2. For each appliance, identify a connector which allows you to step from the appliance connection type and size down to your 8mm copper outer diameter pipe.
3. Ensure each appliance links directly to a manifold or individual check valve before connecting to the tank.
4. Identify a connection type that allows you to join the outlet of the pressure regulator to your copper pipe and the manifold.
5. Identify a connection type that connects the inlet of the gas tank to your fill point.

Basic gas system

The basic gas system will often be used if you have a smaller van where you don't wish to install a fixed hob. It's made up of two main components, a replaceable gas bottle and a portable stove. The stove can be stored away when not in use, and the gas bottle can simply be swapped out for a new one when empty. The gas bottle will need to be stored in a metal-lined gas locker with a drop out vent.

Main components

- Replaceable gas bottle
- Metal lined sealed locker
- Portable stove

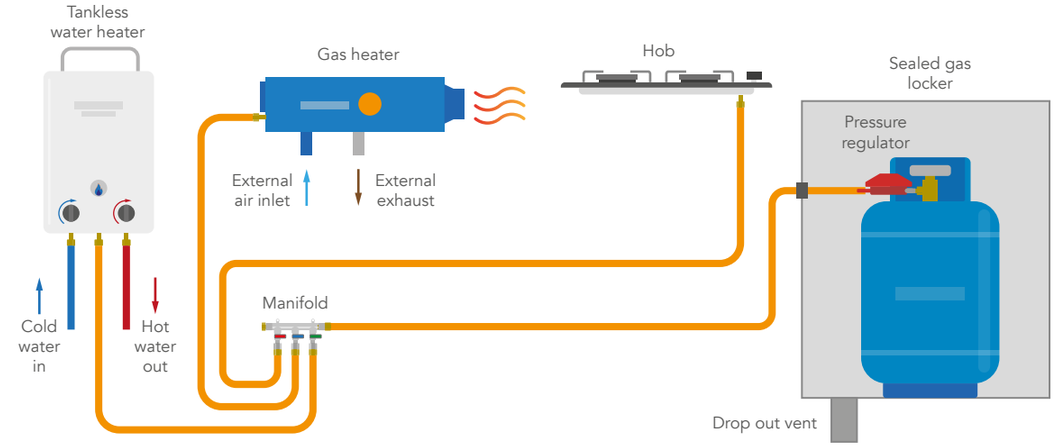


Standard gas system

The standard system is perfect for most vans. It will allow you to cook on a fixed hob, warm up your van on a cold winter evening, and even have a warm outdoor shower with a view! As with the basic system, the gas bottle will need to be stored in a metal-lined locker with a drop out vent. A gas manifold allows you to easily restrict gas to any part of your system.

Main components

- Replaceable gas bottle
- Metal lined sealed locker
- Manifold
- Hob
- Tankless water heater
- Heater

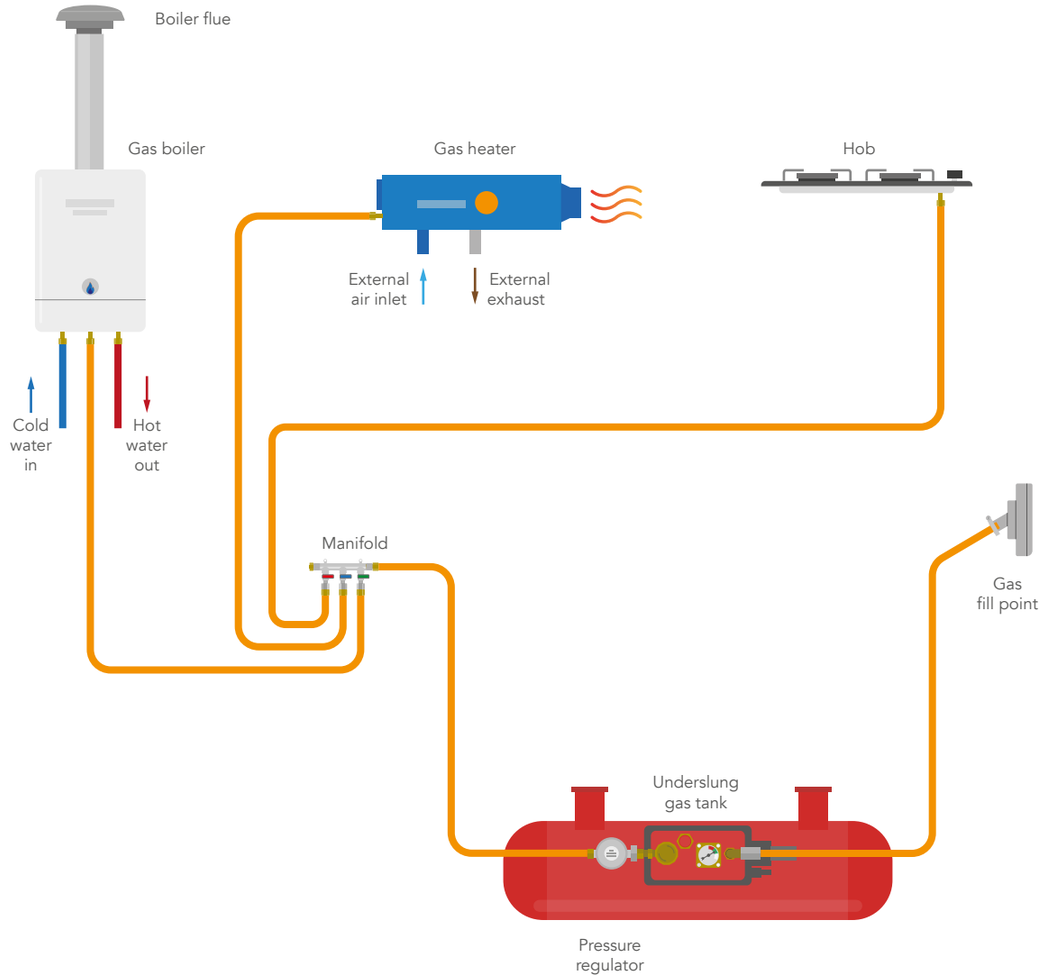


High spec gas system

The high spec system is typically paired with a high spec water system, when your campervan features an internal shower. A gas boiler will mean you can have a hot shower whenever you fancy, and an externally mounted fill point will enable easy refilling of your gas tank. You'll also be able to cook on a fixed hob, and keep warm using a gas heater. An underslung gas tank avoids the need for a metal-lined box in this system. As with the standard system, a gas manifold gives you complete control over the gas supply to each of your components.

Main components

- Underslung tank
- Fill point
- Manifold
- Hob
- Boiler (and flue)
- Heater



ABOVE After battling to install an underslung tank, cooking on gas is a momentous occasion! *@climbingvan*

System feasibility

Once you have settled on your preferred systems and appliances, it's worth having a quick sanity check that everything you have included is feasible. Feasibility at this stage should focus on defining key costs (can you afford what you're proposing?) and technical complexity (can you actually make it?). If you have your heart set on a fancy gas or electrical system but you're not confident in installing it safely, you should pay a professional to install it for you.

At this point, you should also assess the cost of the main components (batteries, gas cylinders, water tanks etc.) before proceeding with any further development. The big-ticket items in electrical, water and gas systems typically represent the overwhelming majority of the total cost of your system, and indeed a good chunk of your total van expenditure. The cost of connectors, pipes and valves add up and shouldn't be overlooked, but the true cost can be calculated once your van design is complete and you're ready to start building.

Defining your specification

Systems based specifications

Remember when you started to define a list of your requirements for your build? It's time to dig it back out and start defining the specifications for each of your requirements. You should start with any system-based specifications to ensure the system you have designed is going to satisfy your requirements and user needs. For each requirement, ask yourself a series of questions like the example below.

Example
Requirement: *The van should maintain a warm internal temperature in cold weather conditions.*

- *Have you specified a heater?* - Yes
- *How is the heater powered?* - LPG
- *Do you have an LPG supply and dedicated check valve?* - Yes, an underslung LPG cylinder and internal check valve
- *Will the heater be positioned in or outside of the vehicle?* - Inside
- *Does the heater need an exhaust outlet, air intake or vent?* - Yes, it needs all of these
- *Does the heater rely on other systems to function?* - Yes, it requires a 12V power supply for the thermostat and ignition.

After interrogating each requirement, you can write a series of basic specifications against each one. Some may only need one specification, whereas some may need several which may also be relevant to other requirements. If this is the case, reference the existing specification rather than duplicating it.

Example
Specification:

- Propex Heatsource HS2000 with thermostat. Requires input of LPG fuel source at 30mbar pressure, internal heat ducting, exhaust ducting, air inlet and drop out vent required.
- 25L underslung LPG tank and 30mbar regulator with test port and through floor mounting brackets.
- Three outlet manifold valve.
- Reliant on 12V electrical system.

Non-system based specifications

You should also complete the non-system based specifications now to remind you of important values and functionality that need to be achieved within the upcoming design development stage.

Example
Requirement: *It should be possible to sit up in bed without hitting your head on the ceiling.*

Specification: The top of the mattress must sit more than 750mm away from the ceiling.

Systems integration

Now you have the diagrams for your individual systems, you will need to think about how they will work physically within your van. Systems diagrams are typically laid out logically, but they rarely bear any resemblance to how the components will be laid out in real life. Therefore it's important to spend some time defining exactly where everything will be mounted, and the paths that cables, hose and pipe will take to connect your systems together.

You will likely want to hide your systems away, but you should make sure you're still able to access them for maintenance, and you will also need to ensure they have adequate ventilation. The position of appliance controls and sensors should also be considered and made easily accessible, so you should consider mounting them on a single systems control panel to enable easy access.

General considerations:

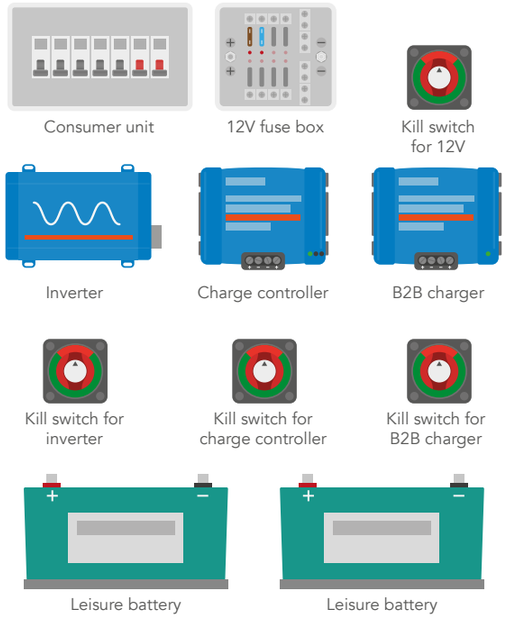
- The position of systems in the van should be determined by trying to balance the overall weight of your build evenly across both sides of the vehicle. If you have a front-wheel drive van it's worth trying to position heavy batteries, water tanks and gas cylinders towards the front of the vehicle to improve traction. Conversely, if you have a rear-wheel drive vehicle you should try to position systems towards the rear axle, and four-wheel drive vehicles… you guessed it, evenly spread over the length and width.
- Ideally, your water and electrical systems should be kept apart in case of water leaks.
- If you're able to fit appliances, or even the majority of a system under the vehicle, this will save you precious space and mitigate the effects of small gas or water leaks. However, you must check the appliances and materials you're using have been designed for external use.

Electrical system

Now you know which components you need for your electrical system, you can start to consider where you will physically mount them. It would be easy to spread your components out across a horizontal surface, but when space is at a premium, mounting components on a wall is a better way of using your available space.

It's a good idea to mount your main electrical components on a system board. Keeping items such as charge controllers, inverters, battery chargers and fuse boxes in one spot will make your electrical system easier to manage, and ensure you can keep your wiring tidy. These components can be mounted somewhere out of the way such as in the boot space of your van, but it's also important to ensure they're protected from any knocks or damage.

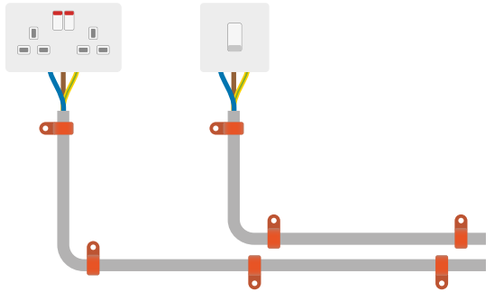
You should lay your components out in a logical manner, such as positioning any kill switch next to the appliance they are connected to. Batteries should be secured in position on the floor due to their weight. It's important to mount



your batteries and other electrical components in a well-ventilated space, either by mounting them in an open area, or by using an inbuilt fan to exchange the air.

WARNING
Over-charging a lead acid battery can produce hydrogen sulphide. The gas is colourless, flammable, extremely poisonous and smells like rotten eggs. It's heavier than air and so will accumulate at the bottom of poorly ventilated space. Hydrogen sulphide becomes harmful to human life once the smell is noticeable. This is just one of the reasons why it's incredibly important to ensure your batteries have adequate ventilation.

All wiring should be run vertically from appliances to the floor before running horizontally so you know exactly where any wiring is once you have clad or covered your insulation. It's really important you don't run any wire horizontally or at random angles, otherwise it will be very hard to know where to avoid, and you run the risk of screwing into it during your build.

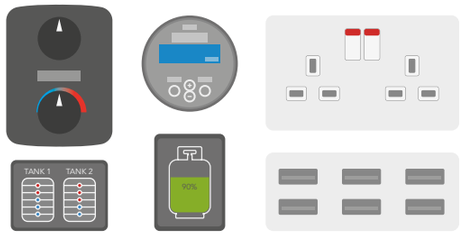


Once you have finished integrating your systems, you will be able to calculate the cable lengths of your system, and therefore establish the wire gauge and fuse sizes needed. We'll go into a bit more detail on this shortly.

Control panel
You may wish to create a 'control panel' for components you will need easier access to such as water pump switches, thermostats and battery monitors. You should consider where in your van is a logical place to mount this. Some people choose to have these visible, however, it may be a good idea to contain them within a cupboard due to visible LED lights on certain components which can be annoying at night.

The control panel is typically made up of multiple electrical displays and switches which all have power and control wires feeding into them. Fortunately, these wires tend to be small as they only carry a small current so it's easier to fit all of your controls in a more compact area. Typical control panels include some of the following items:

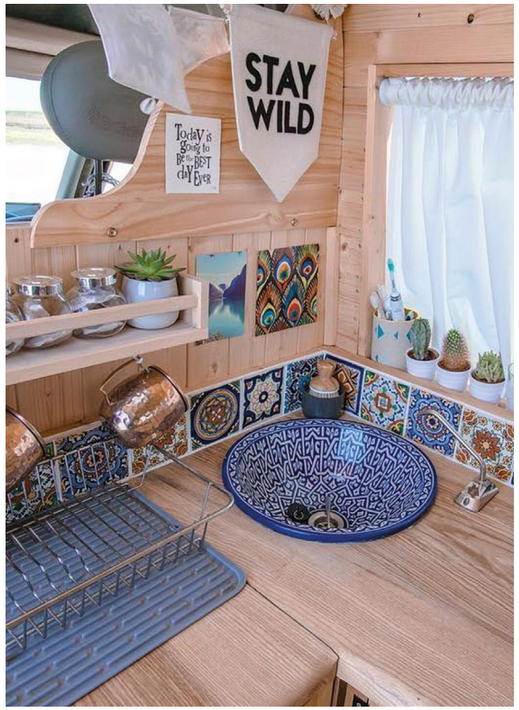
- On/off switches for inverters, water pumps, fans and heaters (remember that a heater thermostat will need to be positioned within the room to work correctly, and so cannot be mounted to a control panel within a cupboard)
- Battery monitors
- Water and/or gas level indicator
- 12V charger and/or mains plug socket

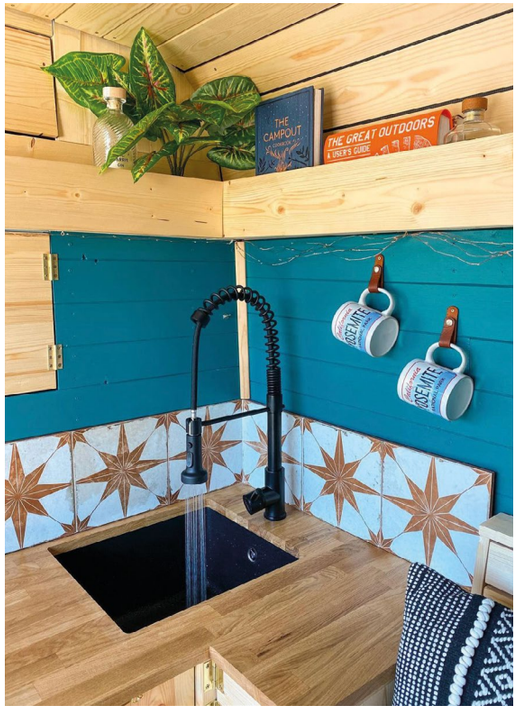


Key considerations:

- Don't try to cram too much into a small space. Instead, mount everything against a wall to avoid encroaching on floor and storage space, whilst allowing for adequate clearance around all major components. This will make connecting wires and servicing in the future much easier.
- You will need to gain access to both the front and rear of your systems board to make connections and mount equipment,

OPPOSITE Our cosy remote working setup, powered by our high spec electrical system. @climbingvan





TOP LEFT Dom and Marie's van has a beautiful, clean aesthetic. *@vanlife.sagas* **TOP RIGHT** Jordan's Transit is a bohemian dream. *@jordanbentley_* **BOTTOM LEFT** Izzy and Laurie's Citroën Relay is cosy, colourful and rustic. *@camperdreamin* **BOTTOM RIGHT** Fabienne and Denis's kitchen shows that minimalist is also beautiful. *@nest.and.nomad*

so it will need to be built separately from the structure it will be attached to.

- Batteries should be fixed in position as low as possible. The system needs a supply of cool air and somewhere for the hot air to escape, so don't box your entire electrical system in a small sealed area.
- The number of cables adds up quickly and can make connecting everything difficult if you haven't left sufficient room behind the systems board.
- Each product and wire needs to be securely held to prevent mechanical wear. P clips and cable ties can help control an unwieldy mess of cables.

Water system

There aren't many components within most water systems, but you will still need to decide where each of them is mounted. The water tank will weigh a lot, so this should be positioned to ensure there is a relatively even weight distribution across both sides of your van. You should try to mount the water pump and accumulator close to your water tank or nearest appliance. Using the space below your sink often provides a space-efficient solution, as there's a lot of space below a sink that is hard to use for storage due to the waste pipe, and other pipes or hoses in that location.

If you are installing your water fill point inside your van rather than on the side of it, you will need to use a one-way valve to ensure that water cannot escape back up the inlet and spill into your van if you are driving up a steep hill or making sharp turns. Some fill points will have a sealed filler cap instead of a one-way valve, but remember you will need a tiny air vent to prevent a negative pressure build-up in the tank when the pump is running. Many fill points have a small hole on them to act as this air vent.

You should fit a bottle trap (a space-efficient U bend) below your sink if your system includes a grey water tank, as this will prevent any smells from entering your van. If you are installing a shower, you should also ensure you have a P bend or a waste trap below the shower tray for the same reason.

If you are installing a hot water system you will need to consider where your boiler will be positioned. Some boilers are floor mounted, whereas others will need to be mounted on the wall, so you should check the requirements for your specific boiler before defining its location. If you are using a tankless water heater for an outdoor shower setup, this will need to be positioned next to a door so you can move it outside when it's in use.

Key considerations:

- Tank inlets should be positioned on the top face of the tank to maximise capacity, with the fill point more than 100mm above the tank inlet to create a downward flow.
- Tank outlets should be positioned towards the bottom of the tank but not on the bottom face. This prevents any dirt that may enter the tank and settle at the bottom from being drawn into the pump.
- If you are mounting an internal water tank, you should ensure you can access the inlet and outlet to periodically check for any water leaks.
- The fill point or fill funnel should be fitted with a filter to prevent particle ingress.
- Each product and hose needs to be securely fastened to prevent mechanical wear, and P clips should be positioned every 300-500mm to help control the path the hose takes.
- If you are installing an internal shower, the grey water outlets for the shower and the sink should connect within the van and exit the vehicle from a single hole. This will prevent the need to drill multiple holes in the van.

Gas system

There are many considerations when it comes to your gas system, as you must follow the British Standards we previously mentioned. As gas can be dangerous, there are a number of safety requirements you will need to adhere to. If you are installing an internal gas tank, your metal lined gas locker cannot be positioned above your exhaust, and must be at least 250mm away from it in all directions. This will ensure you do not have a drop out vent positioned anywhere near any exhaust fumes. You should position your gas locker somewhere easily accessible so you can easily remove and replace the gas bottle when needed. Any electrical cables within the gas locker cannot have any exposed connections and need to be adequately insulated.

In most gas systems, the gas regulator should be connected directly to the gas tank. However, if you are installing more than one gas tank, you can connect the regulator using a high pressure hose no longer than 400mm in length.

You will need to ensure that you install a drop out vent next to every gas connection. In the case of a gas leak, this will prevent build-up of gas within an enclosed space, and will allow the gas to escape outside the van. All gas appliances should be vented to provide air for combustion, and to remove any exhaust gases.

You should install a manifold if you have more than one appliance so you can isolate the gas supply to each part of your system. This should be mounted somewhere easily accessible, so you can turn off the gas supply to each appliance when it's not in use.

Any gas pipework will need to remain accessible to ensure you can check it regularly and perform maintenance if required. Pipes should be held in position using pipe clips, and protected from any bumps or impacts from other objects.

Key considerations:

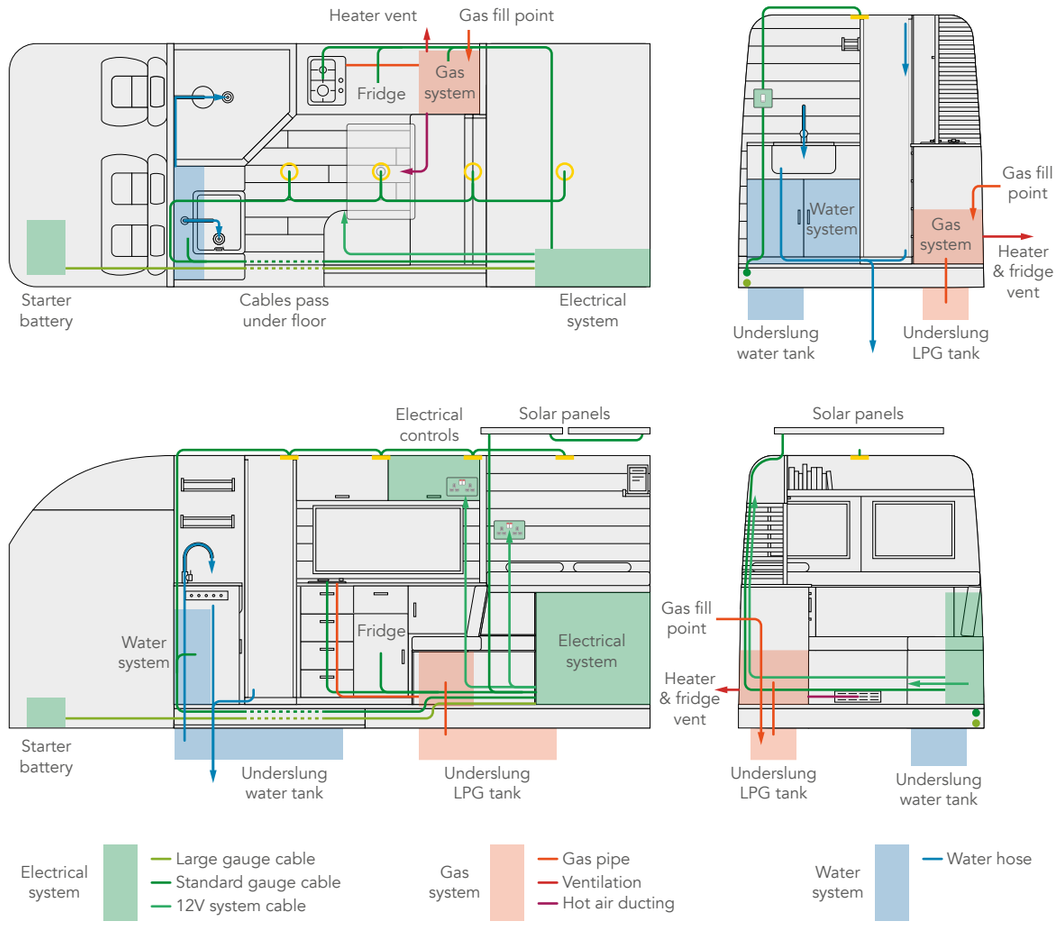
- Tank fill points should be positioned as close to the gas cylinder as possible. They should be more than 500mm from an opening window or door.
- If you are installing a heater you should also include a plan of where the hot air ducting will go and disperse into the living space.
- Drop out vents will need to be positioned below each connection.
- Try to position all check valves or manifolds in a position accessible from the living portion of the van so you can isolate appliances when you're not using the van.
- Pipe clips should be used at 500mm increments to reduce pipe stress and strain.

Wiring, hose and pipe paths

With all of your systems distributed across your van, the final step is to designate where all major wires, hoses, pipes and vents will run. It doesn't need to include details of every single wire, pipe or duct, just the major paths each system will need to follow before breaking off to its specific location, a bit like an underground tube map. You can either use a bit of paper to trace over your paper layout, or add the lines onto one of your vector graphic layouts. This exercise is also useful for measuring wire and pipe lengths, so you're able to determine wire gauges (more on that below) and the total length of wire or pipe needed.

Key considerations:

- Include all major paths and connections to inlets, outlets and appliances.
- Connections for all three systems should all be kept accessible for easy maintenance and checking.
- Try to take the shortest path from your systems to each appliance.
- Try to position manifolds, control panels and displays in the living area so you won't need to empty the boot if you need to access them.



You may find there is too much information to fit in one view, so feel free to spread the information over multiple sheets.

There will be several outlets in your build, such as drop out vents, waste water outlets and flues! These should all be added to your system integration plan (if they are not already) so you don't forget about them and have a headache later into your build. It's worth considering any other components such as WiFi and TV aerials, as these will be connected to your systems and so should also be included at this point.

Once you have defined where your wiring will run for each component, you can work out the wire gauge needed for each circuit within your system. Use the lookup table in the planning chapter to size your wire by checking the amp rating of each appliance and the length of the wire needed to connect it.

Buying eight different wire gauges for your build will be impractical and expensive, so it's a good idea to group your wire gauges once you've specified them and round a few up so you can buy three or four reels of wire for your entire build. Remember, it's perfectly safe to use a higher wire gauge than what you need but it's not okay to use a lower wire gauge. Your specified wire gauge will inform the type of crimp connectors you will have to buy (we'll

explain the different sizes in *Build - Electrical system* on page 223).

You should also specify all of the fuses for your system. Fuses should be rated above the maximum current of the circuit (i.e. above the amp rating of the appliance) but below the amp rating of the wire you're using. When a fuse is being installed on a circuit containing a battery, the fuse should be installed as close to the battery as possible.

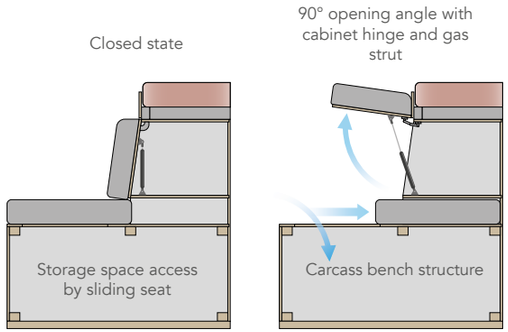
DALE SAYS:
Our electrical system is only 2m from our starter battery, but the sliding side door of our van sits between them, meaning we weren't able to just run the cable along the wall of the van. If we hadn't planned our electrical system and plotted cable paths around the van, we would have needed to run 6m of additional 50mm gauge cable to connect the two batteries. Covering a much longer distance, we would have also needed to increase the diameter of the cable, and these two factors would have meant an additional cost of around £50.

Detailed design development

Performing detailed design development is a great way to resolve areas of complexity before you start building. These typically include any custom mechanisms, space-critical areas (such as fitting a bike below your bed) and visually important details (such as places you might not want visible screws). Design development can be performed either with scaled sketches or digital illustrations and should cover any components moving between different states and show how certain things will be assembled. Remember, the design process is not linear and you will need to revisit earlier tasks if decisions you make in one area impact another.

Moving parts and mechanisms

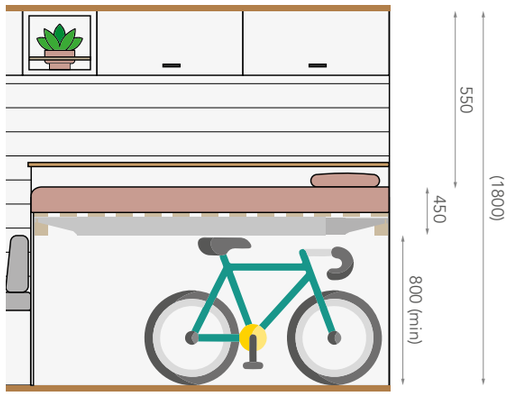
A sliding lower bench and hinging backboard design offer an easily accessible storage area that would otherwise be hard to reach from the living space. The complication here is having two moving elements close to one another and trying to work out how the hinging backboard will be retained.



When designing a moving arrangement, creating copies of your layout will allow you to show elements in their closed and open states, and work out if anything will clash or need adjusting. It will also give you greater confidence in the size of certain areas.

Space critical areas

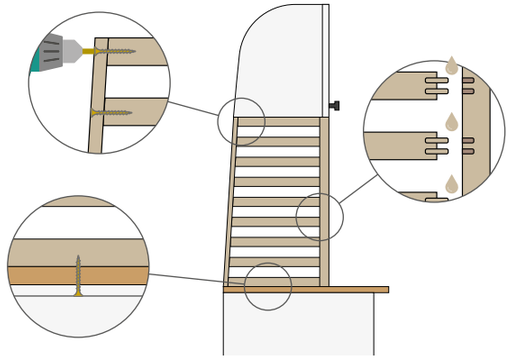
If you want to store your bikes inside your van, you will need to account for their height



within your boot space. Ideally, you want to keep the boot height as low as possible to ensure you can sit up in bed, whilst still fitting everything underneath. This will require taking measurements of your bike, and also details of the bed construction along with your height. This will allow you to confidently define the size of everything whilst ensuring the bike will fit with only a small amount of clearance.

Visually important areas

Visually important areas may be a focal point in your van, such as a bespoke wooden divider or a bookcase, where you don't want any screws to be visible. These areas can sometimes be complex to achieve due to the nature of their design. Trying to minimise visible screws or dowels will make the assembly of the design more challenging. The wooden divider in this example will need to be screwed together where the screws will remain hidden, and rely on dowels and wood adhesive to hold the structure together and achieve the desired aesthetic on the visible faces.



ABOVE Ethan and Katelynn carefully considered how they would construct their decorative divider to ensure no screws would be visible. The outcome is simple but stunning! *@thehuntersvanlife*

3D design development

Until now, we have recommended the use of graphic design and systems diagram software which should carry a good amount of thought and detail. However, you now have a choice to go one step further and convert this data into 3D CAD. CAD, or computer-aided design, can be extremely powerful, but it can also be difficult to use efficiently, particularly if you haven't used it before. Nevertheless, it does present the opportunity to get a realistic insight into how your design will look and work in the real world.

Whether you choose to use CAD or stick with your 2D layouts, you're ultimately trying to create the same final output: your van blueprints. The most useful pieces of paper you can have on hand during the build phase is a 2D drawing showing the size of all major elements, inlets, outlets and system paths in all three planes. So only venture into the virtual reality of CAD if you need to gain more confidence in your design, or if you have a lot of time on your hands!

If you do feel the need to create a van mockup in 3D, there are a wide variety of CAD programs available, from free and fairly basic to advanced and eye-wateringly expensive! We have only included options appropriate for the level of complexity a van build represents and practical for both CAD beginners and intermediate users to both learn and afford.

We have one final warning for you...don't get so engrossed in CAD that you spend more time CADing your van than building it. You won't be the first, and you won't be the last!

SketchUp

SketchUp Free is the simplest free 3D modelling software on the web. Its intuitive user interface and integrated library of free CAD models (3dwarehouse) makes it the best tool for a novice CAD user whilst still allowing sufficient detail to be created.

Using a 'soft' CAD package like SketchUp enables more artistic freedom as it has more of a drag and drop functionality and requires less complex tools and calculations to create your model. It should be used to check if everything will work visually and create a 3D model to reference throughout your build, rather than used to produce dimensionally accurate component plans.

A great time-saving tip is to search 3dwarehouse.com for "van conversion" or for example "Mercedes Sprinter" and you'll find many templates you can download for free. There are countless tutorials available on YouTube to guide you too, so if you want to create a basic space model of your proposed van, go check it out!

PROS

- Free
- Easy to use
- Lots of resources to learn from

CONS

- Not good for modelling complex forms or moving components
- No parametric modelling available
- Difficult to export manufacturing data

Autodesk Fusion 360

Fusion 360 is available for free personal use for individuals who are doing home-based, non-commercial design, manufacturing and fabrication projects. It offers the scope to design practically anything, whether it's a simple layout or complex folding bed structures. The other advantage is you can model parametrically (creating a digital model based on a series of pre-programmed rules or algorithms known as 'parameters') so you can change a single value

and everything else relating to it will update. You can also easily export files for 3D printing or 2D profiles for laser cutting or other computer-aided manufacture (CAM) processes.

Needless to say, you're not going to learn how to use this sort of CAD package quickly, so only embark on this option if you intend to use it for other projects or already have experience in this area. To save time when modelling, you can download standard items and even vehicles from websites like grabcad.com. However, when downloading CAD models, make sure you check the important dimensions are correct before you start to use it; just because something looks right, it doesn't mean it's dimensionally accurate.

PROS

- Free for non-commercial use
- Good for complex layouts and small details
- Parametric modelling available
- Manufacturing data can easily be exported
- Lots of online resources to learn from

CONS

- Steep learning curve for a single-use
- The results are only as good as the time and effort you put in

Design checks

Once you're happy with your van design, you should perform a few checks to ensure you haven't missed anything obvious!

- Have you met all of your user needs, requirements and specifications?
- Have you left enough room to comfortably move around and sleep?
- Have you created enough storage space?
- If you have a large van, have you considered weight-saving techniques?
- Are the other people who will use the van happy with the design and layout you're proposing?
- Can you afford what you've designed?
- Have you identified any areas that you will need to outsource?

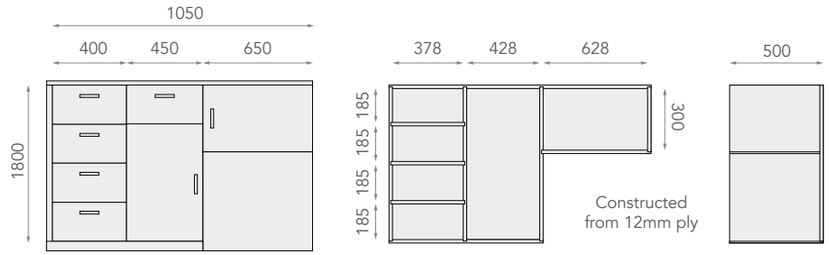
Final design blueprints

Your final design blueprints should be a concise package of information you can have on hand throughout your van build. This will consist of layout views showing critical dimensions, system diagrams, detailed design workings and system integration layouts. The layout views will need to carry the dimensions of each major aspect. Adding these using illustration software can be time-consuming, so you may choose to print a copy of your plan instead and write the measurements by hand.

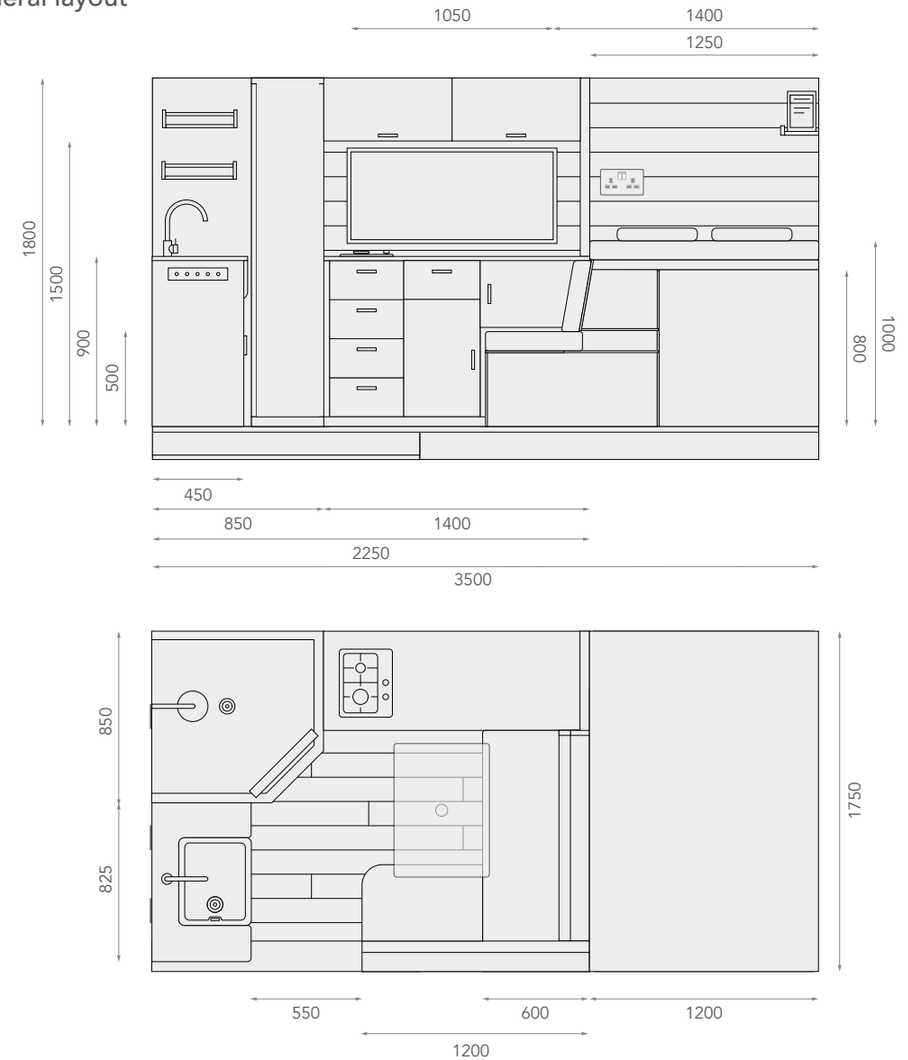
DALE SAYS:

I appreciate this design process might seem daunting, but the important thing is you complete as many of the exercises as possible. Even investing a small amount of time into problem-solving at this stage, when your van resides only on paper, will save you a lot of time and money in the long run, and give you the best chance of achieving your dream van!

Kitchen cabinet construction



General layout



FOUR

Shopping

Shopping for your build

This should be an exciting part of the process, and the first step towards converting your design into reality. However, there's a vast spectrum of items to consider, and if you don't fully prepare, it's easy to forget something vital. This can become the source of inefficiency and expense; get it wrong, and you'll see yourself taking multiple trips a day to the local DIY store.

We've already gone into detail on the electrical, water and gas systems and exactly what you will need, as well as the different appliances you may wish to include. What we will say here is that it's easy to find low-cost electrical components online, but it's important to remember that if you buy cheap, you may well end up buying twice! Low-cost electrical items are cheap for a reason, usually because they aren't well made. You will most likely end up replacing them in a year, negating the cost saving in the first place. Keep this in mind when you're shopping online - if something looks too good to be true, it probably is!

In this chapter we'll cover the essential tools you will need before you can start your build, the best materials to use for different applications, and all of the other consumables, fasteners and hardware needed. If you've never set foot in a hardware store, don't worry! We'll also cover where to shop for your build (i.e. not B&Q!), and when you can expect costs to be incurred.

We have included a breakdown of the build stages below. We'll include a more detailed breakdown at the start of the Build chapter, but for now, this should help you with your planning. Before you start building, create a definitive list of everything you will need to purchase before each stage. This will ensure you are fully prepared, and avoid those frantic dashes to the DIY store.

The shopping list tool

To make things easier, we've created an online customisable van conversion 'shopping list' tool. We spent many hours determining exactly what we needed for our own build and where best to source the items. We wanted to save others the time and effort (and some money!) of going through the same process, so we created a single, customisable resource.

The tool isn't a list of what we bought for our build, but the most important items for your own van, no matter what your requirements are. You can select a few variables when you first start using it to tailor the contents to your van conversion.

Whether you want to install a shower and a toilet, or you want a high spec electrical system with solar panels and a powerful inverter, it should cater to your needs, whatever you are planning. We have included links to purchase everything online, with discount codes where we have been able to secure them. We have worked hard to make sure the links in the tool are to the cheapest places you can purchase the items online, whilst ensuring everything we have included is a high-quality product we would use ourselves.

You can find the shopping list tool at: **climbingvan.co.uk/resources**.

Preparation & Exterior → Insulation → Floors & walls → Electrical system → Layout construction → Water system → Gas & heating → Decorating & furnishing

Tools

The state of your toolkit will very much reflect the state of your finished van. They say a bad workman blames his tools, but without tools, you won't have anything to blame and you won't have a campervan either! There's no need to go over the top and buy every specialist piece of kit you see in a YouTube video of a professional van builder, but there are some tools which are invaluable when converting a van. Investing in them early on so you can use them throughout your build will be vital.

We have included what we believe are the 'essentials' for those converting on a budget, and 'nice to haves' for those trying to achieve a high-quality finish, or intend to embark on other DIY projects in the future.

Essentials

Tape measure

The tape measure is perhaps the most frequently used tool in a van build. You will regularly hear van builders calling for their tape measure after leaving it somewhere obvious!

Set square (engineers square)

A set square will help you check for a right angle which is important in a lot of areas of your build, especially when it comes to things like building a kitchen. This will ensure you don't end up with something very lopsided - a drawer won't fit into a wonky cabinet!

Cordless drill and accessories

A drill is one of the fundamental tools you will need for your conversion, and you will almost certainly use it every single day. You will also need to invest in a **drill bit set** and a **screwdriver bit set** so you can do up screws and drill pilot holes. It is well worth buying two or more extra batteries as many van jobs are utterly reliant on near-constant use of a drill.

Hole saw set

A hole saw is a circular blade which attaches to your drill and comes in a range of diameters. It can be used in a few different areas of your build, from cutting holes in pieces of cladding for lights, to cutting drop out vents in the floor of your van. We'd recommend investing in a good quality set specifically designed for cutting through stainless steel and wood. They should be made from M2 high speed steel and cost upwards of £40 for a set. We fell foul of a cheap set on eBay advertised as a set for metal, but they were about as effective as using a pastry cutter and went blunt after a single cut!

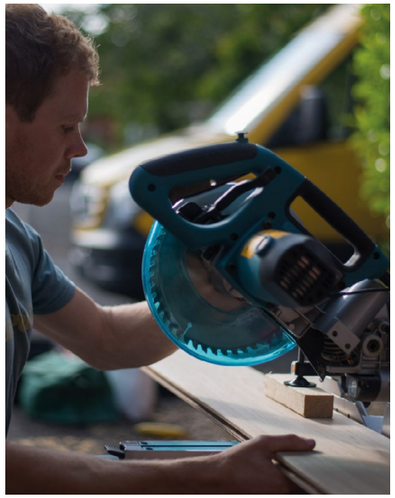
Jigsaw

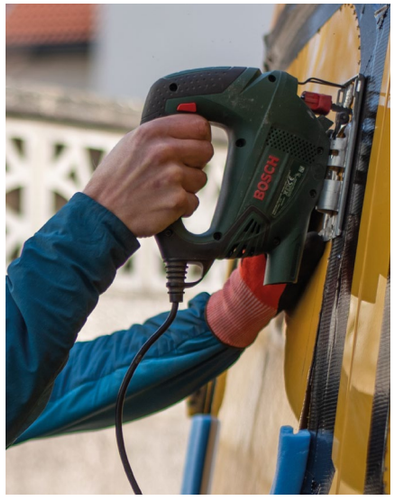
A jigsaw is the saw to have. Jigsaws can cut curves and detailed edges as well as straight lines (if you have a guide). They're useful for so many van jobs, from cutting holes in your van for windows and skylights, to cutting out kitchen cabinets. We'd recommend investing in a decent jigsaw and set of blades to see you through your build - we upgraded near the end of our build and wished we'd bought a better quality one from the start.

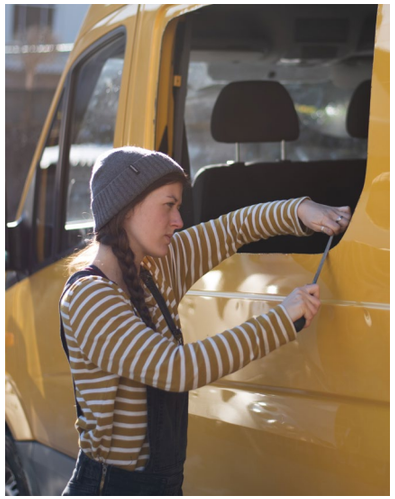
Sanders

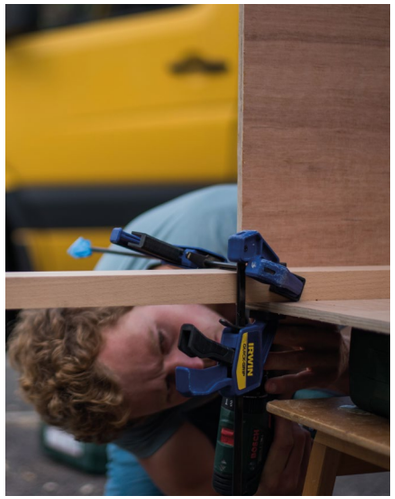
If you're making anything from wood in your campervan, a sander is key. Without sanding the edges of cut wood, you will end up with a very rough finish and potentially a lot of splinters! They're also useful for sanding wooden worktops to get a nice, smooth finish as well as removing any stains or marks in the wood. There are several types available which we've summarised below.

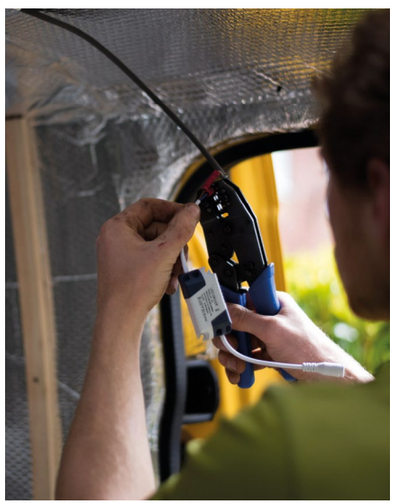
Belt sanders remove large amounts of material in a very short space of time. It's crucial to sand with the wood grain rather than across, as belt sanders sand in one direction. This means if you sand across the wood grain, it can splinter the wood and undo all of your work. If you intend to use pallet or non-finished wood for

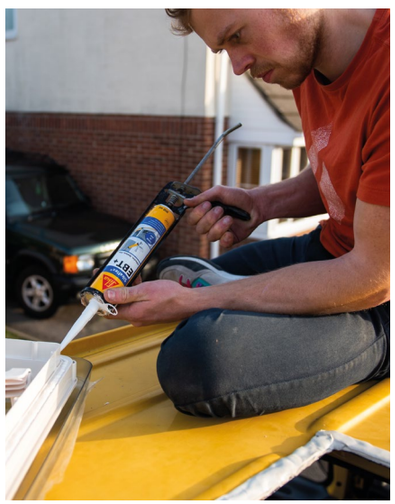


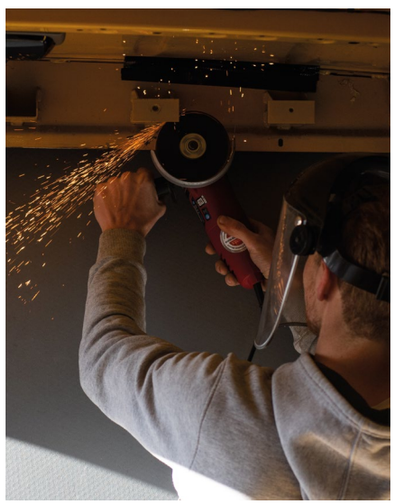












FIRST A drill is arguably the most important tool in your van build toolbox. **SECOND** And a mitre saw comes a close second! **THIRD** The almighty jigsaw. **FOURTH** A hand file. **FIFTH** Clamps are the holy grail of van building. **SIXTH** An electric sander. **SEVENTH** A crimping tool. **EIGHTH** A mastic gun. **NINTH** An angle grinder (where are your gloves?!). *@climbingvan*

your build, a belt sander and finishing sander is a good combination.

Disc sanders come with either orbital or non-orbital sanding attachments that spin from a fixed point. These sanders are best for rougher materials where a lot of material needs removing. You will then need to use a tool with better finishing capabilities to achieve a smooth finish.

Finishing sanders will help you achieve the smoothest possible finish on all surface forms. However, they're not good at removing large amounts of material quickly, and will subsequently need to be used in conjunction with a belt or disc sander to meet the needs of most van builds.

Random orbital sanders leave virtually no scratch marks, which are the common signatures regular sanders leave behind. They can also be used one-handed, giving you the freedom to hold the material with the other hand.

If you pick just one sander for your build, we recommend a random orbital sander as they're the most versatile. These sanders won't remove wood as aggressively as a belt sander, but they will polish a woodwork piece to nearly the same gleam as a fine finishing sander.

Sliding mitre saw or circular saw

Although perhaps not technically an essential, if you're not on a very tight budget, we'd recommend a sliding mitre saw (or a good quality circular saw). Although it's possible to get a straight cut with a jigsaw if you have a guide and a workbench, it's hard to get a truly straight edge and you'll struggle to cut through thicker battens of wood. A sliding mitre saw makes cutting a straight edge easy, which will save you a lot of hassle when putting things together! They make very quick work of chopping through battens so they will save you a lot of time too.

Utility knife

Sometimes known as a Stanley knife (although this is a brand name), a utility knife is a fairly basic but incredibly useful tool that can be used for anything from cutting through foam insulation to vinyl flooring. However, utility knives are responsible for a shocking amount of DIY related hospital visits, so make sure you wear a thick pair of gloves and follow the guidelines on the packaging.

Crimping tool

Crimping tools are used in your electrical system installation to connect two wires with a crimp. Unless you already have a soldering kit, most people use crimps and a crimping tool for their campervan electrical system.

Wire strippers

You will also need wire strippers for your electrical system installation, as they provide a quick and easy way of removing the outer insulation from a wire, allowing you to crimp it. Although it's technically possible to strip wires without a wire stripper, you run the risk of nicking the wire which can cause excessive current and become a fire hazard.

Wire cutters

Wire cutters, sometimes known as diagonal pliers, as the name suggests, are for...cutting wire. The long handles and sharp cutting edge allow you to concentrate a significant force on the cable, giving a nice clean cut.

Adjustable wrench

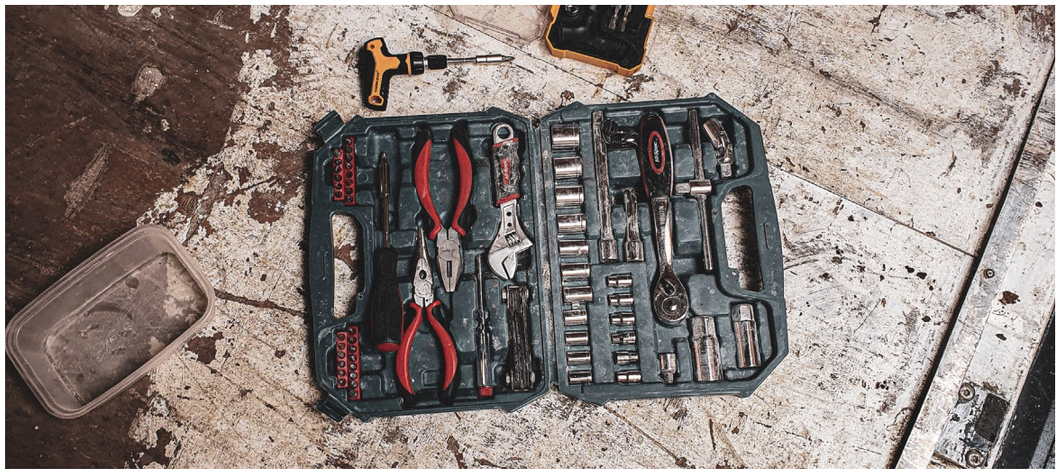
An adjustable wrench can be used to loosen or tighten a nut or bolt. It has a jaw where the nut or bolt fits and an adjustable wheel to tighten. The long handle length will give you a sufficient mechanical advantage to tighten any connection or hold a part in place.

Adjustable pliers

A 10-inch pair of pliers can open up to more than two inches. However, no matter how wide you set them, their jaws always remain parallel, giving them a firm grip on nuts, bolts, or pipes. The adjustable pliers are often used in conjunction with an adjustable wrench, so you can hold one element as you try to tighten the other.

Pipe cutter

The pipe cutter works by using a sharp cutting wheel to slowly penetrate through the metal and sever it. As the pipe cutter is rotated around the pipe in a 360° motion, the cutting wheel cuts through the pipe, leaving a clean cut without deforming the rest of the pipe. It is perfectly possible to cut a pipe with a hacksaw, but it's hard to get a clean cut and it's easy to buckle the pipe when you're clamping it.



ABOVE Merel did her research and bought a random orbital sander, a smart choice for a van conversion. *@dutchexplore*
OPPOSITE You will never regret investing in a good set of tools. *@ittakesajourney*

Set of files

A set of files is useful when you're modifying any existing area of metalwork such as cutting out windows and vents to ensure you can create a clean, smooth edge.

Quick grip clamps

Whether you need to temporarily hold down a sheet of ply so you can screw it in place, draw compound curves, or even need to gain some extra mechanical advantage with your mastic gun, quick grip clamps are cheap and will save you so much time throughout your build that it's worth buying several before you start!

Sealant or mastic gun

During your conversion, you will need to use different types of adhesive to attach your windows and seal up small gaps and any holes drilled through your van. A sealant gun makes this possible and only costs a few pounds.

Long spirit level and phone app

A spirit level is useful for drawing straight lines on sheets of ply and other materials, as it's aluminium construction makes it light, stiff and straight. However, it's important that you don't rely on the bubble level, as your van may not be on level ground! Instead, use the spirit level app on your phone to work out the angle of the van, and then factor this into any subsequent level readings. It may be tempting during the build to use a piece of wood as a long straight edge, but this is unlikely to be straight and you may end up with some very wonky pieces of furniture in your van!

Pocket jig

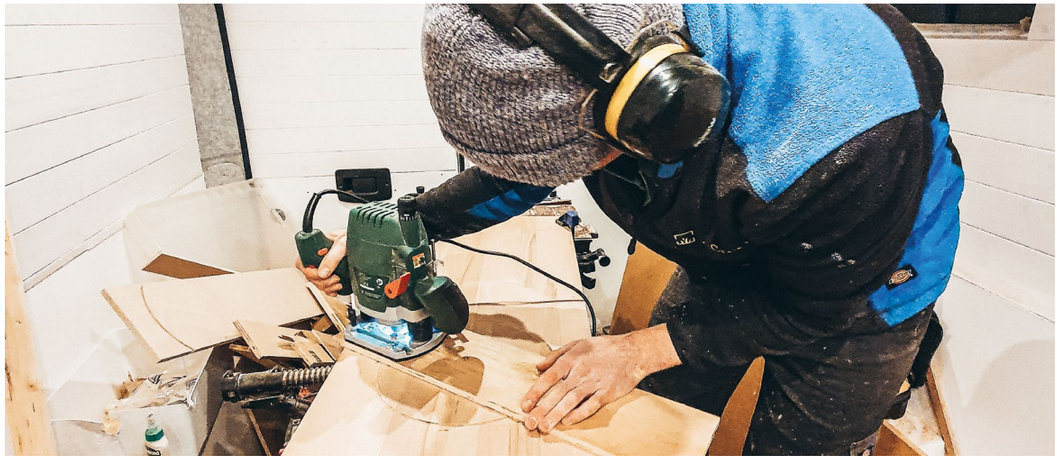
When you need to screw through material at an angle, a pocket jig is essential. It will allow you to drill angled holes so you can screw two battens together. This is a key bit of kit when using the carcassing method.

Safety glasses and mask

It's really important to ensure you have a good set of safety glasses and a mask before you start your build. Whether you're working with insulation, drilling a hole through your van or chopping through wood with a jigsaw, there will be lots of tiny particles flying around and getting a tiny speck of metal in your eye or your throat is likely going to result in a trip to hospital slowing your progress considerably.

Toolbox

Once you've bought your comprehensive collection of tools, you will need somewhere to store them! A sturdy, well-organised toolbox will help you find your tools, and protect them from damage between uses.



Extension cable

We're not sure whether this counts as a tool or not, but we are confident it's an essential bit of kit! Whether you're working in a covered workshop, on the street or on a driveway, getting power to your tools in the van throughout your build is essential.

Nice to haves

Router

It's perfectly possible to build your entire van using a jigsaw, but you won't get the same level of finish as you will with a router. A router will allow you to use the carcassing method of building your units, which is stronger and generally tends to leave you with a higher quality finish. The uses for a router are seemingly endless, as are the number of YouTube videos showing you how to use them. Along with a router, you will also need to buy a set of router bits to cut different sizes and profiles.

Table or track saw

A table saw will substitute the need for a circular or sliding mitre saw and make cutting sheet material or carcassing quick and accurate… if you've got the space for it! A table saw is likely only an option if you have a workshop or garage space to work in. If you're lacking the space, a track saw might be a better option, as you can detach the saw from the thin track and store it separately.

Angle grinder

If you have any protruding metal beams or brackets inside your van, an angle grinder is a useful tool to remove these. We borrowed an angle grinder from a friend to remove some unnecessary brackets before we started any work inside our van and it made our lives a lot easier later down the line. Without it, we would have had to lower our ceiling height slightly or bring our bulkhead forwards to cover it. You can get several different attachment blades for angle grinders to deal with different materials.

Planer

A wood planer can either be a hand or electrically powered tool which is used to reduce the thickness of wood, or even out the level of wood surfaces in small, measurable increments. It's often difficult to cut a piece of timber precisely to size, and you will need to remove small amounts of material to hone the fit and function of the part. A good quality hand planer can be far more useful for the more

ABOVE Tom using a router and guide to cut a perfect circle. *@ittakesajourney* **OPPOSITE** Dale wishing he'd bought a workbench whilst battling to cut in a straight line on a three-legged wobbly table! *@climbingvan*

intricate tasks where you want to have a lot of control, and may be the better option for most van builds.

Sash clamp

Sash clamps are used to glue wide panels and large assemblies together. They consist of a sturdy beam, a clamping head, and a head that can be moved along the bar and fixed solidly in place with a lever.

Mitre clamp

Mitre clamps are designed to hold mitre joints but also work well for butt joints, allowing you to apply any adhesives that might be required, clamp everything together and then screw the two pieces together at the set 90-degree angle.

Hand rivet tool

If you intend to suspend any large or heavy structures from your van walls or you're installing a floating fixed bed, investing in a hand rivet tool to install rivet nuts into sheet metal is well worth the small investment. The process of installing rivet nuts is described in the build chapter and numerous YouTube video tutorials are also available.

Multimeter

A multimeter is a really useful bit of kit used to test your electrical system. They're not expensive, and they will give you peace of mind whilst installing your electrical system. A multimeter has two prongs, and touching these to the positive and negative sides of any appliance or battery will show you its voltage reading. You can use them to check if the voltage of your batteries or the voltage across an appliance is what you would expect it to be, and to troubleshoot any issues.

Pipe bender

A pipe bender allows you to create a tight bend in a rigid or malleable pipe whilst preventing distortion or damage to the pipe. The most common type of pipe bender is mechanical and uses a lever to bend the pipe around a U-shaped guide.

Hex socket set

A hex socket set, also called a six-point socket set is designed to fit over a standard hexagonal shaped nut or bolt head. The ratchet allows you to quickly tighten or loosen bolts that would otherwise be tricky or slow to undo with a spanner. If your van has old racking or other structures left inside with hundreds of stiff bolts to undo, a socket set is a no brainer!

Scribing tool

A scribing tool allows you to trace the profile of one object onto another. This is useful when profiling awkward shapes such as the edges of the van when cladding and building units.

Nibbler drill attachment

If you're planning on installing your own windows, skylights or vents, it's well worth considering the alternatives to the jigsaw. A nibbler shear or nibbler punch drill attachment can make light work of cutting sheet metal and is a wise purchase even if you don't have a future need for it. The punch nibbler acts just like a paper hole punch, reciprocating many times a second and gradually eating away at the sheet metal. The nibbler shears act more like a pair of scissors, cutting through the metal and leaving a smooth edge (without leaving thousands of tiny shards of metal everywhere like the punch nibbler).

We've included a comparison of the nibblers on the next page with the jigsaw so you can decide whether or not to invest in one if you're installing your own windows.

OPPOSITE Brina using a jigsaw to cut the countertop for Ringo's German cousin! *@igor.explores*

Nibblers vs jigsaw comparison
Jigsaw

PROS
- No additional purchase required

CONS
- Very, very loud!
- Doesn't leave a clean edge
- Creates a lot of mess

Nibbler (shear) drill attachment

PROS
- Clean edge
- Quick
- No residue

CONS
- Tricky to make tight turns
- Costs £25

Nibbler (punch) drill attachment

PROS
- Fairly clean edge
- Quick
- Easy to make complex shapes

CONS
- Makes a lot of mess!
- Costs £15

Timber

Whilst material selection has already been covered in several areas of the planning chapter, it's worth knowing the key differences between common grades of timber and crucially how much you should be paying for them. DIY warehouses can be really expensive for some building materials and could drastically inflate the cost of your build, so try to shop at local independent builders or timber merchants, or order from an online specialist.

Carcassing timber

Often referred to as carcassing timber, carcassing is a type of wood most commonly used in structural applications where the timber will be used in an area that won't be visible. It's typically made from spruce and comes in a wide variety of heights, widths and lengths. A decent timber merchant will also be able to cut stock sizes down to specific heights or widths, or even cut all of your timber to its final size! They will usually do this for free or for a small fee. Carcassing timber is also available in several grades, which relate to the strength and quality of the timber. Depending on where you buy the timber, it may be identified using the British or (more common) European standard.

There are 12 strength classes available in the European standard, but C16 and C24 are the most common. C16 should be more than adequate for a van build, as it's rare you will try to span a long distance without adding any additional supports.

Kiln dried timber

You should use kiln dried timber in your van build for any visible structures or cladding as it's dimensionally stable and it won't twist and contract like untreated timber. The kiln drying process lowers the water content of the timber to below 20% where it's considered stable and not considered at risk of fungal decay. If you use a non-dried timber or especially 'green' timber, you will notice over time the wood will move and create noticeable gaps. The bigger the piece of wood, the bigger the potential movement will be!

Treated timber

Treated timber is pressure treated with wood preservative to guard against environmental conditions, making it suitable for external, moist and wet conditions. In contrast, untreated timber (sometimes referred to as sawn timber) is left in its natural state. Hopefully, you won't need any treated timber in your build, as any area likely to get wet should either have a covering or be treated with an oil or wax coating to protect it.

Softwoods

In addition to spruce carcassing, there are numerous other softwoods available to use in your conversion. We've discussed some of the more popular options below.

Pine is perhaps the most common form of cladding used in vans as it's light and easy to cut and absorbs stains well if you want to change its natural colouring.

Cedar is a very light timber with a reddish colour to it and has a slightly aromatic smell. It's often used for ceiling cladding, but it's not advisable for wall cladding as it's very sensitive to UV light. This means if you have doors and windows open, regularly letting the sun reach the timber, it will gradually turn grey where it's been exposed to the sun.

Bamboo is hardwood in all but name – while it's technically a grass, it outperforms most traditional hardwoods, such as oak, ash, mahogany and walnut in robustness. Bamboo has been proven to be three times as strong as oak in hardness test studies! It also offers a beautiful pale complexion and if classed as a wood, it's the most sustainable option.

Hardwoods

Hardwoods are generally used for very different applications, such as hardwearing and aesthetic areas. Typically they should not be used as a substitute for softwoods. Chunky sections of hardwood should be used sparingly in large builds due to their weight unless you're using them in sheet form to build structural cabinetry.

Birch is available in two varieties. Yellow birch is a pale yellow-to-white wood with reddish-brown contours, whereas white birch has a whiter colour resembling maple. Both types of birch are both strong, hard and crucially much cheaper than most hardwoods.

Oak is a part of the beech family and is commonly used for worktops and other high wear areas due to its robustness and ageing characteristics. Several types are available with varying tones and hues.

ABOVE We bought most of our timber in one bulk order to get the best price from our local timber merchant. *@climbingvan*

Timber sheet

As we highlighted in the planning chapter, the advantages of using ply over other sheet materials in a van build are obvious, but which specific type of ply should you be using?

Softwood plywood is characterised by its excellent strength, stiffness and resistance to creep. It has a high planar shear strength and impact resistance, which make it suitable for heavy-duty floor and cabinet structures.

Hardwood plywood has an excellent surface hardness and resistance to damage and wear. It has a reddish surface colour and smooth faces. Consequently, it's the grade we recommend for all load-bearing structures that will ultimately be hidden or painted.

WBP/BWR and marine plywood are widely sold at builders merchants and are made to an exterior grade referred to as WBP (weather and boil-proof). This means the glue line will not break down when subjected to adverse weather conditions, and can also withstand immersion in boiling water. The two types are almost the same, except marine plywood is guaranteed to be free from small holes and has a better quality core than WBP plywood.

Birch plywood is made exclusively from birch veneers of the same thickness, glued and laid up in alternating directions to the required thickness. It provides a superbly consistent strong panel with known engineering characteristics and a visually appealing face and edge. It's also possible to use Baltic birch plywood which has about twice the number of layers as regular birch plywood and has a beautiful pale colour with a subtle grain, meaning it's often used for high-end furniture building. The cost of solid birch ply and particularly pale coloured plywood can be several times more expensive than standard hardwood ply.

Visual grading system of plywood

AB grade is a very high-quality grading (typically the best you will see). The surface of the material will be consistent in appearance and will have no large variations in colour. Small pin knots are allowed, but these will typically only be a few mm in diameter.

B grade shows the natural look of the wood. There will be changes in colour that show the grain pattern. Sound, smooth knots are allowed and these will typically be under 15mm to 35mm in diameter.

BB grade is similar to B grade but allows for larger knots and repairs to the face. Sound, smooth knots are allowed and these will typically be under 50mm in diameter. Open knots are repaired with wooden plugs. The material should be suitable for applications where the visual look is not critical.

C grade plywood is 'structurally' sound but allows for defects on the surface of the material. These defects can include open knots, discolouration, and splits. These defects mean the material is suitable for applications where the strength of plywood is needed but the appearance doesn't matter.

OPPOSITE A peacock among the ply! We used B grade hardwood ply in areas that would be painted and AB grade Birch plywood for visual areas. *@climbingvan*

Standard sizes and thicknesses

Plywood is commonly available in sheet sizes of 2440 x 1220mm (8 x 4ft) and 1220 x 610mm (4 x 2ft) and the following thicknesses:

Sheet material thickness

Thickness	Typical use
3 & 3.6mm	Great for cladding carcassing that won't see any abuse. It can also easily be bent to create gentle curves or steam bent to achieve much tighter radiuses.
5.6mm (called 6mm)	Perfect for cladding 'high footfall' areas of the van, but should not be used for load bearing applications due to the risk of deformation or snapping.
9mm	Can be used to clad thin carcass structures or provide rigid coverage of larger areas with minimal support.
12mm	Great weight saving thickness for cabinetry and structural applications over short to medium lengths.
18mm	Standard cabinet thickness, but rather heavy for most van applications.
25mm	You're joking, right?!

Timber 'should' cost guide

The price of timber can vary significantly depending on where you shop - trade prices are usually around 30% less than what the DIY megastores charge, and small timber merchants can cost even less. If you're organised and confident in your quantities, you may qualify for an additional large order discount of five to 10% if you order all of your timber at once.

We haven't compared the cost of ply between DIY superstores and timber merchants because the quality of ply found in superstores is so poor that they simply aren't comparable.

Consumables

It's easy to forget the importance and sheer volume of consumables you will get through in a van build! Countless bare reels of tape and empty screw boxes are commonplace.

Adhesives and sealants

Before we summarise the most useful adhesives, it's really important to double-check the product you want to use is compatible with the materials you're trying to join. While one adhesive may be able to form a solid bond between plastics, others will simply fall apart!

CLS Spruce should cost

Supplier	0.75x1.5" (19x38mm)	1x1.5" (25x38mm)	1.5x2" (38x50mm)	2x3" (47x75mm)
DIY megastore	£0.79	£1.09	£1.60	£2.57
Timber merchant	£0.55	£0.78	£1.00	£1.87
Average % difference	30% cheaper			
Prices established by averaging independent UK timber merchants November 2020. Please be aware the cost of wood can fluctuate significantly depending on supply and demand. Cost per metre and no bulk order discount applied.				

Spray adhesive
500ml = 4m² coverage
Spray adhesives are ideal for a wide range of applications but are commonly used to attach auto carpet to the vapour barrier or ply lining of your van. The adhesive is projected as a mist from a pressurised can, creating a consistent coating. This one-handed application leaves the other hand free to handle the materials being joined together.

WARNING:
Inhalation in high concentrations can have a narcotic effect and may cause headaches, fatigue, dizziness and nausea, so always ensure you are working in a well-ventilated space and using PPE.

PVA or wood glue
1ltr bottle
PVA glue, or wood glue, is the go-to adhesive for joining wood together. Assuming the two surfaces you are glueing together are prepared properly, clamped together and left to dry, wood glue can even be stronger and more durable than screws! Because of its viscosity, the adhesive can reach all surfaces of the material you're going to join.

Superglue
1 small tube
The old favourite for mending, well...practically anything. It's worth having a small tube on hand just in case, but you're unlikely to use it with prior planning!

Sikaflex EBT+
2x 330ml tubes
EBT+ is the go-to general adhesive and sealant for internal applications and is capable of bonding all common building materials. It's permanently elastic and has excellent grab and gap filling properties, making it ideal for a wide range of applications, such as bonding wood to metal, fixing tiles and more.

ABOVE We had a few small surface rust spots when we uncovered our floor, so we sanded down the surface and painted the areas with Hammerite rust paint. *@climbingvan*

Sikaflex 292i sealant
330ml tube
This specific grade of Sikaflex is suitable for structural joints in wet or even submerged environments which will be subjected to high dynamic stresses. It's suitable to bond metals, particularly aluminium, and paint coatings and plastics such as GRP or ABS. This means it's perfect for sealing skylights and vents. It's advisable to score plastic faces with a knife before trying to bond them to give the adhesive the best chance of creating a chemical bond.

3M VHB 4950
A reel if required
This tape can be used for sticking solar panel mounting brackets to the roof of your van. Whilst it's technically a tape, it carries a heavy-duty adhesive compound on both sides of the thin tape which provides immediate handling strength. See Exterior in the build chapter for more details.

Dicht-Fix
375ml pot
Dicht-Fix waterproof sealant is a permanent elastic sealing compound containing carbon fibre strands. It creates an immediate waterproof bond, and will even adhere to wet surfaces in the rain, snow and frost! It's compatible with practically every material and can easily be applied with a brush or spatula. If you're worried about leaking skylights or vents, applying a thick layer of Dicht-Fix around each connection will alleviate any concerns.

Mastic sealing tape
19mm x 5m
Mastic is a Blu-Tack like tape which is commonly used as the sealing material for any skylights that have an external overlap joint and use an internal moulding to clamp the exterior skylight in place. The butyl tape doesn't have any adhesive performance and should only be used to create a level surface before the adjoining parts are fixed in position. It can also be applied in layers so you can even out undulations to ensure you have a flat and reliable sealing face.

Silicone
300ml tube
Silicone is a polymer sealant which is typically dispensed from a sealant or mastic gun and is widely available in clear, white, grey, black and woody browns. Most silicone sealants are highly resistant to temperature, water, and chemicals, making them versatile for indoor and outdoor use. Silicone is typically used to seal bathrooms and sinks. Using the right method you can apply silicone sealant neatly, leaving its presence unnoticed and clean.

Threadlock
50ml tube
Threadlock is used to prevent the accidental loosening of fastener assemblies due to vibration. While not necessary in all applications, it's easy to apply to any nut and bolt that are placed together.

Tapes

Masking tape
A few rolls
The self-explanatory tape, used to cover or protect areas typically from painting.

Electrical tape
1-2 rolls
Electrical tape is used primarily for safety reasons to protect, insulate, and shield wires and cables which conduct electricity. It's also known as thermal insulation or insulating tape, with widespread uses in the electrical section of your build.

PTFE tape
A roll per system
PTFE or Teflon (which is the trade name of the same polymer) tape is used to seal threaded water and gas connections. However, you use different PTFE tapes for the water and gas systems. Pink PTFE tape should ideally be used to seal water connections, but white PTFE tape can also be used, though you may need to apply more of it as it has a lower density. Yellow tape is reserved for gas connections as it has a higher density better suited to gases.

Duct tape
A single roll
Duct tape shares a similar trait to superglue in that you rarely intend to use it until something goes wrong and you need to bodge something! This extra-sticky tape has a thick, woven backing and is easy to tear to the length you want, perfect for use in a hurry! It's fairly strong when applied tightly but will leave a sticky residue on smooth surfaces if removed, so avoid using it to mask any painted panels of your van.

Paints, oils, waxes and varnishes

When you're nearing the end of your build and you're looking to finish and protect surfaces, you have a few options. Each has its advantages and recommended uses which we've summarised below.

Paints
Paints will obviously colour a material, but will also protect it. Ideally, you should use a wipeable paint such as an eggshell, as living in a small space like a campervan means you're likely to need something a bit hardier than a matte paint! Eggshell is a good balance between not being too shiny but still being much more hardwearing than a matte paint.

ABOVE Hammerite rust paint shouldn't only be used on previously rusty areas, it can also prevent rust from forming in the first place, so make sure to paint any newly exposed metal edges. *@climbingvan* **OPPOSITE** Charlie (different Charlie!) giving her cladding a lick of paint. *@wandering_home_*

You may also need to purchase anti-rust paint so you can coat any freshly exposed metal to prevent it from rusting.

Oils
Wood oils can be used, not only to protect wood but also to change its colour or tone by using a darker stain. You can also use a more natural stain if you want to maintain the colour of your wood and bring out the natural grains. You can apply Danish oil using an old cloth or rag. Oils offer more durability than a wax polish and are easy to work with and to repair, but they do have slower drying times.

Waxes
Wood wax is used as a finishing product to protect wood from absorbing moisture. It will enhance the natural wood colouring and grain effect, typically leaving you with a high shine finish. However, matte variants are also available. Most waxes for wood are water and stain-resistant, making them ideal for floors, tables and countertops.

Varnishes
Forming a seal on the surface of the wood, varnishes are the strongest of all wood finishes. They create a transparent, protective coat with a glossy finish.

Standard components

Fasteners and fixings

Knowing what type or grade of fasteners to use can be a little confusing, so we've summarised the most important things to consider.

Screw and bolt types

A multitude of different screws and bolts are available, but for a van conversion, you should only need four. For your build, you will require one type for wood, two for sheet metal and one that is compatible with standard nuts or a tapped hole.

Wood screws have a tapered point and sharp external cutting thread.

Sheet metal screws look similar to wood screws, but their threads tend to finish at the head rather than dropping short like on a wood screw. This ensures the thread is always engaged with the material, regardless of thickness.

Self-drilling SMS screws carry a cutting blade profile at the bottom of the screw. This means you don't have to drill a pilot hole first as you do with a normal sheet metal screw.

Hex bolts have a continuous, fine pitch thread. They are exclusively used to connect to preexisting nuts or tapped holes.

Head types

In addition to the four most common screw and bolt types, there are four additional head types we would recommend using: slotted, Pozidriv, hex and Torx. If you find yourself using a Bristol screw head, you've gone way over the top!

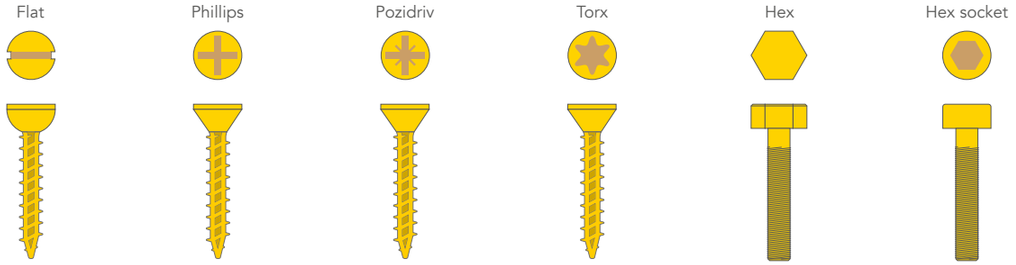
Slotted heads are the oldest type of screw in use today, but nowadays they're mostly used for decorative purposes as they're less noticeable than other screw types.

Pozidriv heads are similar to a cross-shaped Phillips head, but the shape has been modified to improve engagement.

Hex and hex sockets come either with an external hexagonal head or a 'hex socket' Allen key style connection which both limit the opportunity for the driver to slip. They're typically only used with bolts.

Torx heads carry a star-shaped head, making them far more secure than regular slotted or Phillips head screws. The Torx head allows a higher torque transmission to tighten screws and bolts more securely.

OPPOSITE Charlie giving it her best try hard face! *@climbingvan*



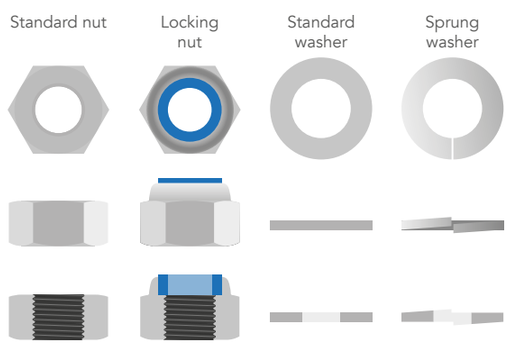
Nuts and washers

We promised to go into every detail in this book, so here you have it...the humble nut and washer! Although seemingly insignificant, selecting the right nut and washer for an application can have a big impact, or prevent one! Conventional nuts and washers have a tendency to vibrate loose over time, especially if they are in a moving van. Bolts and washers are often used to secure underslung water and gas tanks, which are the last thing you want vibrating loose mid-road trip!

Thankfully, for these critical high vibration applications, locking nuts and sprung washers are available to prevent the connections from loosening under vibrations. If you want to be doubly safe, use thread lock adhesive to further limit any movement in the nut.

Fastener materials and coatings

Deciding on the material and coating of your fasteners will very much depend on whether they will be exposed to the outside of the van or if they will come into contact with water. As a general rule, we'd recommend zinc and yellow passivated or carbon steel screws for interior woodwork and stainless steel for exterior fittings. Whilst zinc and yellow passivated screws don't cost much more than plain carbon steel screws, stainless steel will add a hefty lump to the total cost, so try to use these sparingly. Alternatively, you can spray the exposed fastener with an underbody coating to protect the non-stainless fastener from rusting.



How many fasteners do I need?

Ordering the following size and quantity of screws is a good starting point, but by no means will this be enough to finish a large, complex build! You should keep an eye on quantities and order more as and when required. As a rough guide, we used an estimated 2,000 screws in our build, which is a staggering 4kg just in screws! In addition to this, you will also need to purchase specialist screws, nuts, bolts and washers as required, but the required quantity of these are easier to establish when your systems and appliances start arriving.

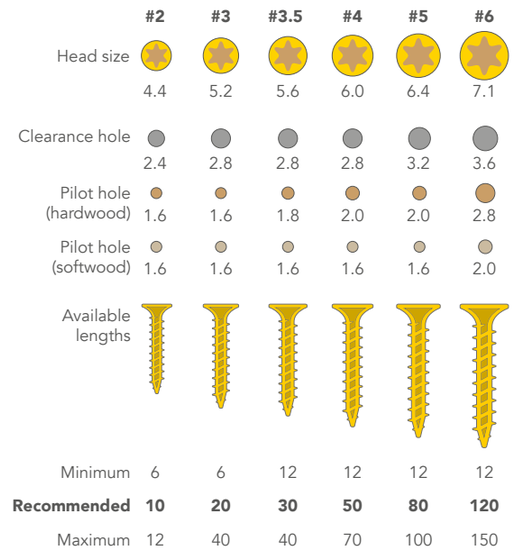
Drill bits

It may be tempting to just drive a screw directly into metal or timber and save the time drilling an appropriate hole, but you're likely to damage either the screw or the material. Knowing when to use which drill bit and size will dramatically improve the quality of your structures and furnishings.

Screw quantities

Screw size	Typical use	Qty
#3 x 10mm	Fixing hinges or thin objects to single thickness 12mm ply.	200
#3 x 20mm	Joining two layers of 12mm ply together or fixing thinner material to carcassing.	200
#3.5 x 30mm	Fixing 12mm ply to battens.	200
#4 x 50mm	Joining two battens across their width.	200
#5 x 80mm	Joining two battens across their depth.	100

Wood screw sizing chart



Hole types

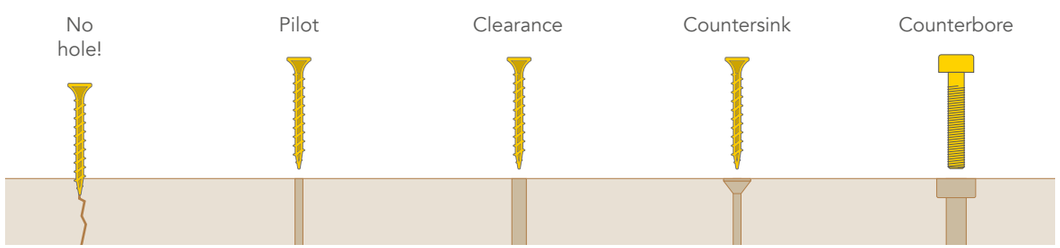
Pilot holes are a small guide hole used for either fixing screws or guiding the path of a much larger drill piece diameter. A pilot hole should create sufficient room for the shaft of a screw to fit snugly, allowing just the thread to cut and nestle into the material. Without a pilot hole, the screw may well split the wood.

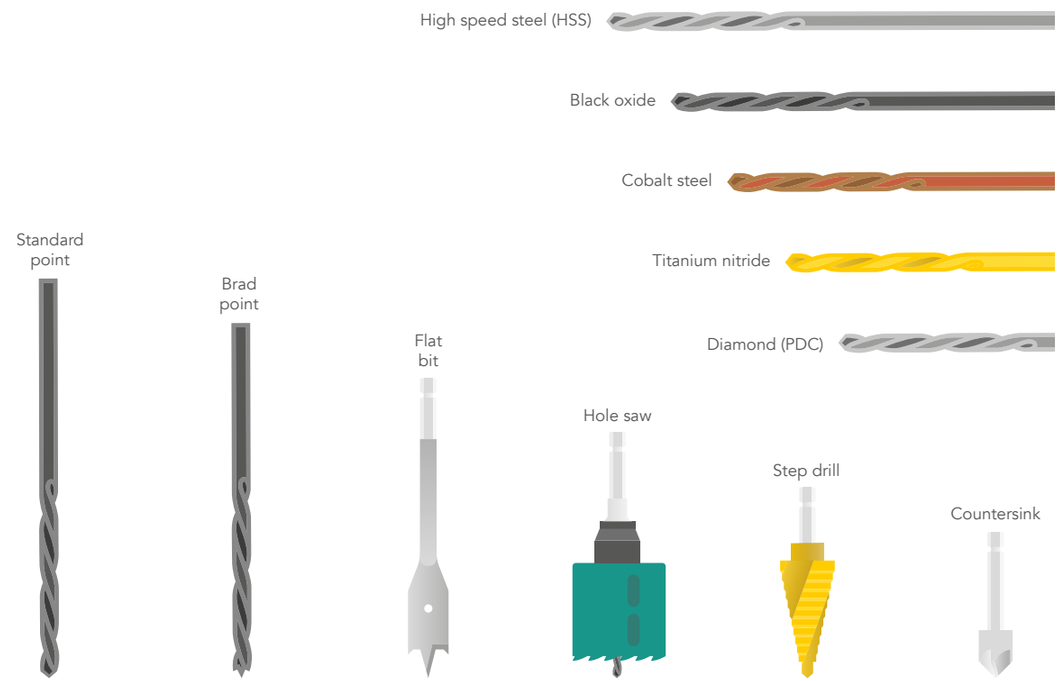
Clearance holes create clearance for both the shaft of the screw and the thread, but they are still small enough to hold the head of the screw. The wood screw sizing chart shows the recommended clearance and pilot holes for given screw sizes.

Countersink holes aim to hide the head of a screw below the top surface of the material. It's important they are used in conjunction with pilot holes to prevent the screw from splitting the thin material.

Counterbored holes are typically reserved for hiding the head of a hex or hex socket bolt below the surface of the material. The counterbore diameter and depth only need to be slightly larger than the head diameter and height of the fastener you are using.

Square holes...only joking, although it is possible with a mortise drill bit!





Drill bit types

Standard point drill bits are typically used for cutting through metal due to their shallow cutting angle, but can also be used for timber.

Brad point drill bits are exclusively designed for use with timber and feature a characteristic spike to help you drill in the correct place.

Countersink drill bits aim to create a space for a screw head to sit in, and only need to cut a few millimetres deep.

Hole saw bits can cut large diameter holes. They can be used with a regular drill.

Flat drill bits can cut holes in wood to a greater depth than a hole saw, but are not available in as wide a range of diameters.

Step drill bits can cut through thin sheet metal, and enable you to cut a wide range of diameters from a single bit. The step drill can follow the path of a pilot hole, gradually cutting bigger and bigger diameter holes.

Drill bit material

The correct drill bit is useless if it's not made of the right material. You need to ensure the drill bit you use is made of a harder material than what you will drill through.

High speed steel (HSS) drill bits will be sufficient for most timbers you would ever consider putting in a van, but they aren't appropriate for most metals.

Black oxide drill bits offer enhanced performance when drilling through plastic, wood and non-ferrous metals such as aluminium and copper.

Cobalt steel drill bits are used when drilling lots of large holes through hard materials. They distribute heat better than steel and will stay sharp for longer.

Titanium nitride drill bits can be used for all wood, plastic and ferrous metals such as steel. They have great longevity and durability. Investing in a set of sizes between 1-10mm will see you through a van build and further DIY projects for years to come.

Diamond (PDC) tipped drill bits should be reserved for glass, tile and ceramic, and are unlikely to see much use in a typical conversion.

Jubilee clips

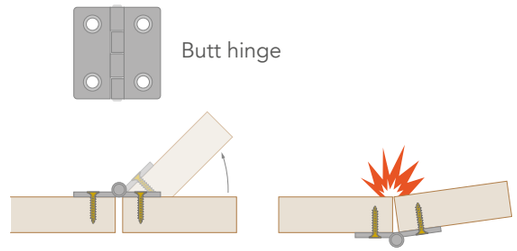
Jubilee clips, sometimes referred to as pipe clips, are metal hoops featuring a tightening barrel. These can be adjusted with a screwdriver. A jubilee clip is used to fix hose or ducting to pipe or connectors, applying even pressure around the diameter. They are available in a range of sizes which cover a range of diameters. Having a selection of jubilee clips for your build will be extremely useful.

Hinges, struts and hardware

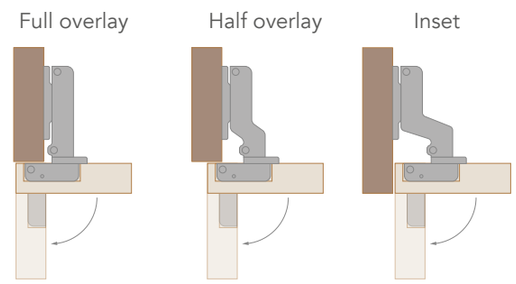
Hinges

This may not seem like the most riveting subject, but you'll be amazed at how many different types of hinges there are, and how something seemingly simple can stop everything from working. It's important to understand the different types of hinges you might require in your build, and the applications for each of them.

Butt hinges are designed to support large amounts of weight, such as a door. They use a fixed pivot point which means you need to ensure you mount them correctly to prevent the moving door from crashing into the part it has been mounted to.



Concealed hinges are most commonly found in kitchen cabinets and can cater for a range of opening angles. Concealed hinges are typically used for 18mm thick doors, as one half of the hinge is concealed within the thickness of the door, whilst the other is screwed in place. Once installed, you can alter the position of the door using three screws which finely adjust the angle and clearance of the door. There are three major variants available which allow you to mount a door in various different positions.



Full overlay hinges are used by most kitchen manufacturers as they completely hide the cabinet the door is attached to. However, it's important you remember these hinges have been designed for cabinet doors which only overlap with a single cabinet panel and don't share a cabinet overlap with another door. Generally speaking, full overlay hinges should only be used on the last cabinet in a row.

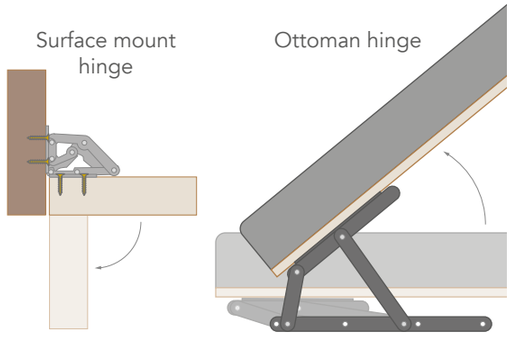
Half overlay hinges are very similar to the full overlay hinge but are used when two doors overlap the same panel.

Inset hinges are visually very different from other concealed hinges, as they hold the door between the sides of the cabinet, exposing the front edge of the cabinet walls. Inset hinges only tend to be used if you have furniture grade timber and want to show off the grain or layers of the wood.

Creating the hole to attach a concealed hinge is only really possible with a router, so if this isn't available to you, we'd recommend using surface-mounted hinges instead.

Surface mount hinges can be used to achieve a full, partial or inset style door. The major advantage for van builders is that they don't require the use of a router, and you can attach them to a door thinner than 18mm. However, as well as making it trickier to hone the position and angle of the door than a concealed hinge, they're also more expensive.

Ottoman hinges sometimes referred to as bed hinges, use a four-bar linkage (pictured) to swing the door open. They're specifically designed to create a large offset from the door's starting position so cushions and backboards can be left in place when opening the door. Many ottoman hinges come with an attached gas strut, so be careful if you buy one of these. It's likely to have been designed to support a heavy mattress, and probably won't be suitable for your bench seating.



Gas struts

Gas struts can be used to hold cupboard doors in an open state. They use a cylinder containing a pressurised gas to hold a piston (a long metal rod) in an extended position. The higher the pressure inside the cylinder, the greater the force the strut can exert.

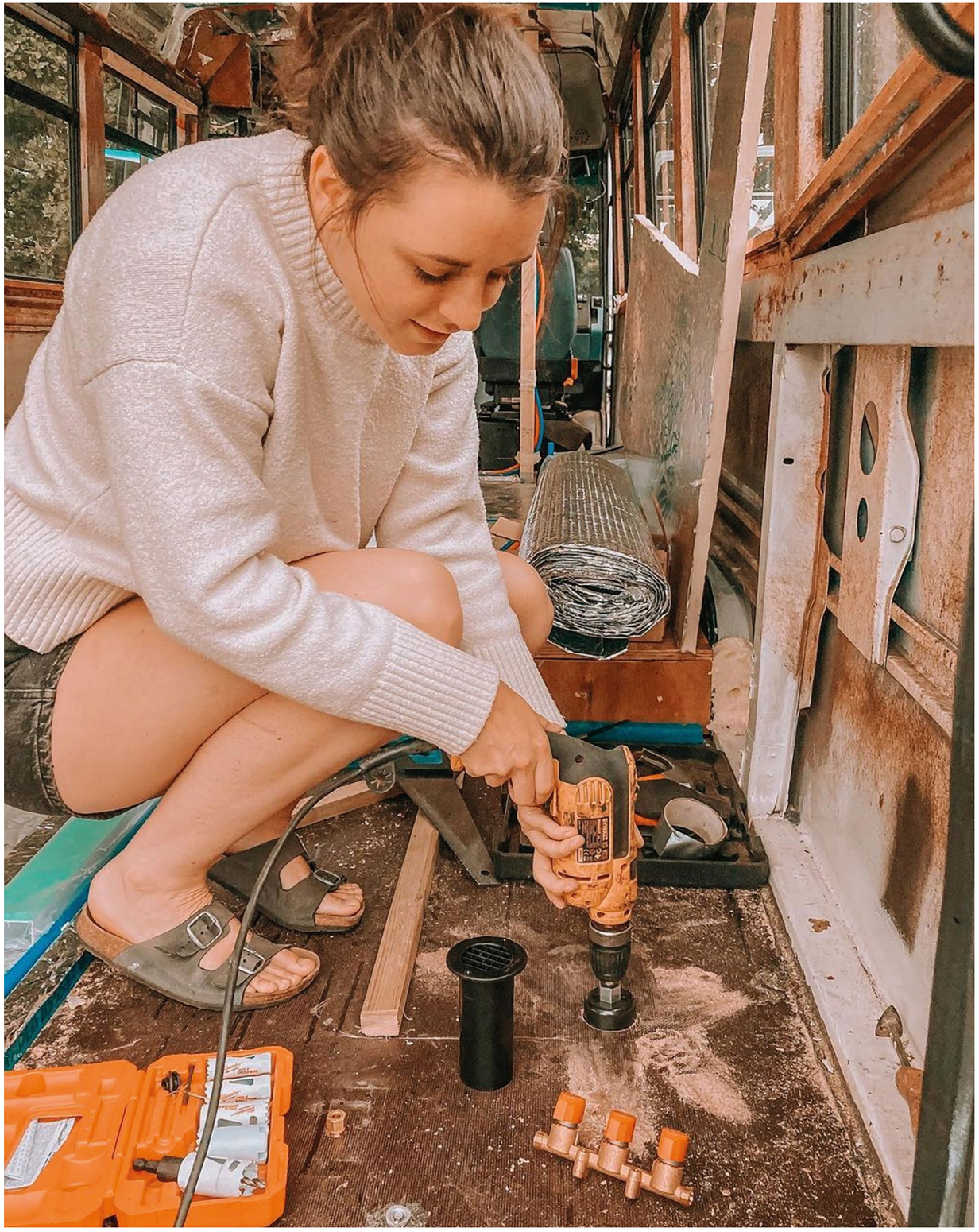
Choosing the right gas strut is important, as there is a fine line between the door being too heavy for the strut to hold it open, and the strut being so powerful that you struggle to close the door! To check if a strut is suitable for your application, you will need to use the following equation:

$$L = (W \times H \times 1.15) \div F$$

Where L is the strut mounting distance in millimetres, W is the weight of the door in newtons, H is the depth of the door in millimetres, and F is the force of the strut in newtons. You will need to find a gas strut that you think is suitable and check if the value you calculate for L will work for your intended use.
In case you're sitting scratching your head at everything we've just said, we have provided a worked example below of how to specify a gas strut for the most common application: an overhead cupboard door. Please remember, if you need your door to open in a different orientation or to a greater or lesser angle than 90 degrees, you will need to research this specifically. We decided against filling the next 30 pages with every conceivable example!

Example
A cupboard door is 200mm high and weighs 1kg. To check if a gas strut that has a force of 2N is suitable for the door, first convert from kilograms to newtons, by multiplying the weight of the door by 10 (or 9.81 if you want to be pedantic!).

1kg x 10 = 10N



OPPOSITE Selecting the correct sized hole saw is only half the battle when drilling a drop out vent! It's important to buy hole saws designed for cutting through metal, otherwise you'll have a hard time! *@wandering_home_*

Next, multiply by the depth of the door and the factor of safety:

W x H x 1.15
10N x 12mm x 1.15 = 138

Divide by the force of the gas strut:

138 ÷ 2N = 69mm

This means that the strut would need to be mounted 69mm away from the hinge, making it suitable for the application as the door is 200mm high.

A good rule of thumb is that the strut should be mounted at least 50mm away from the hinge, and will obviously need to have a mounting distance less than the height of your door.

Fitting the strut is very easy. Connect one end of the strut at your calculated distance (L) with the door open at 90 degrees, and then swing the piston towards the cabinet, mounting it as close to the edge of the cabinet as possible.

Drawers and mechanisms

Drawer runners

Drawer runners, sometimes known as ball bearing runners or linear guides, provide smooth movement for weight-bearing tables and drawers. They're available in various lengths and working loads so you can easily match them to your application. However, they're relatively heavy and expensive, so for a drawer in a kitchen unit, roller drawer runners might be a better option.

Catches and latches

One thing you will quickly realise when setting off on your first van trip is that taking corners at speed can wreak havoc with the contents of your cupboards! There are hundreds of methods of retaining doors and drawers, but we've described the most common options.

ABOVE A bolt latch is a simple and reliable option to keep your kitchen drawers and cupboards closed. *@thedixietribe*

Roller catches are one of the cheapest and best performing latches for campervans. They consist of a spring-loaded roller which is attached to a cabinet, and a metal clip that is screwed to the door. When the door is closed, the metal clip is pushed into the roller, holding it in position. In our experience, the holding force is sufficient to retain both drawer and door fronts from flying open. Roller catches are a great option as they aren't visible externally.

Magnetic latches work in a similar way to roller catches, but as the name suggests, they use magnets to retain the door fronts instead of a sprung mechanism.

Push lock knobs have a small latch which locks when the knob is closed, holding cupboards and drawers closed. Pushing them disengages the latch and presents a small knob that can be pulled to open the cupboard or drawer. We would recommend these if you're happy with the aesthetic.

Twist and bolt latches are a cheap and reliable method of retaining cupboard fronts, sliding tables and more. Bolt latches are commonly found in bathrooms and on garden gates, using a metal bolt to retain a door. Twist latches work in a similar manner, using a piece of wood or metal on a pivot point to keep a door closed. They're easy to make yourself from leftover material, allowing you to match them to the aesthetic of your van. Sometimes the simple option is the best option!

Places to shop

There are certain materials and items for your build that are best to buy from a physical shop. Any very large items such as sheets of ply or long pieces of cladding will come with expensive delivery fees if you order them online, so it's a good idea to try and find a local timber merchant to source these from. You will find a local timber merchant is much cheaper than a DIY superstore, and the quality will also be much better. We would generally recommend avoiding DIY superstores (such as Selco or B&Q) because of this.

For certain items throughout your build, such as your batteries, we'd recommend visiting a specialist store. If you have a battery shop nearby, popping in means you can talk through your requirements with someone who can ensure you're making the right purchase for your needs. Another example of this is a specialist motorhome store which might stock niche items that are otherwise hard to come by.

We shopped for the vast majority of our van build purchases online. Many companies offer free delivery over a certain order price, and it's so easy these days to compare prices across many different websites within minutes. To avoid spending your time visiting lots of individual stores, and the ease of browning, it makes sense to make the majority of your purchases online.

The other benefit of shopping online is using websites such as eBay, Gumtree and Facebook Marketplace. You should set up alerts for high ticket items such as fridges and heaters early on, as finding a second-hand appliance at a heavily discounted price could save you hundreds. We saved over £800 by buying our fridge, heater and inverter from Gumtree and eBay, so it's definitely worth doing!

DALE SAYS:
Builders merchants (such as Travis Perkins or Jewsons) tend to have better quality materials available, and if you run your own business you can set up a company account to benefit from some pretty hefty savings (anywhere from 10% up to 40% depending on the item).

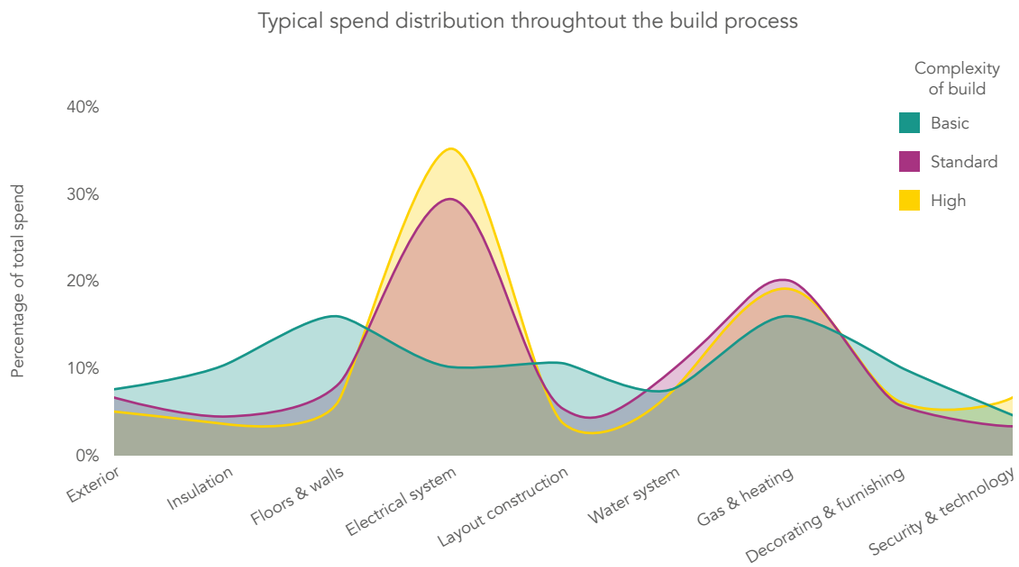
Estimating quantities

With extensive planning and clear design plans in your back pocket, it should be possible to establish fairly accurate quantities of different materials you will need. This can largely be achieved by knowing the exact proportions of your van and measuring lengths and areas. Estimating scrap rate is especially important for timber, as its natural composition means that knots and cracks are prevalent. It's therefore necessary to order extra to account for the scrap rate, which for timber shouldn't be more than 10-12% (if it is, it's probably worth complaining to your supplier!).

Forecasting costs

If you're on a tight budget, it's important to anticipate when you will need to purchase items for your build, as the costs won't be spread evenly across the conversion process. Some phases of your build will dwarf others in terms of cost (the electrical system in particular!), and the variation in cost will also vary depending on the complexity and finish of your van.

If your van conversion has a high spec electrical system, this is likely to be the most expensive area by far, whereas if you have a more basic spec van, you may end up spending more money towards the end of your build when buying appliances. In some areas, it's possible to spread the cost more evenly, for example by buying some appliances before you need them, but this will not always be possible - trying to spread the cost of the electrical system would mean halting the progress you're able to make, as these costs are incurred towards the start of your build.



OPPOSITE After all of that talk of tools and materials, we thought we'd treat you to a photo of a beautiful van! *Dom Rand & Jess Johnston @ourbigredhome*

FIVE

Build

Phases of the build

We have divided the build phase into nine sections. Some tasks can be performed concurrently, but some areas must be completed before others can start. Within each section, we have provided a detailed breakdown of each specific task, written in the order they should be completed in. We've analysed several builds and researched the process used in other industries to establish this process.

A note on your 'workshop'

Before you can start converting your van, it's really important you have a good area to work in. We started our build on the street near our house and immediately ran into issues with our too-short extension cable and unhappy neighbours when we started cutting holes in the side of our van! We ended up doing most of our conversion on Charlie's mum's driveway, as it meant we had space to work and could store all of our materials and tools.

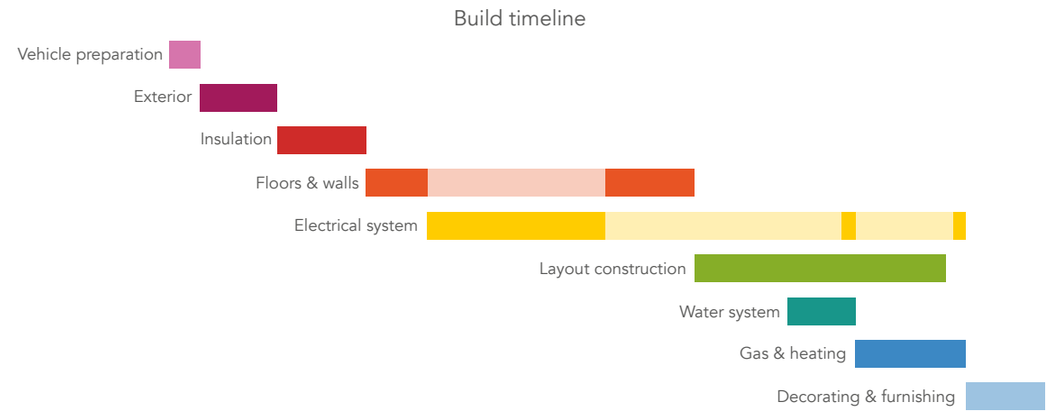
You will need to make sure you have easy access to power, space for cutting and assembling large pieces of ply, and somewhere to store everything. If you don't have a driveway or a space near your house, it's worth asking a friend or parent to work from their driveway or garden, or even consider renting a workshop space for at least the start of the build.

Arguably, the most valuable item you can invest in is a workbench. Your back will thank you at the end of the build if you buy or build a workbench to use when making and assembling items throughout your van conversion. At the start of our build, we had a shaky setup, balancing sheets of ply on an old office cabinet and a recycling bin. It was a nightmare to work on and it gave us horrendous backaches by the end of the day! It makes all the difference having a level surface at a sensible height to work from.

Health and safety

The dreaded health and safety section…this is by no means an exhaustive list but there are several important warnings here. Remember, if you're using a new tool or doing something unfamiliar, you should read the relevant guidance and ensure you observe safe working practices at all times. You don't want to join the 4,800 people who end up in hospital each year due to a power tool related accident![14]

14 NHS England » NHS on hand this bank holiday as DIY injuries increase. England.nhs.uk. Available at: <https://www.england.nhs.uk/2019/04/nhs-on-hand-this-bank-holiday].



DALE SAYS:
Be extra cautious when you're working on the roof of your van. I can confirm that falling onto your back from that height isn't very pleasant!

Electrical safety

Electricity can kill or severely injure people and can cause damage to your van. However, you can take simple precautions when working with or near electrical equipment to significantly reduce the risk of injury to yourself and others.

When working on your electrical system, you should ensure you never touch the positive and negative wires. If you touch the negative and positive of a 12V battery with your hands, you will generally not receive an electric shock (although we would still advise against doing this). However, if you accidentally connect the terminals with a metal object such as a spanner, you will create a short circuit which will heat the spanner up very quickly. A short circuit can create sparks or smoke, which in turn can create a fire hazard.

It's important to join wires together safely. If you don't join them properly you run the risk of the wires becoming exposed, allowing the positive and negative to touch which will create a short circuit.

If you're connecting 230V appliances, you should always make sure appliances are disconnected when wiring them up, as 230V carries a shock hazard risk. It's good practice to ensure any appliances are disconnected when wiring them, whether they are 230V or 12V.

If you're unsure what you are doing at any point when installing your electrical system, stop and speak to a professional.

Gas safety

There's a danger of fire, explosion and carbon monoxide poisoning from both gas appliances and the gas supply itself if they are not properly installed and maintained. Ensure you pressure test your system and have it signed off by a qualified gas registered engineer.

Personal protective equipment (PPE)

Personal protective equipment (PPE) is important in protecting you against health or safety risks. It includes items such as gloves, eye protection, safety footwear and masks. Ensure you wear PPE whenever you are using any tools or materials that can cause you harm.

Vehicle preparation

Tools

- Socket set
- Adjustable wrench
- Drill and drill bits
- Angle grinder
- Crowbar
- Mastic gun
- Paint brush
- Clamps
- Jigsaw
- Set square
- Circular/mitre saw

Removing old structures

Depending on the base vehicle you have purchased, you may need to remove old or unwanted structures to leave you with a blank canvas to work from. The list of possible obstructions is fairly substantial, so we've listed some of the most common along with how best to remove the structures.

Glued brackets

If your floor has angled brackets that have been glued in place to support old structures, they are best removed with a crowbar to force the bracket off the floor. Remove the glue afterwards with a sharp implement such as a Stanley knife.

Racking

If you have purchased a courier van that contains parcel racking, you're likely to have hundreds of bolts to undo to remove it. To make this easier (or in some cases possible!), use a socket set and adjustable spanner to hold the nut and undo the bolt. Be warned, if you don't invest in a socket set for this job, it will take so much longer than it should (we're speaking from experience!).

Dale says: If you're shrewd, take pictures before you dismantle everything and make sure you keep all of the fasteners, as racking sells for a decent price on auction sites. We sold ours for £400 and the person who bought the racking even offered to help remove it, which took four hours with all of us working on it!

Seats

Whether you want to remove seats in the front or rear of the vehicle, they're likely to be held in place in one of two ways. If you're lucky, they will be bolted to a captive nut welded into the floor and in this case, the bolt can simply be undone. If you're less fortunate, the nut won't be fixed and will be free to spin around as you turn the bolt head. This means you'll need to crawl under the van to hold the nut whilst someone else undoes it from the inside.

Rivets

Rivets are a pain to remove. The quickest way to remove them is to use a sharp drill bit roughly two thirds the size of the rivet head, and drill straight through the head until it drops off. Push the remainder of the rivet through the hole. However, be careful not to push too hard and punch through to the outer skin of the van!

Welded brackets

Welded brackets are the most awkward structures to remove, and often using an angle grinder is the only way to remove the projecting bracket. There are a few critical tasks you should do before you start cutting.

Ensure you cover all surrounding surfaces with a protective cover, as sparks and tiny shards of metal will spray from the angle grinder and could burn through fabric or chip paint. Most importantly, protect yourself with PPE, and ideally wear old clothes.

ABOVE Face mask - check. Old clothing - check. Plastic sheeting to protect front seating - check. Gloves - not check! Always wear gloves when you're using an angle grinder! *@climbingvan*

Preventing rust

Sealing side panels

Many vans that have plastic side panels use a clip feature to attach them to the side of the vehicle. These can allow water ingress as they are not sealed, and so rain can work its way behind the plastic panel and into the van via the clip holes. If left unsealed, rainwater can build up in the cills of your campervan and soak your insulation, and this will cause a whole raft of issues. Before you start your conversion, remove these panels and apply silicone to each individual clip feature to seal them, preventing water ingress.

We would highly recommend watching a few YouTube videos before using an angle grinder for the first time and ensure you have the correct blade fitted, as they can be dangerous if used incorrectly.

Painting chips

If you have any chipped paint on the outside of your van, clean the chips and paint them with anti-rust paint to protect your vehicle. If left untreated, these can cause much bigger rust issues down the line.

Dealing with rust

Surface level rust

If you have small areas of surface rust, fully remove the rust using tools such as a drill or angle grinder with a wire brush or sanding attachment, and treat the areas by painting them with some anti-rust paint such as Hammerite. In some instances where there are multiple patches of rust, it might be beneficial to repaint the whole floor to serve as a barrier to future rust issues.

Penetrative rust

In the case of more penetrative rust (the type you press your finger into and it starts disintegrating), you will need to remove the worst affected sections and have some welding work done. If this is the case, we'd recommend taking your van to a garage, unless you already have welding experience.

ABOVE One of the most important seemingly minor jobs you can do in your build, sealing the side panels! *@climbingvan*
OPPOSITE Rachel and Sam had a battle on their hands dealing with rust issues before they could start their build. *@thedixietribe*

Building over cab storage

If you plan on adding storage above the cab, do this now. Remove the cab headliner (the material lining the roof) and any handles so you can see what structures are naturally available to attach your structure too. The headliner will need to be cut in half so you can replace on either side of your structure.

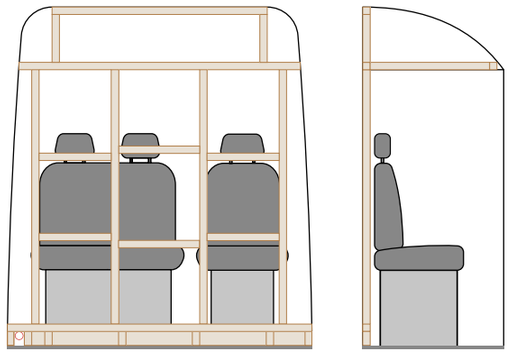
1. Build a basic carcass structure to create a platform for your storage area.
2. Either glue it into place using Sikaflex EBT+, or use sheet metal screws which need to pass through the timber and into the metalwork of the van.
3. Clad the carcass structure with a thin piece of ply for the cab side and a thicker piece on the living space side to create a strong structure with pockets for insulation.
4. Draw a guide on the non-visible side of the headliner to mark where you will cut it. Doing this is fairly tricky as you need to roughly estimate where the cut should go.
5. Cut the headliner and fix it back into place once your structure is complete.
6. Once everything is aligned, clip the liner back into position and reattach any handles.

TIP:
If you're not confident that your line on the headliner is correct, cut above the line you've drawn so you can make incremental cuts as you offer it back into place from the underside. It's more important it looks correct within the cab, as that's where it will be most visible.

Building a bulkhead

If you need to replace an existing bulkhead or build one from scratch, you should build a structure capable of retaining insulation, as the cab area is the least thermally efficient area of the van. You should construct the bulkhead using the carcassing method so you can pack the gaps between the timber with insulation. You will also need to add a thin layer of ply to the cab side of the structure which can eventually be covered with auto carpet, cladding or paint.

1. Using a socket set, unbolt the front seats from the floor.
2. Start to build up the batten structure consisting of columns and cross members.
3. As you need to clad the structure on the cab side with ply, use scrap cardboard, a pencil and scissors to create a template. Start by cutting a piece of card roughly to the shape of a section of the bulkhead and offer it up. Mark the areas that need to change with a pencil and remove them. Repeat this process until each portion of card fits, and then stick each section together to form a template.
4. Use the template to cut a sheet of 3mm ply to size.
5. Clad the cab side wall, using screws or nails and PVA wood glue to secure it in place.
6. At this point, you should have the bulkhead in place, with the cab side clad with ply. Before you put your seats back in, it would be wise to try and finish the ply face either using paint or auto carpet. We cover how to use auto carpet in *Floors and walls on page 218*.
7. Replace the seats and ensure they are securely attached (or if you are fitting new seats, follow the details in the next section).



OPPOSITE FIRST The cab headliner removed ready for the build to start. **SECOND** Dale attaching the wooden frame to support the over cab storage. **THIRD** Charlie practising her handstand surfing...or checking the base of the overhead storage fits? *@climbingvan*

NOTE:
You will likely be trying to cut some fairly complex shapes to try and match the curvature the walls of the van, so to make the process a little easier, work on just one side at a time. Within reason, vans are relatively symmetrical, so with a bit of luck, once you have finished creating the template for one side of the bulkhead, you can flip it over and draw around it for the other side.

Installing swivel seats

1. Unbolt the seat from its base (the swivel adapter will be connected between the seat and the base).
2. Bolt the base of the seat back into position in the van.
3. The wiring harness that you disconnected below the seat will need to be fed through the hole in the middle of the swivel seat adapter. Before you do anything else, disconnect your vehicle starter battery to avoid creating a short circuit.
4. On the cable coming out of the floor of the van, you need to remove the wires from the connector head of the wiring harness so you can feed the cable through the hole in the swivel seat adapter. Use a small tool to disconnect each wire from the connector.
5. Post the cable through the bolt in the swivel seat and then reconnect the wires to the connector head.
6. Screw the swivel seat adapter into place on top of the seat base.
7. Reconnect your vehicle starter battery.
8. Bolt the seat back into position on the base, and reconnect the wiring harness.

Exterior

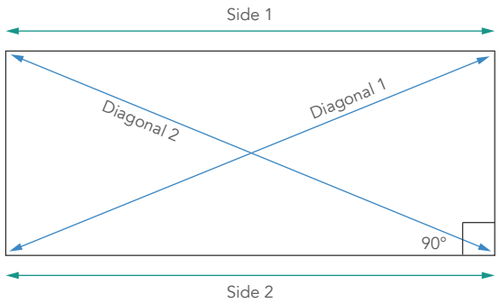
Tools

- Drill and drill bits
- Jigsaw or nibbler
- Metal file
- Paint brush
- Circular/mitre saw
- Clamps
- Socket set
- Ratchet spanner
- Hole saw
- Mastic gun

Techniques

Checking a square or rectangle

When marking out a square or rectangle for a window or skylight, it can be tricky to tell if the shape you've marked out is correct. It's easy to end up with corners that aren't 90 degrees. To avoid this, you can measure diagonally between corners. If the two diagonal lengths are equal and the side lengths are equal, you have 90 degree corners! You can also check this by using a set square if you have one.

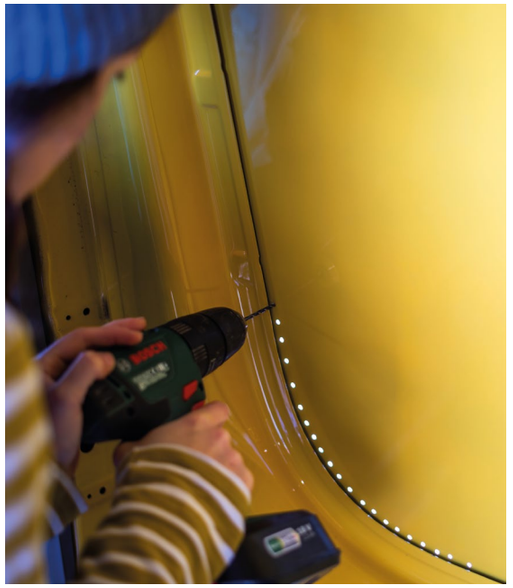


Example 1
Side 1 = 100 and Side 2 = 100
Diagonal 1 =141 and Diagonal 2 =141

As the sides are equal and the diagonals are equal, the shape has 90 degree corners.

Example 2
Side 1 = 100 and Side 2 = 100
Diagonal 1 = 136 and Diagonal 2 = 107

The sides are equal but the diagonals are not, so the shape does not have 90 degree corners.



Marking out windows, vents and inlets

Whether you're cutting side windows, vents or inlets, the process of marking out the holes is typically the same. Most exterior products will provide detailed instructions of the aperture (hole) size they require for the product to fit, but often neglect to commit to saying how best to mark out and ultimately cut the hole!

There are two main ways of marking out a template for a window, vent or inlet. The first uses tape, allowing you to make adjustments easily if required. The second uses a small drill bit to create a guide, used if you are fitting windows designed to fit the curvature of a panel on your van.

Drill bit

To use the drill bit method, use a small drill bit with a 1-2mm diameter to drill a series of holes following the edge of the internal panel profile. Connect the dots with Frog or automotive masking tape on the outside of the van where the panels are flatter. This will give the foot of the jigsaw or nibbler tool a smooth surface to run along.

We'd strongly recommend covering any nearby surfaces, both inside and out, with cardboard to protect the bodywork and paint from any sparks or tiny shards of hot metal. If you don't do this, you may well find that a few days later tiny orange specks of rust will start to appear around the area you have cut. Cardboard works well because the shards of metal will bury themselves into the card or bounce off, whereas the hot shards of metal can burn straight through plastic sheeting.

Tape

Create a template of the item you need to install on your van. It may be easiest to first measure the centre point of where the product will be installed, and then measure out.

TIP:
Use a product such as Frog Tape or an automotive masking tape. Normal masking tape and other tapes can leave a big mess when you need to remove them and can easily

ABOVE LEFT Dot-to-dot for adults! Charlie creates a path for the jigsaw to follow. **RIGHT** We used the cardboard box that the windows came in to protect the paintwork whilst cutting out the window. *@climbingvan*

lead to you spending hours slowly peeling tiny pieces of tape off the van.

Once you have marked out the shape with the tape, it's time to check a few things.

1. Is it in the correct position/does it visually look sensible?
2. Does the area you have marked out match the requirements in the product instructions?
3. If you hold up the product against the taped off area, does the entire aperture fit where intended?

If you've marked out a rectangular or square profile simply measuring each side, this won't be enough to tell if it's correct. See *Techniques* on page 201 for the best way to check that your template is correct.

To ensure motorhome-style windows are level inside your van, use the spirit level app to first check the angle of the van floor as a point of reference, and then the window itself. Rather than the window being at zero, you want it to be at the angle of the floor (as the floor is unlikely to be level in a van if you're parked on a hill!).

For both methods, remember:
check twice, cut once!

Cutting holes for windows, vents and inlets

With the guidelines marked out and the surrounding area covered, you're now ready to cut a big hole in your van!

Jigsaw method

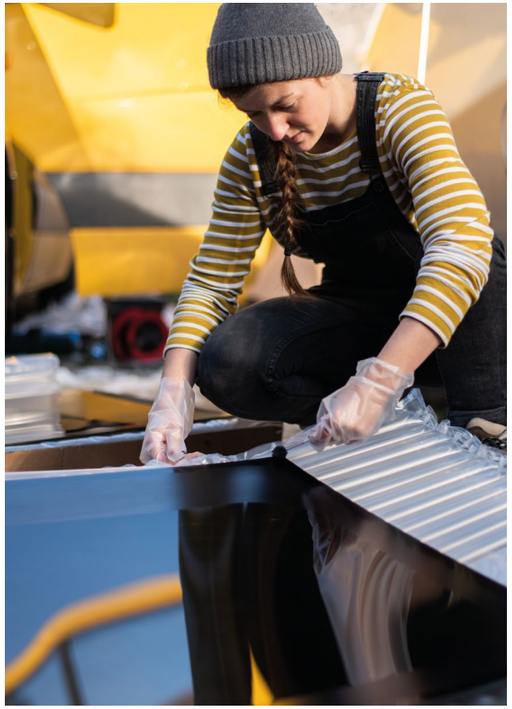
1. Make a hole large enough to pass the blade through so the jigsaw can sit level on the panel.
2. Ensure you have some safety glasses, gloves, ear defenders and some old clothes on, as the shards of hot metal can easily burn through synthetic materials.
3. Cover the surrounding areas of your van with a protective cover as the hot shards of metal will leave marks on the painted surfaces. You may not notice the effects of this until the day after when lots of little brown specs will become visible!
4. Insert the blade through the hole, bring the jigsaw up to speed and slowly but firmly push it through the metal following the guide closely. This will be very noisy, so bear that in mind if you live in a close proximity to other people!

Nibbler method

1. Drill a hole big enough for the nibbler shears or punch to fit through.
2. Ensure you are wearing suitable PPE. Gloves are particularly important as the cut edge of the panel will be very sharp and you may need to hold it as the panel starts to peel away.
3. Start to follow your taped guide with the nibbler tool.
4. Once you have finished drilling the holes in your van, file any sharp edges. Paint the cut edge with anti-rust metal paint to keep the edge from rusting. You don't need to paint a big area, just any exposed metal.

TIP:
We'd recommend using the nibbler shears as they leave a smooth edge and don't create any mess, whereas the nibbler punch will create thousands of little shards of metal.

OPPOSITE TOP We used a stepped drill bit to cut four holes in the roof of our van. **BOTTOM** With the holes drilled, it was easy to cut four straight lines with the jigsaw. *@climbingvan*



Fitting windows

Bonded windows

1. Bonded windows typically come with a fixing kit which consists of a little pot of primer for the windows, an applicator and a tube of adhesive. Apply the primer to the face of the window where the adhesive will contact. Try not to apply any primer in areas that will be visible through the window aperture from the inside of the van.
2. With the window primed and surfaces cleaned, apply the adhesive all the way around the edge of the van panel, ensuring there is a gap of 30-50mm from where the edge of where the window will sit. Some windows will give specific guidance on where to apply the adhesive, but generally speaking, you want to form a continuous line approximately 10mm in diameter. This will not only help to adhere the window, but will also prevent any water ingress.
3. Once the adhesive is in place, lift the window into position. You'll feel the adhesive start to grab straight away, so try to hone the position of the window before pushing it firmly into place.
4. Use scraps of cardboard to wedge below the window to hold it in place, and use an automotive tape to temporarily hold the window in the desired position. Once complete, you shouldn't drive the van or slam any doors for the rest of the day.

NOTE:
The primer can take up to an hour to set before you can press the window onto the van, so try and plan for this. Ensure the metal you're applying the adhesive to is clean and free of any tape or metal debris.

Motorhome-style windows

Motorhome-style windows are installed with a slightly different process to bonded windows. They consist of an outer window element and internal fascia. You'll need to build a wooden window frame to provide a thick, solid structure to clamp the window to. The outer window and internal moulding are screwed together, clamping the wooden window frame between them. This frame will ultimately be covered by insulation and cladding so it doesn't need to be a thing of beauty.

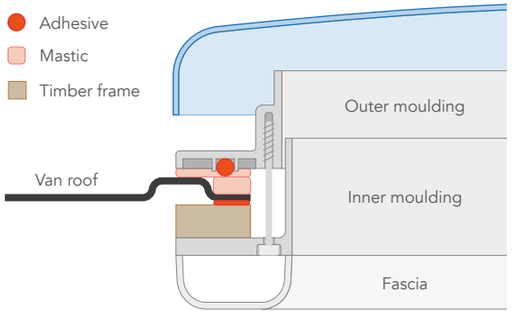
1. Build a frame to sit around the edge of the hole you have cut for the window.
2. Glue it in place by applying Sikaflex EBT+ or a similar adhesive to the back of the wooden window frame and use clamps passing through the window aperture to hold it tightly in place. Use some scrap wood on the outside of the van wall to clamp against, as this will help to spread the clamping force and prevent the clamp from scratching the metalwork of the van.
3. Once the adhesive has set, remove the clamps and insert the outer window component. Check the instructions for your specific window as to whether you will need to use adhesive, or if your window relies solely on an in-built seal.
4. Place the internal moulding on the inside of the window frame and screw the two parts together, sandwiching the panel and frame in place.

Fitting a skylight

Fitting a skylight is a very similar process to fitting motorhome-style windows, and most require an internal frame, but some rely only on adhesive to secure them in place. The crucial difference between fitting side windows and a skylight is that the roof is rarely flat! Manufacturers often put ribs and troughs into the roof of a van to give the large areas greater strength. This means you need to create a level surface before attaching your skylight to avoid any leaks. The most common way of achieving this is to use a product called Mastic sealing strip, which is in quite similar to Blu-Tack.

ABOVE TOP Priming the edge of the windows. **BOTTOM** We fit our windows on the coldest day of the year. It was so chilly that we couldn't use the adhesive gun and had to use a clamp for extra assistance! *@climbingvan* **OPPOSITE FIRST** Dennis builds a simple frame for the window. **SECOND** Applying the adhesive. **THIRD** Enjoying the view. *@travelution_*

1. Use Mastic to build up layers to account for the undulations in the roof of the van. Add several layers in the troughs to create a level surface.
2. Run an additional continuous strip all the way around the roof aperture. Take the time to ensure the surface is level before you install your skylight.
3. Run a continuous line of adhesive such as Sikaflex EBT+ between the sealing strip and frame of the skylight. Once you have applied this, press the skylight in place.
4. Place the internal moulding on the inside of the skylight and screw it into place.
5. As with any roof installation, to be extra safe and alleviate any concerns of future leaks, paint a layer or two of Dicht-Fix waterproof sealant around any area of concern.



Fitting an air-conditioning unit

Fitting a roof-mounted air-conditioning unit follows the same process as that of a skylight. Once you have cut a hole in the roof of your van and applied layers of mastic to create a level sealing face, build an internal frame to clamp the external unit and internal structure together. Connect the cables and leave them to one side. Fitting the internal moulding and control unit can wait until you have finished insulating and cladding the ceiling of your van.

ABOVE We used several layers of mastic to create a flat surface for our Dometic Mini Heki S skylight. *@climbingvan*

Fitting vents and inlets

Fitting other vents or inlets to the van is very similar to fitting windows or skylights. Vents and inlets typically have an external seal or gasket provided with the product and clamp either side of the metal skin of the van. Roof products follow the same logic as skylights and require a mastic seal if being installed on an uneven surface. They may or may not require a frame such as the skylight installation, so refer to the installation instructions of individual products to check this.

It's really important you refer back to your system diagrams at this stage and ensure you have adequate ventilation for appliances such as fridges and boilers, as it will become much more difficult to install wall and ceiling vents after this point in your build.

Fitting roof racks, awnings and ladders

Roof racks

Most vans are manufactured with pre-installed mounting points for roof racks and awnings and are typically found beneath rubber caps in the rails running along the side of the van roof.

1. Remove the rubber caps with a knife to expose either a threaded insert or a clearance hole.
2. Put a washer and a nut in place from inside the van. It's wise to apply silicone all the way around every newly exposed hole before you lift the roof rack up and into place to prevent any leaks.
3. Use a ratchet spanner and socket set to secure the roof rack tightly in place.

Awnings

The process of fitting an awning is very similar to a roof rack. However, if you're fitting both a roof rack and an awning you may need to buy an adapter bracket as both products use the vehicle roof mounting points. In this scenario, attach the roof rack and then use adapter brackets to connect the awning to the roof rack.

Ladders

Ladders are bolted to the wall or door of your van by drilling a few holes through the skin of the vehicle.

1. Hold the ladder to the outside of the van, marking the bolt holes for the attachment points with a pen.
2. Use a small drill bit to drill pilot holes through each of the marked attachment points through the skin of the van.
3. Use these holes to drill larger bolt clearance holes as instructed by the manufacturer.
4. Apply a small amount of silicone around each hole on the exterior of the van. This will ensure that when the ladder is clamped in place, water can't leak through.
5. Lift the ladder into position and push the bolts through the holes, locking them in place with either a backing plate or large-headed washers and nuts.
6. Tighten each bolt with either a socket set or a spanner.

Fitting a log burner flue

So far we've encouraged you to install as many of the exterior modifications as possible, but fitting a flue for a log burner is the exception. At this point you can identify the location you want the flue to exit, so you can ensure you leave the area below clear of any insulation or cladding. This will make it easier to install the flue in *Gas and heating* on page 287.

If you are installing a log burner, you need to install air vents in close proximity to the stove. This draws fresh air into the van, allowing the fire to burn effectively. The marine standard for log burners in boats advises you install at least two vents, one high and one low, each with a

diameter of at least 52mm. This will provide enough oxygen for both you and your stove.

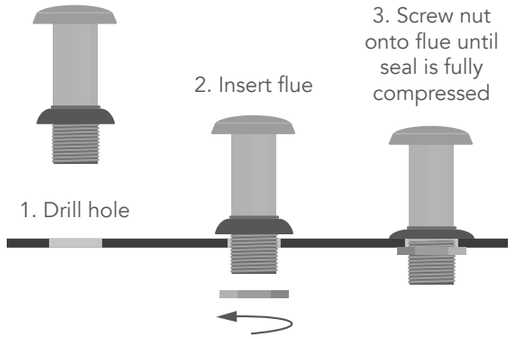
Fitting a boiler flue

To fit a boiler flue, you will need to attach a cowl or mushroom vent to your roof. This acts as a rain cap for the flue. The flue will then connect to the cowl from the inside. The exact installation of these can vary between products, so you should refer to the installation instructions with your specific boiler.

1. From inside the van, use a small drill bit to drill a pilot hole, marking the centre position for the flue. Aim to install this on the flattest surface you can, otherwise you will struggle to create a watertight seal.
2. From the roof of the van, use a hole saw to cut a clearance hole for the flue.
3. File the edges of the hole, removing any metal debris. Use an anti-rust paint such as Hammerite to protect the edge.
4. Some cowls and mushroom vents will have an inbuilt flue pipe and rubber seal. If this is the case, simply place the flue pipe through the hole. You shouldn't need to use any adhesive or sealant as the seal will create a watertight connection with the roof. From inside the van, do up the connector to compress the seal and hold the flue pipe in place.
5. If your cowl doesn't have a seal, you will most likely need to use screws and sealant to attach it. If this is the case, use Sikaflex EBT+ or another suitable sealant to attach the cowl to the roof, and then screw it into place from the inside. This installation may vary depending on the specific flue.
6. If the internal diameter of your flue duct is a different size to the flue pipe, use a stepped reducer to connect the two together.

The flue duct will be connected later in your build, once you have installed your boiler.

Some flues require you to mount them to the van wall rather than the roof, such as the flue for the Truma Combi 4. The Truma Combi 4 has a special flue which has an inner and outer flue duct. Mount the flue to the side of your van using the same method as detailed above for fitting vents and inlets. Ensure you mount your flue duct as close as possible to where your boiler will be mounted.



Fitting solar panels

Mounting with adhesive

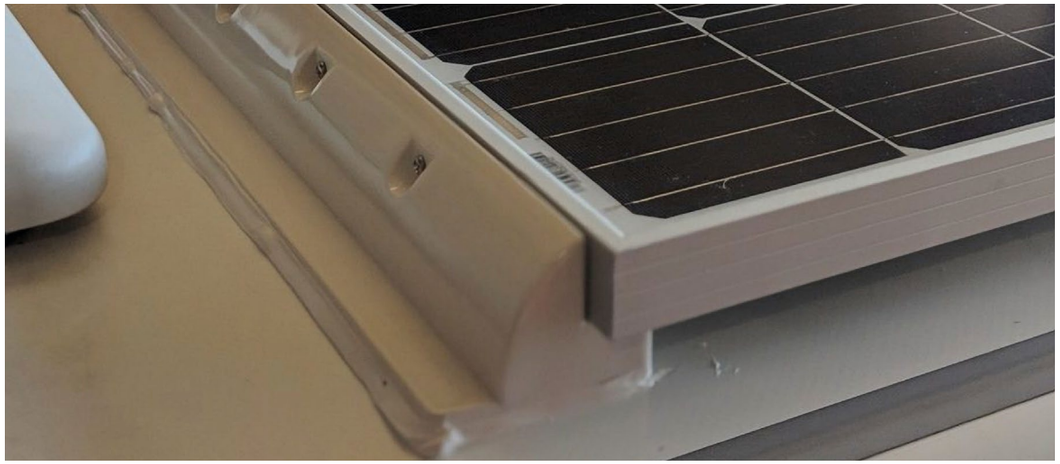
Mounting solar panels with adhesive is one of the most robust methods of permanently connecting your solar panels to the roof, but you need to make sure the surface it will bond to is prepared before you start.

Painted metal and fibreglass roofs ideally need to be sanded down to the structural material in the areas where the adhesive will be used. Bonding the solar panels directly to paint may not be sufficient to hold the panels in extreme conditions. Sanding the paint will allow the adhesive to make a secure bond between the structure of the van roof and your panel.

Rigid panels

If you're fitting multiple solar panels to your roof and the thought of drilling even more holes in your van is becoming all too much, using the correct adhesive will provide sufficient holding power to secure your solar panels to the roof.

OPPOSITE Before we cut any holes in the roof, we double-checked the position of every item to be confident it would all fit. *@climbingvan*



We have detailed two different adhesive based methods. Before applying any adhesive, use a solvent-based cleaner to prepare the roof of the van. This will ensure the solar panels are bonded securely to the roof.

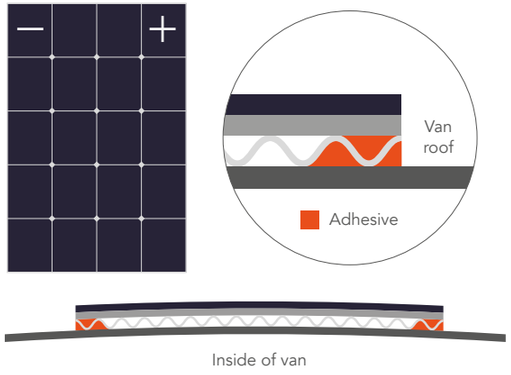
Sikaflex 292i is recommended for this application as it has been specifically designed to achieve high strength fastening adhesive for structural assemblies. Generously apply the adhesive to each contact point before pressing it into position and leaving it to fully set.

The other adhesive option comes in the form of a tape. 3M VHB 4950 is a heavy-duty mounting tape, applied in a very similar way.

1. Clean the mounting surfaces with a solvent-based cleaner.
2. Apply a strip of adhesive tape below each contact point and press it firmly in place. The tape offers a cleaner solution and doesn't need to be left to set for very long, whilst still providing a high strength bond and long-term durability.
3. Cover the bonded area with Dicht-Fix, as this will ensure any exposed metalwork is protected.

TIP:
If you have sanded the paint away in the area you are mounting the panels, ensure the adhesive covers all freshly exposed metal to prevent any rusting.

Flexible panels
When installing flexible solar panels, it's important that they have sufficient airflow beneath them, as this prolongs the life of the panel. If your van has an undulating roof, you can mount your solar panel directly to the roof using the adhesive tape as detailed previously. Some flexible solar panels are provided with a structure that will promote airflow, but if yours aren't and you are mounting them to a flat roof, use a thin sheet of corrugated plastic to achieve this.



1. Glue the solar panel to the sheet of corrugated plastic using an adhesive such as Sikaflex 292i.
2. Glue the plastic to the roof of your van as shown in the illustration.
3. If your roof has a big curvature to it, position weights in the corners of the panel to hold it in position until it has set.

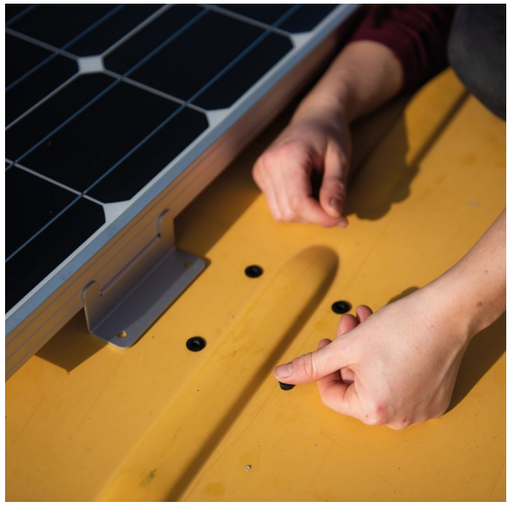
Mechanical connections

Whilst adhesive connections are proven to be durable, they are challenging to remove, and if the bond were to break, there is no mechanical connection to stop the panels from blowing off the roof. Using a mechanical fixing either on its own or in conjunction with adhesive perhaps offers the most secure solution.

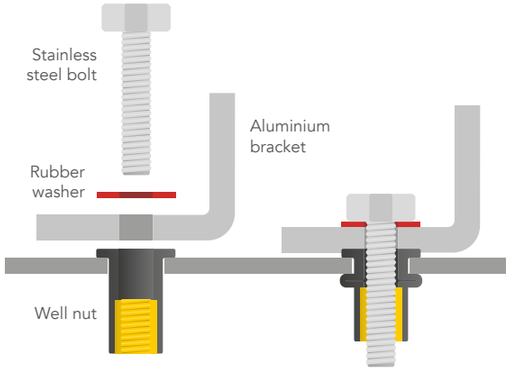
We recommend using rubber well nuts, as they not only create a mechanical connection but also seal the hole they sit in when tightened. This gives you the opportunity to unbolt the panel brackets if you ever need to.

The well nuts are made from a brass nut over-moulded by rubber. As the screw engages into the thread, the nut is drawn upwards, expanding the rubber around the hole. This creates a seal between the roof and the bracket, stopping any water from passing through the hole. In theory, it is still possible for water to ingress around the head of the bolt and down the helix of the thread, so to reduce this risk, use a high shore hardness rubber washer to seal between the bracket and the head of the fastener. We recommend using M5 well nuts.

1. Screw the brackets to the solar panels.
2. Lift the solar panels into position on the roof and use a pen to mark through the holes in the brackets. Try to avoid drilling holes through the metal ribs on the inside of the van.
3. Remove the solar panels and drill the holes, using the recommended drill bit size for your well nuts.
4. Remove any burrs or shards of metal from the drilled holes both outside and inside, as these can cause the nut to tear and create a leak path.
5. Place the well nuts into the holes.
6. Screw the solar panels into position, placing a rubber washer between the bracket and bolt head. Push down on the solar panel as you screw it in, as this will prevent the well nut from pushing through the roof.
7. Check from the inside of the van that each well nut is compressed evenly.



ABOVE Side mounting solar panel brackets glued securely to a van roof. **OPPOSITE** Rubber well nuts are inserted into drilled holes to create a watertight seal when tightened. *@climbingvan*



TIP:
It's suggested you use a hole size of 10mm for M5 well nuts, but in our experience we found this to be too big as it was easy for the head of the well nut to get pulled through the hole. Instead, we suggest drilling 9.5mm holes to ensure a snug fit.

Cable connection and entry

1. Connect each solar panel together using solar branch connectors. These cables need to pass through a cable entry housing so they can enter the van without allowing water in.
2. Drill a suitably sized hole for all of the cables to pass into the van, whilst ensuring it's smaller than the cable entry housing.
3. It's important you prevent the cables from rubbing on the cut edge of the hole, as over time this can cut the protective coating of the wire and create a fire hazard. Press a rubber grommet into the hole to cover up the sharp edge of the hole and protect the wires. Alternatively, use a series of tape strips to cover all edges of the hole and create a smooth cable entry path.
4. Post your cables through the cable entry housing, into the van.
5. Fix the cable entry housing to the roof using Sikaflex 292i.

TIP:
Make sure you label the positive and negative wires when you post them into the van, as you won't be installing your electrical system for some time, and it's easy to forget which wire is which if they aren't coloured accordingly.

Leak testing

When you've finished modifying the exterior of your van, it's well worth checking for any water ingress issues:

1. Place pieces of paper below any holes you've made or uncovered.
2. Once the sealant or adhesive has fully dried, pour water all over the roof and sides of your van.
3. Wait a few minutes and then inspect the sheets of paper. It should be easy to spot even the smallest leak, as the paper will be covered with small watermarks.
4. Got a leak? Good, you caught it early! Dry off the affected area and apply copious amounts of sealant. Wait for this to dry and then repeat the above steps until you're leak free.

DALE SAYS:
A good friend of ours skipped the leak test stage. After he had been living in his van for a while, he realised he has a rising damp problem (not something you would usually expect to find in a van!). He couldn't work out what was causing it, but after much head-scratching and dismantling a lot of his van, he realised the roof vent was leaking and dripping onto the insulation. The water was being funnelled by the vapour barrier down the walls of the van to the floor, causing the damp problem.

Insulating

Tools

- Bread knife
- Utility knife
- Circular/mitre saw
- Drill and drill bits
- Mastic gun
- Scissors

Cleaning the van

This isn't the most exciting job, but it's important to give the van a deep clean before you start. Removing little shards of metal and other debris from cutting windows and vents ensures rust doesn't have a chance to form. Make sure your floor is as level as possible by removing any unwanted brackets, adhesives and foreign objects, so that when you batten and insulate your floor, it doesn't rock around on any high points.

Sound deadening

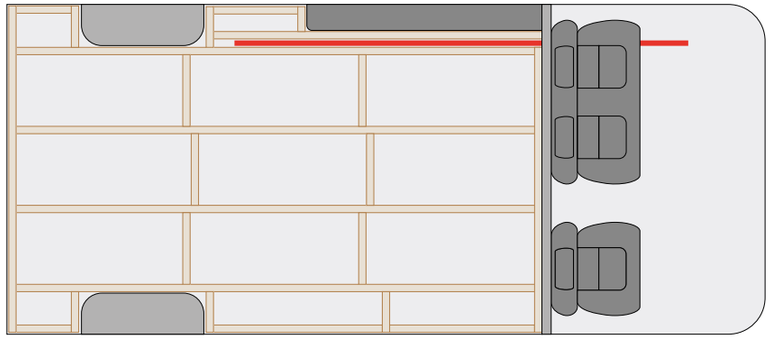
Applying the sound deadening material to your van is an easy job to tick off the list. Aim to apply your butyl sound deadening strips to approximately 30% of the area of each panel.

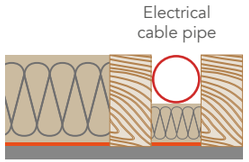
Battening the floor

The floor batten structure is required to support the insulation and provide a stable and level platform to build from. Aim to build a structure which loosely hugs the walls of your van, with three columns down the length of the van, and additional battens between the columns at 1220mm spacing. Spacing your battens in this way is sufficient to limit sagging between sections and allows you to use the standard width of an insulation panel in each portion.

You will notice the floor of your van probably isn't flat, and likely has a series of ribs down its length. You can either lay your battens in the grooves or place them on top of the ribs. This depends on the depth of the ribs and the size of the battens you are using. Just be aware that if you choose to lay your structure in the grooves, you need to plane down the widthways battens to account for the height difference. It's important the depth of the batten is as close to your insulation depth as possible, so the insulation doesn't rattle or get crushed.

ABOVE We applied sound deadening strips to each wall and ceiling panel to dampen outside noise. *@climbingvan*





1. Lay the lengthways battens in position in the van. Mark out where they will need to be modified and then cut them to size.
2. Measure and cut the horizontal battens.
3. Screw the battens together to create a single structure.
4. If your system plan requires a cable path running below the floor, build this into your batten layout now.
5. Apply a fairly constant length of polyurethane-based adhesive between the metal floor and the underside of the wooden structure to stop everything from moving around.
6. You may need to add some weights on top of the structure whilst the glue is setting to account for any bowed wood or undulations in the floor and to ensure the adhesive contacts all surfaces. This will prevent rattles in the floor and provide a level surface to build from.

NOTE:
Using uPVC pipe for your cable path is a great way to control where cables go and can easily be placed alongside a batten. Ensure the internal diameter of the pipe you purchase is large enough to fit all of the cable diameters you need to post down it!

The other consideration at this stage is whether you need to gain access to any nuts or bolts on the van floor. Some vans have a spare tyre which is either suspended under the van by bolts and is only accessible from the inside of the van, or is attached via a safety plate that needs to be unscrewed from the inside. Try and identify if this is the case with your van before you cover it up, as you many only realise the issue years later when you get an unexpected puncture and can't access your spare tyre!

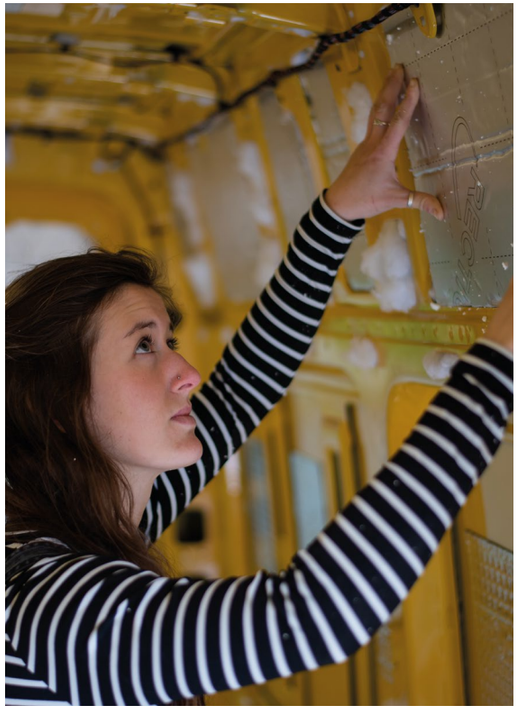
Insulating the floor

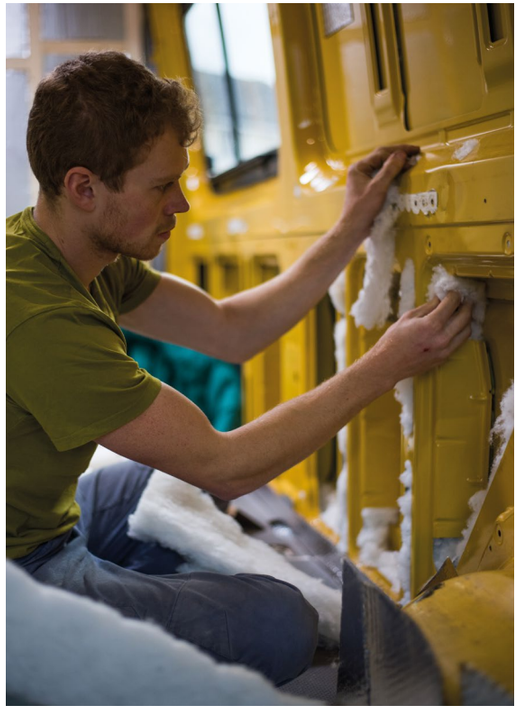
Now to make some quick progress! Cutting the insulation board to size is really easy; you can do this by scoring the panel with a knife and snapping it down the length of the cut. This method creates much less mess than a saw and leaves a clean edge. Use loose-fill insulation to fill any difficult gaps around the edges.

Insulating the walls, ceiling and doors

Cut your insulation board to the same size and profile as the large gaps, securing them in place with tape if necessary. Remember, you are aiming for the board to sit around 20mm away from the skin of the van so the radiant barrier can work effectively, reflecting unwanted heat back out of the van. You can achieve this by wedging the board against the ribs of the van, or by using small offcuts of foam to create the desired offset.

If you intend to install a log burner, it's important to leave the area where the flue will exit clear of





ABOVE TOP We started insulating by filling gaps in the batten structure with insulation board. **LEFT** Charlie carefully fits a piece of insulation board between the ribs of the van. **RIGHT** It's important to stuff every possible crevice with insulation to ensure ultimate cosiness! *@climbingvan*

insulation or any combustibles. Please refer to *Installing a log burner* on page 286 for details.

Filling cavities

Leaving gaps in your insulation can compromise the performance significantly, so it's important you fill the cavities and the columns with loose-fill insulation. This isn't a quick job, but it's nice and easy, so try and rope in friends and family if you can. Use a small amount of spray adhesive or tape if you are struggling to get the loose-fill insulation to stay in place. Be mindful of interfering with door mechanisms, and make sure you leave access to serviceable areas such as light bulbs.

Installing a vapour barrier

Once you have insulated all of the surfaces in your van, it's time to turn your van into a little spaceship! We'd recommend starting with the walls, using spray adhesive to secure the vapour barrier to the skin of the van and the insulation as you unroll the sheet. Once the walls ceiling and floor are covered with the vapour barrier, it's critical you use aluminium tape to seal up all gaps in the barrier.

ABOVE TOP Slowly turning Ringo into a spaceship. **BOTTOM** Once you've finished installing your vapour barrier, your van will look like somewhere a paranoid conspiracy theorist might inhabit. *@climbingvan*

Floors and walls - Part 1

Tools

- Jigsaw
- Drill and drill bits
- Circular/mitre saw
- Utility knife
- Scribing tool
- Scissors
- Hole saw

Techniques

Profiling methods

1. Use a piece of paper and a pencil to create a stencil by folding the paper up against the edge of a surface and drawing around it. Cut the paper out, check it fits, modify if required and use a jigsaw to cut the profile.
2. Use a contour gauge to copy the profile of the object and draw around it. This is definitely worth a google if you aren't familiar with one!
3. Use a scribing tool. This holds a pen or pencil at a set distance away from a surface. The material you need to cut is placed at a distance away from the profile you need to copy onto the material. Use the scribing tool to draw the profile onto the material by keeping one end in contact with the van wall, and slowly moving it down the length of the profile you need to trace.

Cutting and attaching the subfloor

Depending on the state of the existing flooring in your van, you may not need to complete this step. The subfloor panels are merely required to provide a stable platform to build from and don't need to look nice as they will soon be covered with a more cosmetic floor covering. If you are reusing your existing floor, simply lay it on top of the vapour barrier and screw it into the battens under the floor.

1. If you can, use your old flooring as a template to draw around. If you're not able to do this, measure the space and mark it out on a sheet of 12mm ply. This will provide sufficient strength whilst not adding too much weight.
2. Screw the ply into the floor battens and through the vapour barrier.

TIP:
Use screws that won't go through the batten and come into contact with the metal floor, as this will create a thermal bridge, creating damp spots on your floor. Ensure you leave holes in the floor to access any important nuts, bolts and cable paths.

Carpeting difficult areas

If you intend to cover any complex surfaces with auto carpet, this is the easiest time to do it. Before you start, remember the auto carpet will match the form of the area you apply it to, so you may need to remove high points and cover holes with tape to create a smooth surface.

1. Start with plenty of material and use the spray adhesive to stick the material to one end of the structure you're applying it to.
2. Stretch the material around the structure, using more spray adhesive to capture its position at regular intervals.
3. Once the area is covered, cut the material to size with a pair of scissors, and tuck the edge away or glue it into place.

Fitting flooring

When you're ready to fit your flooring, you should first check the surface you are laying it onto is flat and free of any projections, as these can cause undulations in the floor, and can cause vinyl flooring to rip or wear unevenly.

Vinyl flooring

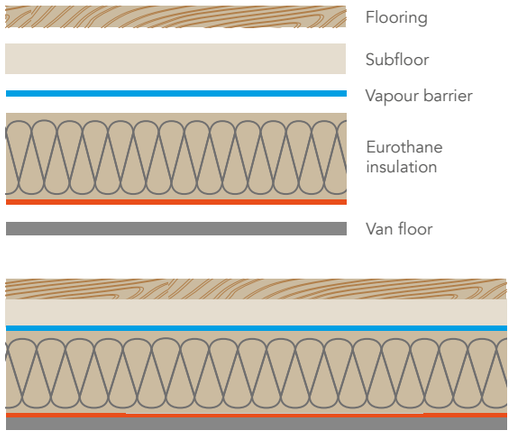
Fitting vinyl flooring doesn't require an underlay, as the vapour barrier and insulation below will already reduce noise and heat loss.

ABOVE TOP & BOTTOM We carpeted any areas we knew would be tricky to cover with cladding. *@climbingvan* **OPPOSITE** Daan and Merel laying laminate flooring in their van. Laminate is hardwearing and usually weighs less than hardwood alternatives. *@dutchexplore*

1. Orientate the material to best fit the van, and align the material against two adjacent sides of the van (the rear doors and the left side for example).
2. Apply the vinyl flooring directly to the wooden floor panels with spray adhesive to prevent it from bubbling or sliding around, glueing the corner in place first. Use the spray adhesive with the doors open and a mask on, as the mist-like drops are harmful to inhale. Using a retractable utility knife and wearing a pair of protective gloves, carefully cut the material to fit the profile of the van.

NOTE:
Remember, most edges won't be visible, so you don't need to be too precious about areas that will end up covered by units. Instead, you should focus on ensuring visible areas are neat. It's important that your floor is smooth before you lay it, otherwise any bumps will be visible through the vinyl.

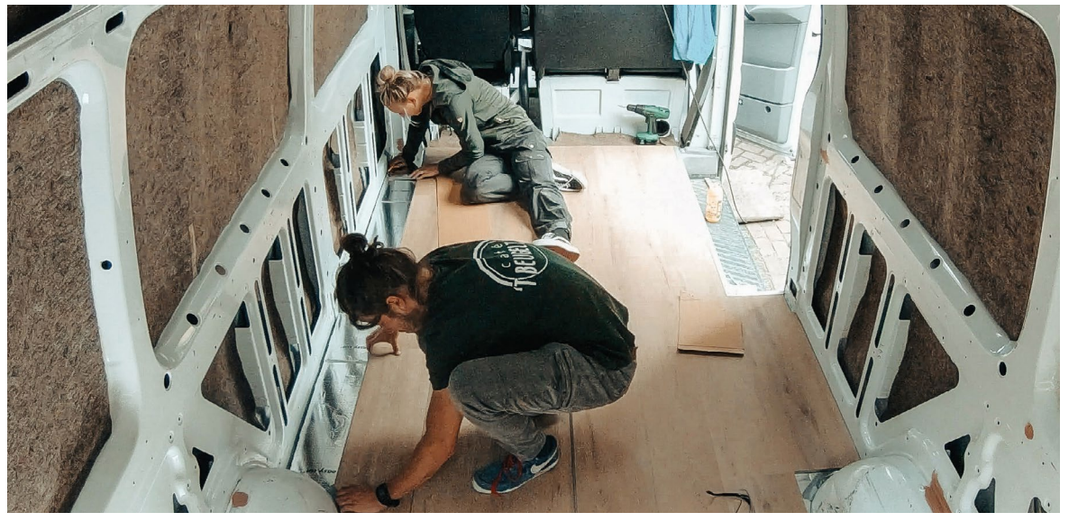
Edging strips should be glued or screwed into position later in the build once other structures have been added. More information can be found at the end of the build section in *Decorating and furnishing* on page 296.



Laminate and hardwood flooring

Unlike vinyl, laminate flooring should not be glued down as it's a natural material which will slowly expand and contract over time, and subsequently needs to float on the subfloor.

1. Lay your first planks at the edge of the most visible area, such as the side door. This means you will have a whole plank in the area that is most visible, leaving any awkward cuts for areas that reside below cabinets and other structures.
2. Cut planks to length with a mitre or circular saw, or if you don't have access to these,



a jigsaw will suffice. Use one of the profiling methods in *Techniques* on page 218 to cut around any challenging areas.

3. Leave a 10mm gap between the edge of the floor and the walls to account for any movement or expansion.

Protecting the floor

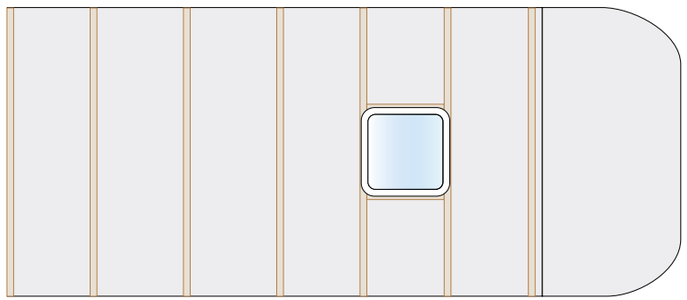
As you will be building and working over your floor for some time, it's worth covering it with cardboard or dust sheets to keep it in good condition. If you have a wooden floor, don't wax or oil the floor until the end of your build because if you dent or scratch your flooring, it's easy to sand it before applying the final protective coat.

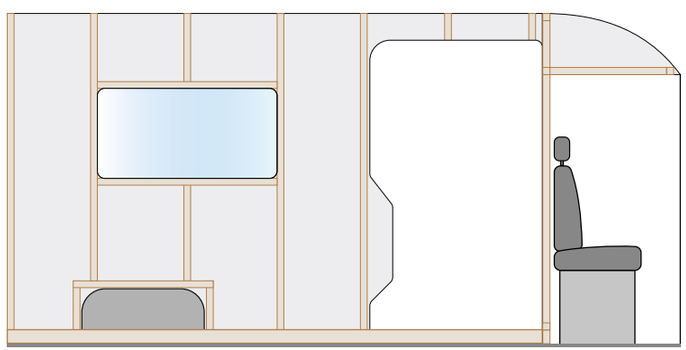
Battening the walls, ceiling and doors

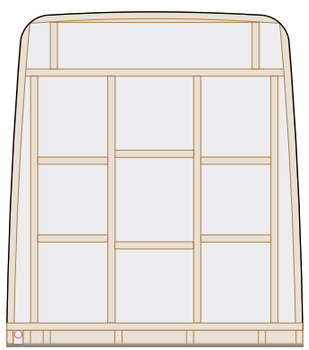
You will need to create a wooden substructure to attach the ceiling and wall cladding to. Use battens approximately 30x20mm in profile, as these will give you enough room to house wires behind your cladding and provide sufficient strength without adding significant weight or dramatically reducing the usable width inside the van.

1. Before attaching anything, pilot hole and countersink each batten so you don't split the wood and render it useless (see *Hole types* on page 184 for a explanation of how to do this and what size hole to drill).
2. Attach each batten to the van to the metal ribs of the van, starting from one end. This allows the batten to flex to the profile of the van, so you can capture the curvature periodically with self-cutting screws.
3. Continue the process on the ceiling and rear doors, but not the sliding doors.

NOTE:
As a general rule, the battens always need to be perpendicular to the orientation of your cladding, so if you're being a rebel and want to have vertical cladding, you will need to position horizontal battens.







It's very important you check the clearance between your sliding door and the side of the van before you add any battens or cladding. Some vans will only have a very small clearance space between the door and the side of the van. If this is the case, install your cladding directly to your door without any battens. In some cases, you may not be able to attach cladding to your sliding door and will need to finish them with a different method.

Battening window frames

1. Build a wooden frame the size of your window using battens.
2. Screw the frame to the existing wall battens.

TIP:
Using thicker battens for the frames allows you to add little window sills and frames to block the view of any insulation or metalwork. Just be careful to maintain a gap between the wooden battens and the window, as condensation will form on the inside of the window and can cause damp to form on the wood.

ABOVE We decided to build a window frame as it allowed us to clad past the edge of the window, leaving a much neater final aesthetic. *@climbingvan*

Electrical system

Tools

- Wire strippers
- Wire cutters
- Crimping tool
- Circular/mitre saw
- Jigsaw
- Drill and drill bits
- Multimeter

Techniques

Using wire strippers

When using a wire stripper, it's important to match the size of the wire to the correct notch (setting) on the wire stripper. Too large a notch will mean the wire doesn't get stripped, and too small a notch may cause damage by digging into the wire. When using stranded wire, the tool may cut off the outer ring of wires, decreasing the total diameter of the wire and reducing its strength. If a wire is accidentally nicked, cut the damaged part of the wire off and try again.

How to crimp and connect cables

Connect cables with a cross-sectional area over 6mm^2 to components such as your battery with cable lugs.

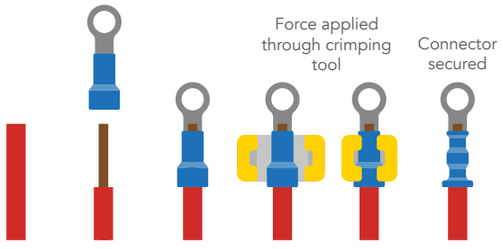
- **Through lugs** connect cables to each other.
- **Ring lugs** connect cables to a point such as your battery or a bus bar and come in a variety of sizes. They have a number relating to the wire gauge of the cable, and a number relating to the post diameter you will connect to.

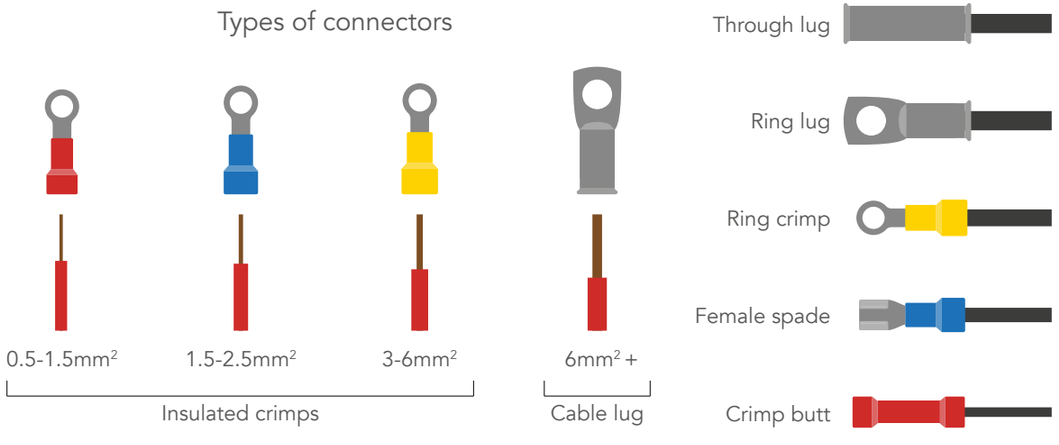
Use insulated crimps and a standard crimping tool for cables less than 6mm^2.

- **Crimp butt connectors** connect wires to each other.
- **Female spade crimp connectors** connect to a male spade style attachment.
- **Ring crimp connectors** attach to a nut and bolt style attachment.

To attach a crimp to a wire:

1. Strip the insulation from the wire.
2. Attach the crimp to the wire using a crimping tool.
3. Ensure no insulation is crimped inside the lug, and there is no exposed wire visible outside the lug.





If you are attaching the crimp to a bus bar with a nut, place a sprung washer between the crimp and the nut before tightening it. The lug should sit flat against the surface below.

IMPORTANT

Do not insert anything between the lug and the surface below such as a washer or fuse, as this will reduce the current carrying capacity of the connection. Always use insulated tools when tightening a nut. An accidental battery short circuit can be very dangerous, and the currents can melt your uninsulated spanner, or the spark can cause a battery explosion.

If you are connecting to a **spade connector,** simply push the female spade connector onto the male connector, ensuring you have made a good connection between the two.

To connect two wires together, use a **butt connector** and insert both wires into either end of the butt connector, making sure enough exposed wire has been inserted to ensure a strong connection. Check the connection is adequate by gently pulling the two wires and ensuring there is no movement.

Once a connection has been crimped, first cover each individual wire, and then all wires. Electrical tape can be used to do this, but it is best practice to use heat shrink. This will ensure the connection is protected.

To connect a wire to a **screw connector**, use wire strippers to strip a length of wire. Insert the bare end into the connector cavity, making sure no cable insulation enters the connector, as this can lead to increased resistance which can cause the connector to heat up and melt.

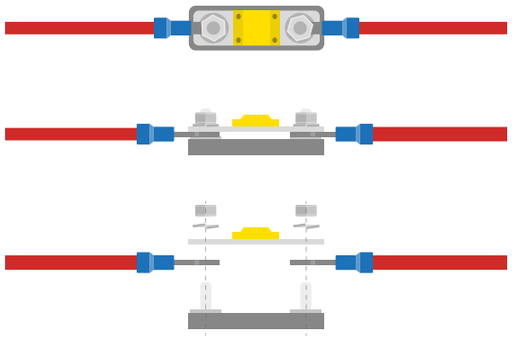
Ensure that no uninsulated cable is visible outside the connector as this is dangerous; it can cause electrocution or a short circuit.

How to install inline fuses

1. Mount the fuse holder in a sensible position by screwing it to a structure.
2. Connect a ring crimp connector to each end of the wire, making sure to select the correct size crimp for your wire gauge.
3. Attach the wire to either side of the inline fuse by threading the crimp connectors onto the bolt.
4. Attach the fuse and a sprung washer on each side, before doing up the nuts.

TIP:

In the case of a circuit that includes a battery, ensure the fuse is installed as close to the battery as possible.



Grounding components

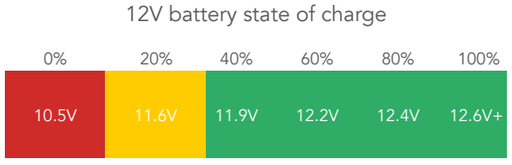
Each component in your electrical system should be grounded in case of a power surge. Grounding the component ensures the surge will reach the ground, and a grounded person touching the component will not be electrocuted. This is sometimes referred to as earthing. Use a grounding wire (usually yellow and green striped) to connect the grounding terminal on the component to a grounding point on the chassis of your van. If you ground your negative bus bar to the chassis of your van, you can use this single point as a central grounding point.

1. Use a self-tapping screw to connect to an internal metal beam. Alternatively, connect to an existing bracket within your van with a locking nut (rather than a standard nut which can come loose over time).
2. Make sure you sand the point you are connecting to and remove any paint so that you are grounding to bare metal.

Each component in your electrical system may need to be grounded in a slightly different way, so always refer to the installation instructions of an individual component.

How to use a multimeter

As you're using the multimeter to measure the voltage of a 12V system, set it to the 20V setting, which means it can read voltages up to 20V. Touch the tip of the red probe to the positive terminal on your battery or appliance and the tip of the black probe to the negative terminal on your battery or appliance. The voltage reading you see is the voltage passing through your battery or appliance. Use this chart to see how different voltage readings across your batteries correspond to different levels of charge.



SAFETY WARNING

Electricity is dangerous. It only takes a very small amount of current across the human heart to stop it. Electrical work should always be carried out by a qualified electrician, or at the very least your system should be checked by a qualified electrician before it is fully connected. The local safety guidelines and requirements should always be followed.

Remember:

- Both AC and DC voltages are dangerous.
- Always use insulated tools when working with electricity and batteries.
- Do not short circuit batteries as this can cause fire or explosion.
- Battery charging can sometimes create explosive gases.
- Undersized wiring or bad electrical connections can cause a fire.
- All components should be grounded to the chassis of your van.
- All live parts of your electrical system should be enclosed to prevent contact.

After connecting each 12V or mains power appliance to your fuse box or consumer unit, check it turns on and works as you would expect it to. Before connecting the next appliance, disconnect the previous one by removing its fuse or turning off the MCB. Ensure each appliance is working individually before connecting them all to the fuse box and consumer unit.

Mounting batteries

Mount your batteries in a frame or box to ensure they aren't able to move around. Build a snug frame around the base of the battery using battens screwed into the floor, and ensure they will be well ventilated.

Mounting major components

Before you start to wire up your electrical system, you will need to do a little bit of woodwork to mount all of your components. You should have already decided where you are going to mount your main components when you designed your electrical system, so now is the time to build a basic structure to attach them to. Ensure that you follow the mounting instructions for each individual component. For example, install a MultiPlus with at least 10cm around the appliance for cooling.

OPPOSITE We positioned all of our components on a piece of ply and used scraps of cardboard to indicate where we needed to create slots for cables to pass through, which works really well to ensure everything fits and looks tidy. *@climbingvan*

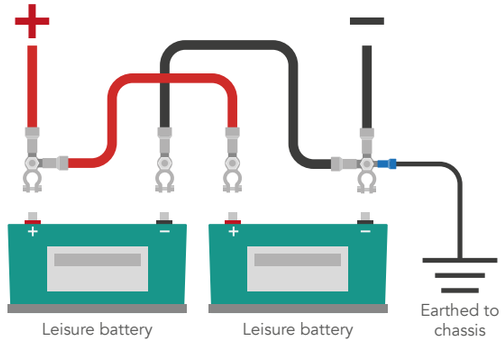
Building a control panel

It's a good idea to build a control panel where you can mount any switches and monitors you are using, so you have one place to control and check on all of your systems. We'd recommend building this in the front of your van somewhere accessible, although it may be worth hiding it away in a cupboard or behind a door so the LEDs don't keep you up at night! See *Systems integration - Electrical system* on page 151 for how best to lay this out.

1. For each component you need to mount, refer to its instructions for details of the required cut out size, and draw this onto the piece of ply that will become the control panel.
2. Use a drill and a jigsaw to cut out the shapes you have drawn.
3. Mount each component onto the board by placing it into the correct hole and either screw it into place or attach it using a nut and a bolt from the back of the board.

Connecting batteries

If you are using more than one battery, you should connect your batteries together in parallel. By connecting your batteries in parallel, you are combining their amperage (adding together the amp hour rating of each battery) whilst keeping the total voltage the same. If you connect the batteries in series, you would be changing the circuit from 12V to 24V in the case of two batteries, 36V in the case of three batteries, and so on.



Firstly, connect a battery terminal connector to each battery post, as these make connecting other components to the batteries easier and ensure a good connection. To connect the batteries, connect the positive terminals and the negative terminals together. Make sure to ground your battery to the vehicle chassis.

When connecting other components to your batteries, use the positive terminal of one battery as the positive load and the negative terminal of the other as the negative load. This ensures your batteries charge and discharge at the same rate, prolonging their lifespan. If you don't do this, you will end up overworking one battery whilst undercharging another.

Connecting bus bars

Connect the positive and negative bus bars to your batteries, as this makes all of your wiring much easier to manage.

1. Connect the positive bus bar to your positive battery load via a circuit breaker, and connect your negative bus bar to your negative battery load.
2. Ground the negative bus bar to the metal vehicle chassis.
3. Once you have finished connecting components to your bus bars, install a cover over the bus bars to enclose them and prevent accidental contact.

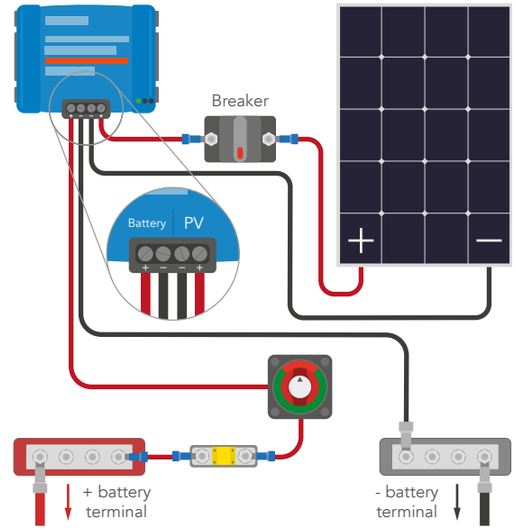
Connecting solar panels and a charge controller

When you installed your solar panels, you should have fed the positive and the negative wires through the cable entry housing on the roof (and hopefully labelled them!).

1. Connect a length of wire to the existing cables so you can connect the solar panels to your charge controller.
2. Ground the solar charge controller to the vehicle chassis.
3. Connect the battery positive terminal on the charge controller to the positive bus bar via a fuse and a kill switch. Connect the battery negative terminal on the charge controller to the negative bus bar.
4. Connect the charge controller positive PV terminal to your solar panel positive wire via a breaker, and the negative PV terminal to your solar panel negative wire.

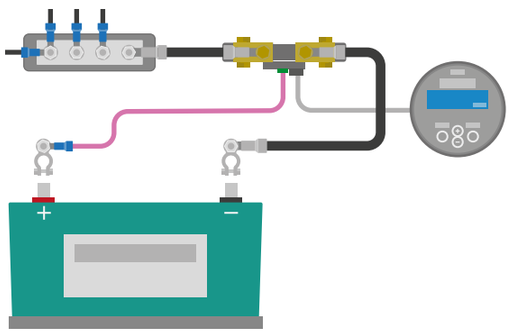
IMPORTANT

Make sure you connect your charge controller to your batteries before connecting it to your solar panels.



Connecting a battery monitor

Different types of battery monitors are installed in different positions within your electrical system. If you have a simple voltmeter, connect it directly to the positive and negative terminals of the battery, in the same position you are connecting your positive and negative loads (i.e. on different batteries to get a reading across both). If you have a battery monitor with a shunt, it's not quite as straightforward.



1. Connect the shunt between the negative battery terminal and your negative bus bar.
2. Connect the temperature sensor to the positive battery using the supplied

ABOVE A great example of a control panel mounted in a campervan living space, providing quick access. *@city2_vanlife*

temperature sensor cable. Connect it in the same position you are connecting your positive and negative loads.

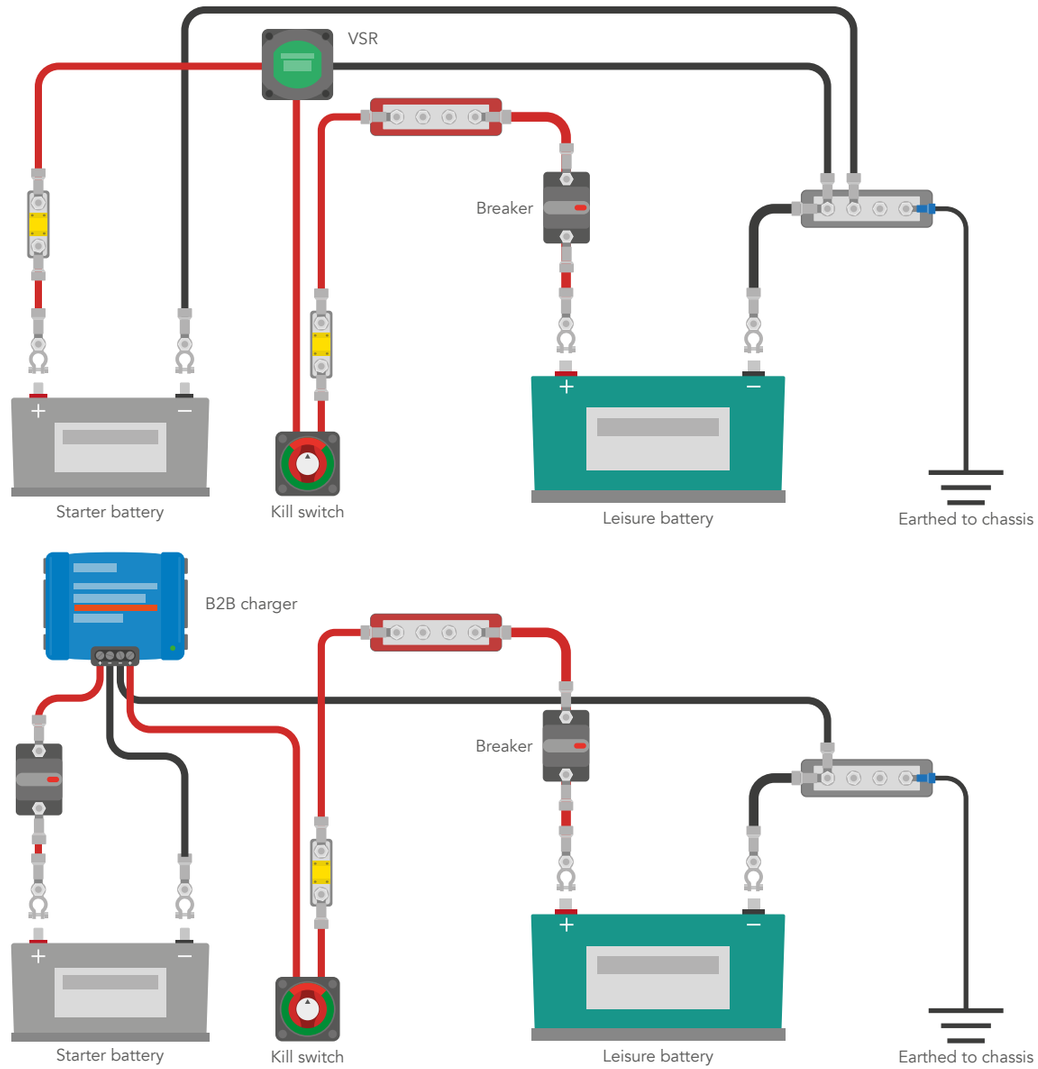
3. Connect the battery monitor to the shunt using the supplied data cable.

NOTE:
This information is specific to the Victron battery monitor. Check the instructions on your specific battery monitor to ensure you connect it correctly.

Connecting a VSR or battery to battery charger

VSR

1. Ground the VSR to the vehicle chassis.
2. Connect the VSR to the starter battery via a fuse.
3. Connect the starter battery negative terminal to the negative bus bar.
4. Connect the VSR to the positive bus bar via a fuse and a kill switch.



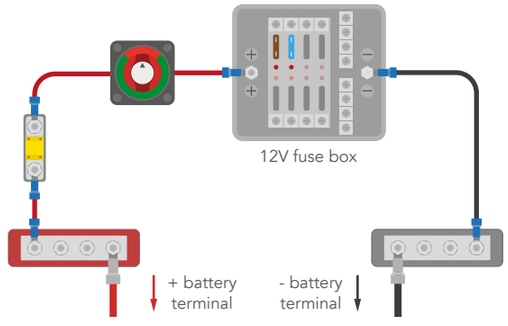
OPPOSITE All of the most organised van builders label their cables. *@city2_vanlife*

Battery to battery charger

1. Ground the battery to battery charger to the vehicle chassis.
2. Connect the positive input terminal on the battery to battery charger to the positive bus bar via a fuse and a kill switch.
3. Connect the negative input terminal on the charger to the negative bus bar.
4. Connect the positive output terminal on the charger to the starter battery positive terminal via a breaker.
5. Connect the negative output terminal on the battery charger to the starter battery negative terminal.

Connecting the 12V fuse box

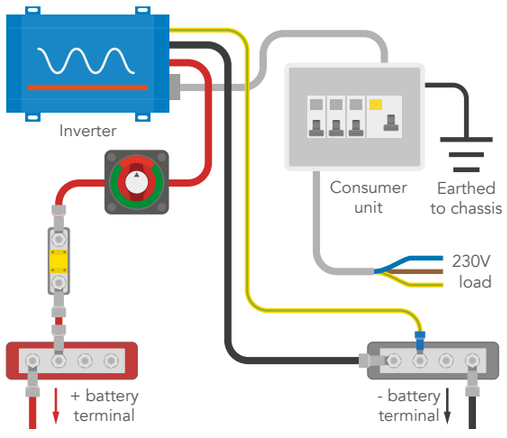
1. Connect the positive terminal on the fuse box to your positive bus bar via a fuse and a kill switch.
2. Connect the negative terminal to the negative bus bar.

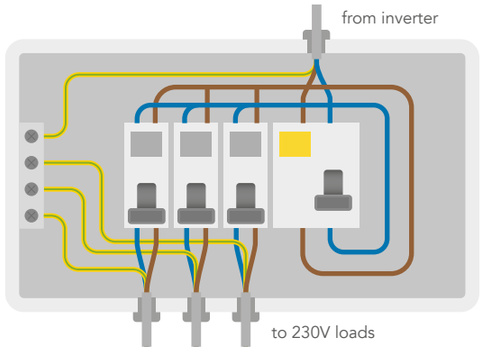


Connecting the inverter and consumer unit

If you aren't installing shore power but you are installing an inverter, you should follow these steps. If you are installing shore power, move onto the next section.

1. Ground the inverter to the negative busbar.
2. Connect the inverter positive battery terminal to the positive bus bar via a fuse and a kill switch.
3. Connect the negative battery terminal to the negative bus bar.
4. If you have an inverter switch, connect this now. The method of connection will vary with the exact make and model of the inverter you have purchased, but typically they have a data cable connector that connects straight to the inverter.
5. Ground the consumer unit to the vehicle chassis by connecting a grounding cable to the ground bar.
6. Connect the inverter to the RCD live and neutral input points within the consumer unit using 2 core + earth cable. Ensure you connect the ground from the 2 core + earth cable to the ground bar.
7. Connect the live and neutral outputs from the RCD to the live and neutral inputs on any MCBs that will be in use.

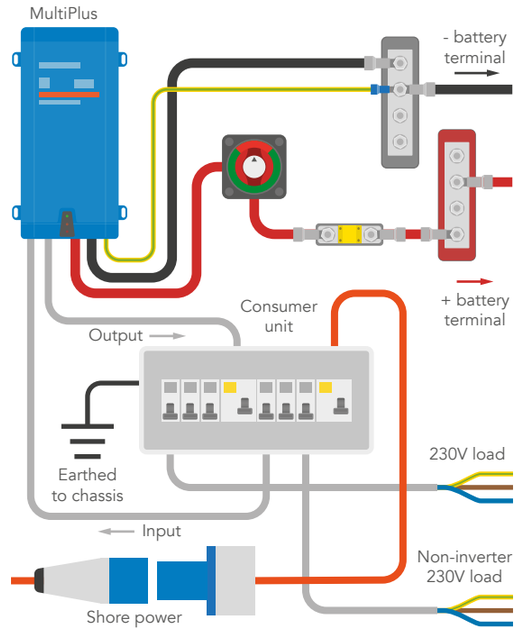




Connecting the shore power, consumer unit and MultiPlus

You should have already installed the physical hook up point on the exterior of your van. To connect it to your system:

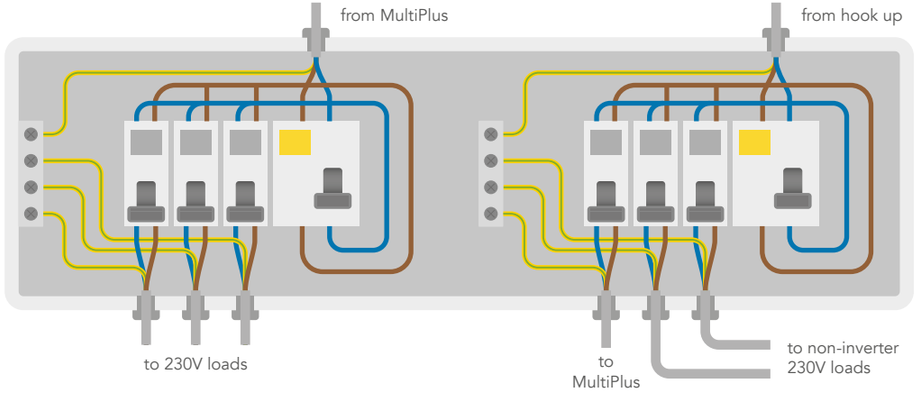
1. Ground the consumer unit to the metal vehicle chassis, and ground the MultiPlus to the negative bus bar.
2. Connect the hook up to the right-hand RCD in the consumer unit using 2 core + earth cable. Ensure you connect the ground from the 2 core + earth cable to the ground bar.
3. Connect the battery positive terminal on the MultiPlus to the positive bus bar via a fuse and a kill switch.
4. Connect the battery negative terminal to the negative bus bar.
5. To connect the MultiPlus input and output power terminals, connect the 2 core + earth cable to the supplied male and female connectors. These push directly into the AC in and AC out connection points on the Victron MultiPlus.
6. Connect the MultiPlus output to the left-hand RCD in the consumer unit, connecting the ground to the ground bar within the consumer unit.
7. Connect the live and neutral outputs from each of the left and the right RCDs to the live and neutral inputs on any MCBs that will be in use.

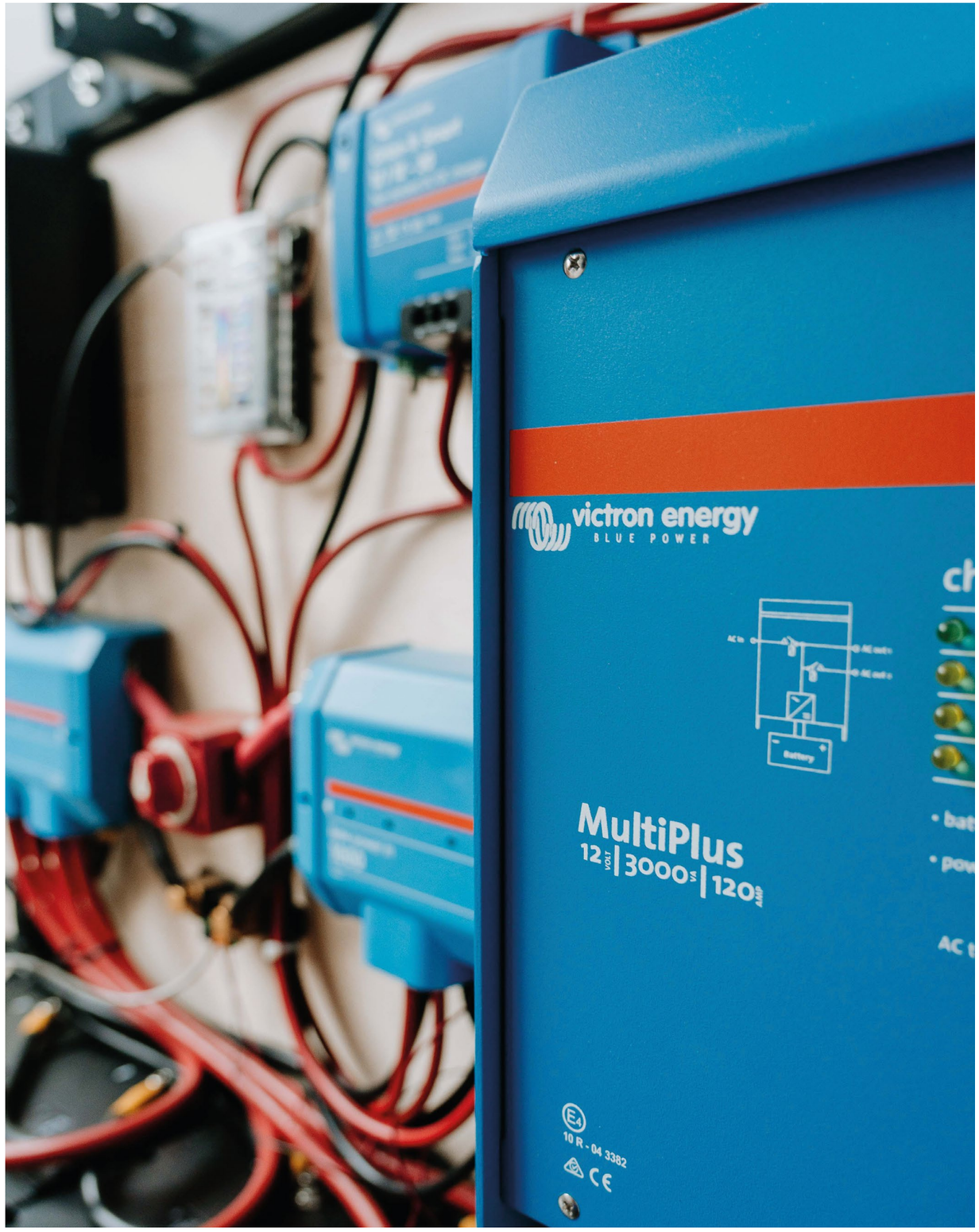


8. Use 2 core + earth cable to connect one of the output loads on the right-hand RCD powered by the hook up to the MultiPlus input, ensuring you connect the ground to the ground bar in the consumer unit.

Connecting plug sockets and 230V appliances

Any mains power appliances and plug sockets connect to your batteries via the consumer unit you have installed. Each appliance or set of plug





sockets are connected to an output load on the consumer unit. If you have installed shore power and you plan on using any appliances that should only be used when you are connected to a hook up (such as an air conditioner if your leisure battery power is not sufficient to run the unit by itself), connect these to the right-hand output of your split consumer unit. Connect all other loads to the left-hand output.

If you haven't installed a hook up, you won't have a split consumer unit, so you can connect each load to any of the MCBs on your consumer unit. To connect a mains plug socket:

1. Connect the 2 core + earth cable to the consumer unit.
2. Wire the 2 core + earth cable to the socket via a pattress box, which at this point will be hanging freely from the cable behind the plug socket. This is fine, as you will install it properly when you attach your cladding or ply.
3. If you are running cable for a mains powered appliance that's not yet installed in your van, connect the cable to the consumer unit, but leave the MCB switched off. Run the cable to wherever the appliance will be installed, and ensure you label the wire.
4. Label each MCB in your consumer unit so you know what each one is powering, should you need to isolate a circuit.

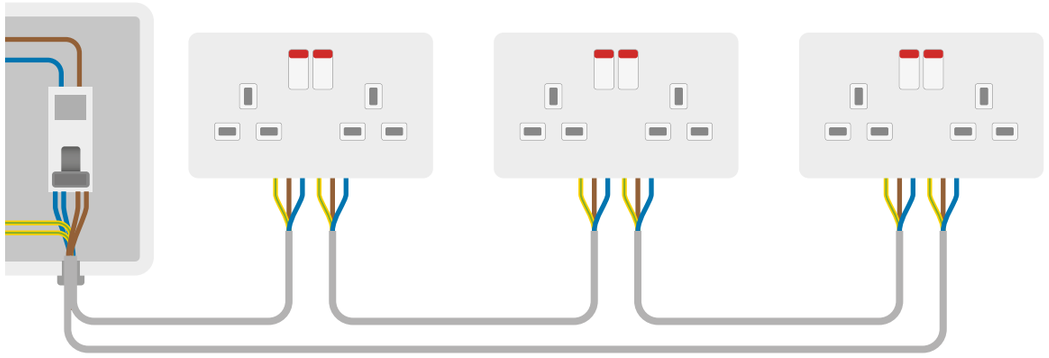
TIP:
Plug sockets can be connected in a ring circuit and connected to a single MCB within your consumer unit (see below).

Connecting 12V appliances

Any 12V appliances you are installing will need to be connected to your batteries via your 12V fuse box.

1. Run lengths of cable from your fuse box to any 12V appliances you need to connect, whether or not they are installed in your van yet.
2. If the appliance is not yet installed in your van, label the wires at the appliance end and connect them to the fuse box, but don't put the fuse in until the appliance is connected.
3. For the appliances that are installed, connect them to the fuse box, selecting the correct size blade fuse for each appliance.

NOTE:
Most 12V fuse boxes come with a set of labels you can stick onto the fuse box cover so you know what each fuse is connected to. You might find the labels don't quite cover everything you need them to, so you can also make your own.

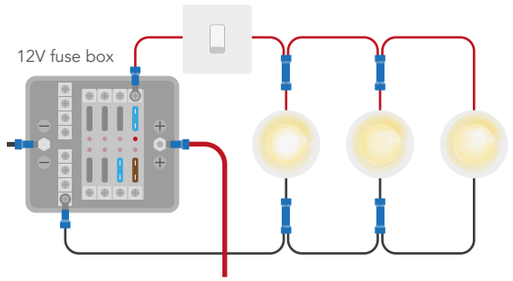


OPPOSITE The organised chaos of a half-finished electrical system. *@wondering_nancy*

Wiring lights and switches

Your lights are likely to be one of your 12V appliances and will need to be connected to your fuse box via a light switch.

1. Wire all the lights together in parallel.
2. Connect the negative wire directly to the 12V fuse box.
3. Connect the positive wire to the fuse box via a light switch, using the COM and the L1 terminals. Make sure to do this when the wires are not connected to your fuse box.
4. When connecting the cable to the switches, first run it through the correct sized pattress box. This will be installed properly once you have clad your van.

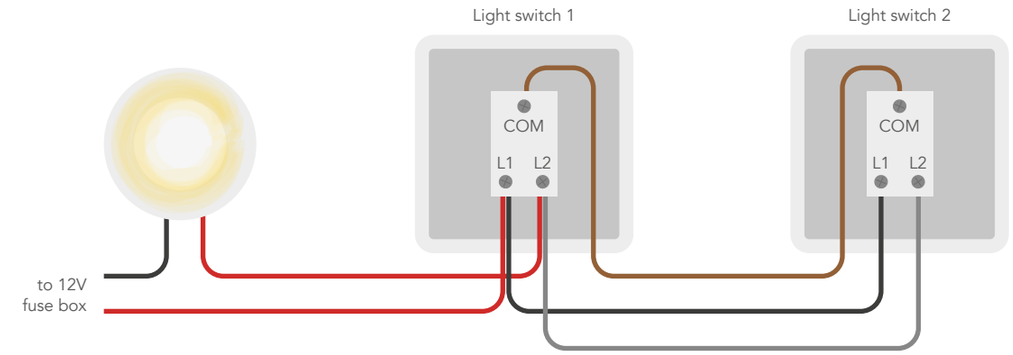


You may want to control your lights from more than one place. If this is the case, you will need to install a 2 way switch.

1. Connect the positive wire from the lights to the L1 and L2 terminals in the first light switch.
2. Run a length of 3 core + earth cable from the first light switch to the second.
3. In both light switches, connect the brown cable to the COM terminal, the black cable to the L1 terminal and the grey cable to the L2 terminal.
4. Connect the earth at both ends.

Safety checks

Once you have finished wiring up your electrical system, make sure to run a few safety checks. Multimeters are useful for this, and we describe how to use one in *Techniques* on page 225. Measure the voltage across your batteries to check the current state of charge, and to see if the value matches up with the value on your battery monitor. Make sure to turn off the connection from your solar charge controller to your batteries long before doing this, as the voltage will show a higher reading whilst the batteries are being charged. It can take up to an hour for your batteries to reach the voltage of their actual charge after they've been charging.



OPPOSITE There's something very exciting about finishing all of your wiring, tentatively flicking a switch, and seeing your van light up. *@climbingvan*

Floors and walls - Part 2

Cladding the walls, ceiling and doors

Whether you're cladding your walls with ply or cladding, both share many of the same steps and complications.

- For both options, pick a screw length that will go through your ply or cladding and two-thirds of the batten depth. This ensures you don't create a thermal bridge from the exterior van walls to the inside of the van.
- Tuck any wires between the vapour barrier and ply or cladding. Be careful not to screw too close to any wires or pinch the cables with the material. We'd recommend photographing where all of your wires are before you clad, so when everything is covered away you can check it's safe to screw in certain areas.
- Create holes in your ply or cladding to accommodate switches and lights. Light switches and plug sockets require square or rectangular cut-outs, so create these using a jigsaw. The hole size needs to be a little smaller than the pattress box, so the cladding is sandwiched between the pattress box and the fascia when you screw the fascia on.
- Ensure you have adequate space behind the pattress box to fit all of your cables, which may require you to cut into your insulation a little. If this is the case, cover any missing vapour barrier with a patch and use aluminium tape to seal it.
- Spotlights are designed to fit into standard hole sizes, so use a hole saw to create the mounting hole. Once they're in place, fold the spotlight legs into the hole, which will pull the light into position.

NOTE:
If you're building a fixed bed and plan on attaching it to the walls, make sure you consider this when cladding your van. You will need to drill clearance holes in the ply or cladding before mounting it to the walls so rivet nuts can pass through the hole in the wood and into the metal beams of the van. Any insulation and vapour barrier will also need to be removed around the mounting holes. Ensure the hole is larger than the outer diameter of your rivet nut head to give yourself enough room to attach it. See *Layout construction - Fixed bed* on page 249 for more information.

Ply lining

1. When cladding your van with ply, the trickiest part is measuring and cutting each sheet to size. To make life easier, cut some scrap cardboard to size with scissors and use it as a template.
2. Use the template to draw onto the ply, and use a jigsaw and mitre saw to cut the shapes out. Try and keep any edges that join with other sheets vertical to save time cutting subsequent sheets and to stop the joins from being too unsightly.
3. Drill a series of pilot holes around the perimeter of each sheet, and then countersink each hole.
4. Screw each sheet into place with self-tapping screws.
5. If you wish to have an arc where your van ceiling meets the wall rather than a sharp corner where two pieces of ply meet, carefully bend a sheet of 3mm or 3.6mm ply into place. You may need to wet or steam the sheet to do this.

TIP:
Identify which edges of the ply will be visible, and crucially, which areas will sit behind units. For example, if a kitchen unit will sit in front of the ply, you don't need to be as neat with those areas. Moreover, you may not need to cover every surface of the van if some areas won't be seen once finished. This is a great way to cut down on weight, time and cost!

ABOVE TOP Fabienne and Denis did a stunning job of creating beautifully curved ceilings in their van. *@nest.and.nomad*
BOTTOM We used a practice bit of cladding as a template to get the holes for the plug sockets and light switches exactly right. Once we were happy, we traced the shapes onto another piece. *@climbingvan*

The big time saving here is to mark out and cut your first piece, and then turn it around and see if it fits the other side of the van. If it does, your day just got a whole lot easier as you can now use your existing sheet as a template to create a mirrored version!

Another big-time, cost and weight saver is to only use ply or cladding in areas that will be visible. Not cladding behind kitchen units and other structures that have a back panel avoids doubling up on material, and ultimately it will never be seen.

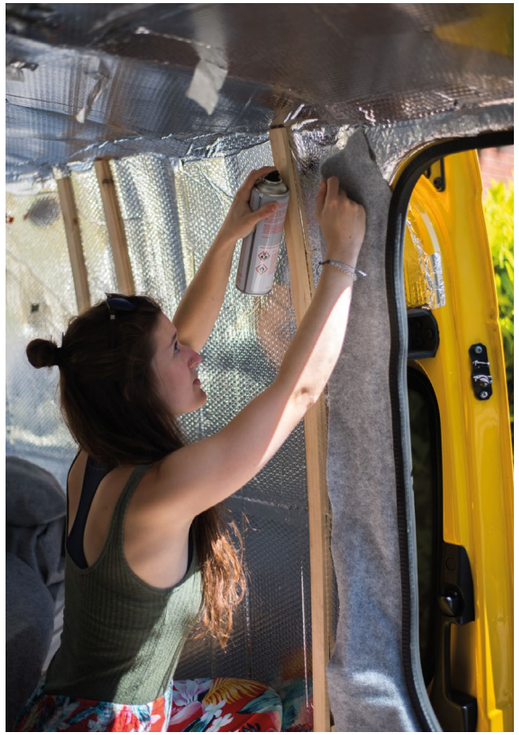
Carpeting

Once your van is ply lined, you can now auto carpet your walls and ceiling if you plan on doing so. Carpeting at this stage allows you to hide the edges away more easily than once the van is full of units. Before starting, we'd recommend using gaffer tape to cover any joins or seams in the ply and bodywork, as this helps to blend out any sharp transitions when you come to install the carpet.

As with previous auto carpet references, try to use a large roll of carpet and work from one corner, gradually securing the carpet in place as you go and tucking in edges where possible. If you intend to secure any structures with adhesives directly to the walls or tile kitchen areas which are covered in carpet, the carpet will need to be trimmed back to ensure adequate adhesion.

Painting

We'd recommend you don't paint any ply or cladding at this stage, as it risks being scuffed during the rest of the build. You're also likely to end up painting a bigger area than you really need to, as units and other materials will likely cover a lot of your visible wall space.



ABOVE Cutting carpet to size and glueing it into place. **OPPOSITE FIRST** We offered up a few scraps of cladding to create a template for awkward profiles. **SECOND** Who knew someone could have so much fun cladding! **THIRD** If we thought carpeting was a workout, cladding the ceiling was 10 times worse. We both felt absolutely wrecked for days afterwards! *@climbingvan*

Cladding

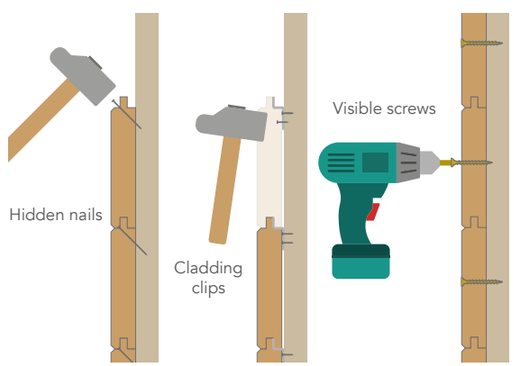
Whether you're fitting a single piece of cladding or multiple pieces per row or column, you're likely to use one of the following methods to attach it to the wall. Whichever method you use to attach your cladding, you will need to profile the edges of your cladding to the edge of your van. Refer to *Techniques* on page 218 for how best to approach this.

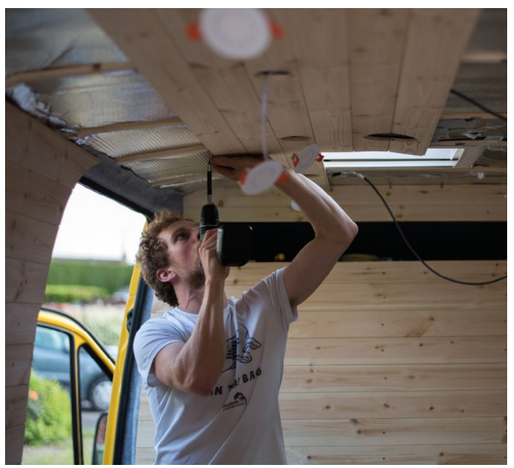
Visible screws

Using screws is the easiest method of attaching the cladding to the wall and ceiling battens, but these will remain visible, so if you're using this method, use small-headed screws. The tongue and groove of the cladding does most of the hard work holding each piece in place, so the screws merely need to support the weight of the cladding.

Pinning

Hammer in small 'lost head' nails or pins on the front face of the cladding for a strong but visible connection. You can attach cladding by pinning or nailing through the tongue of the cladding to achieve a hidden fastening, but this is tricky and slow with just a hammer and can cause softwood cladding to split. It also makes seating the cladding evenly along the groove more difficult. Professional cladding installers often use this method, but they will speed the process up by using a nail or pin gun.





Cladding clips

If you're converting your van by yourself and can't get someone else to come and help you with this job, don't even consider using cladding clips! They are extremely fiddly to use, and even with two people, it can be a bit of a nightmare. However, if there are two or more of you and you have some patience, cladding clips give you the opportunity to install cladding with no visible screws.

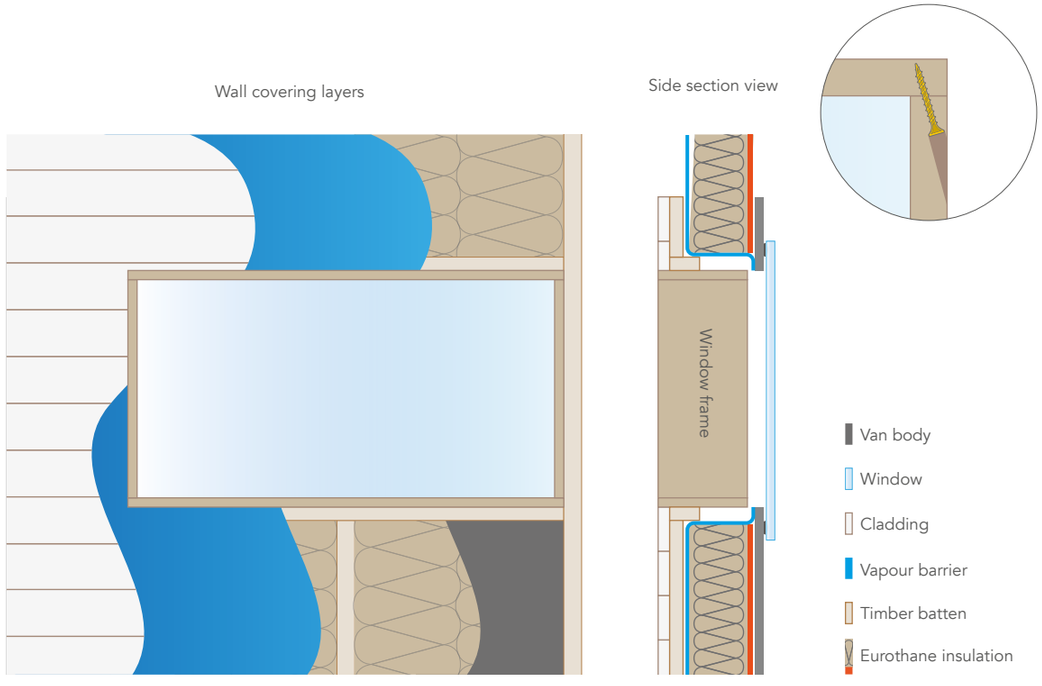
To use cladding clips, secure them to the bottom of the surface you are cladding using small screws. Once in place, they create a hook which the cladding can slot into. As soon as one piece of cladding is in place, add more clips above to hold the previous piece in position and create a mounting point for the next.

Painting

As with ply, we'd recommend you don't paint your cladding until towards the end of your build. This is particularly important if you have used non-treated timber, as the change in humidity levels will cause the timber to expand and shrink. This results in small gaps forming between your cladding, which if the wood has already been painted will show lines of non-painted wood. Leaving the cladding to adjust to its new environment for as long as possible helps to reduce this issue.

Finishing windows

Once the walls have been clad, build internal window frames and sills to cover any visible gaps between the wall and insulation stack. The illustration shows a typical construction, held in place with screws, pins or adhesive. Ensure the top frame and sill span the full width of the window aperture, and the cut side panels act as column supports at either side.



Layout construction

Tools

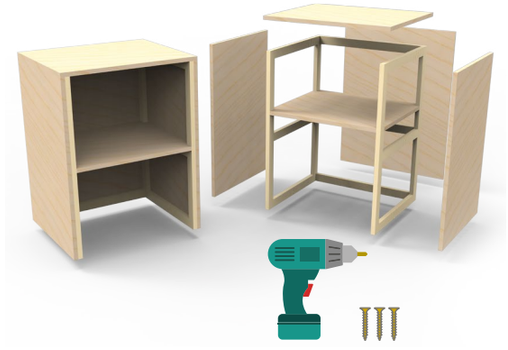
- Jigsaw
- Drill and drill bits
- Circular/mitre saw
- Set square
- Clamps
- Router and bits (optional)
- Pocket jig (optional)
- Mastic gun
- Paint brush
- Electric sander

Techniques

Carcassing method

The carcassing method can be achieved in one of two ways which we'll refer to as 'carcassing' and 'partial carcassing'.

Carcassing involves building a skeletal batten framework which can then be clad with ply. This method is best for anyone relatively new to DIY because it allows you to easily make adjustments to ensure everything is square and the right size. You can offer up your ply once you're happy with the structure and use it as a template. When you add your ply cladding it will add a lot of strength to the structure, so you don't need to use massive battens.



Partial carcassing involves cutting the ply before the battens. The battens are used to connect the ply together, acting like an angled bracket. This method is better for structures such as kitchens because you attach drawers and hinges to the walls of the ply. You will need to be more confident when using this method, as it's harder to make adjustments.

Common types of joint

For both of these methods, it's useful to know the different types of joints used.

Butt joints are the simplest form of joint and provide a strong connection. Once you've cut your battens to size, simply attach them to one another using a pocket jig and screws (more on that shortly).

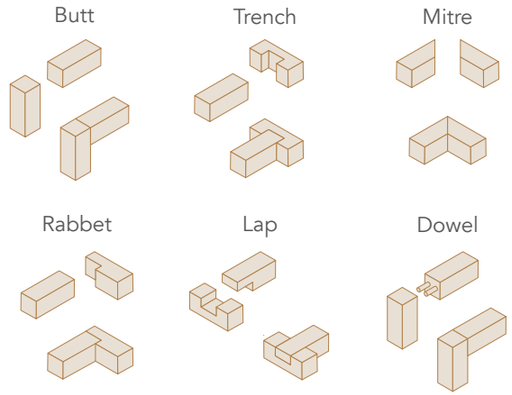
Trench joints are better at load-bearing, due to the large material engagement. They're used in applications where a lot of weight is focused in a localised area such as a ladder leading up to a bed.

Mitre joints are a more visual joint and are commonly used when the batten structure will remain visible.

Rabbet joints are very similar to trench joints but are used at the end of a batten rather than in the middle of one.

Lap joints are the strongest joints as they provide engagement in all planes but one. You might use a lap joint if you were building a non-permanent structure, as it can be slotted into place and removed when not in use.

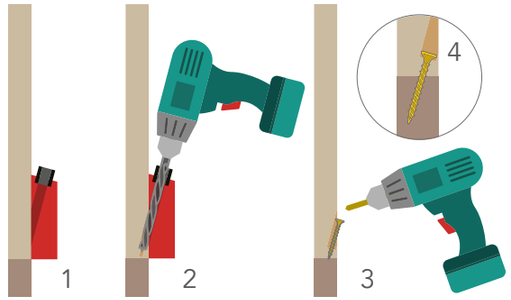
Dowel joints are similar to butt joints but would be used in a more visual spot where screws aren't appropriate.



How to use a pocket jig

Butt joints are the main joint used for the carcassing method and require a pocket jig. This allows you to drill an angled clearance hole for the screw head in one batten, so it can make contact with the second batten. The pocket jig will be supplied with drill bits.

1. Position the pocket jig close to the end of one batten and clamp it in place.
2. Using the pocket jig, drill the holes to provide clearance for the screw heads. Ensure you only drill just below the surface of the first batten.
3. Remove the pocket jig. Clamp the two battens together, and insert wood screws into the drilled holes.
4. Screw the two battens together.

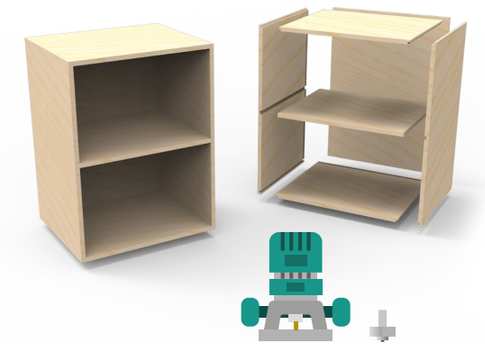


Cabinetry method

The cabinetry method also takes two guises. The standard method uses a router to cut trenches into the ply. The ply is sandwiched together, using glue in the trenches to hold its structure. The second method is useful if you still want to achieve the cabinetry aesthetic but don't have access to a router, which we'll refer to as 'screwed cabinetry'.

Cabinetry requires prior planning. The concept relies on the sheets of ply intersecting one another in pre-cut slots. You need to account for the depth of the trench when measuring out your ply, which can quickly become confusing if you're not familiar with this way of working.

A router has a rotary cutting blade which is used to cut trenches and other profiles into flat pieces of wood. It requires you to have a good workbench setup as the wood will need to be clamped in position, or you may need to use guides to define the path the router takes.



Screwed cabinetry is a good option if you do not have a router but still want to use the cabinetry method, and can be achieved using a drill and small screws. By clamping the ply together using a batten to hold its position, you can screw directly through one face of the ply and into the side of another. This isn't as strong as the regular cabinetry method and is

OPPOSITE Lisa used a pocket jig and clamp to drill angled counterbored holes in their birch ply. *@travelution_*

more time consuming as every screw hole will need to be pilot holed first.

Common router profiles

There is an almost infinite number of router profiles you can use, but a select few will cover you in 99% of situations. There are two major types of router bits for cutting profiles. The first type has a bearing (spinning wheel) which runs along the edge of the wood, which translates the profile of the bit onto the material. The other type doesn't have a bearing and can either be used freehand or more commonly, with a guide that the router runs against.

Rabbet cuts should be used at the edge of a sheet of material to create a stepped profile to connect to a corresponding sheet.

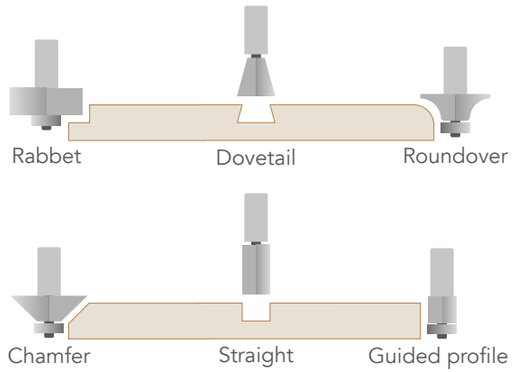
Dovetail cuts create a positive engagement between two pieces of wood. A corresponding piece would need to be slotted in to securely connect the two parts.

Roundover cuts apply a set radius to the edge of a piece of wood. They are a decorative cut used to remove sharp edges and provide a clean finish.

Chamfer cuts are used similarly to round over cuts, removing a harsh edge on a piece of wood but creating a different aesthetic.

Straight cuts are used to create a parallel trench cut, which a sheet of ply can sit into. They come in standard sizes which match standard ply thicknesses.

Guided profile cuts plane the edge of a sheet of wood, shaving off a small amount of material to give a smooth finish.



How to build a cabinet using the cabinetry method

1. Measure everything and sketch it out on a piece of paper.
2. Once you've done this, work out where all the cuts will need to be and draw these onto your sketch.
3. Work out the size of each piece of ply based on their intersection with other parts. For example, if a shelf will connect into a trench cut on one side, to account for the trench, add the depth of the trench to the length of the shelf.
4. Now that you have worked out the exact sizes of each piece, you can mark them onto a sheet of ply. For any trench cuts, draw a centre line to mark where they will be cut.
5. Cut the pieces of ply out of the sheet.
6. Use the correct router bit to create the trench cuts where required. The width of the bit you use needs to be the same as the material thickness to create a snug

ABOVE We made our slide out table using old wooden floorboards in a very similar fashion to the cabinetry method. We glued along the tongue and clamped the structure together. *@climbingvan*

connection, and the depth needs to be half the material thickness.

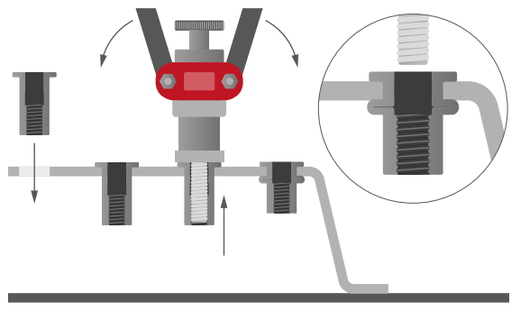
7. Once all your pieces of ply are ready, build the entire structure up dry (without glue) to ensure everything fits together correctly. At this point, you can make any necessary adjustments.
8. When you're happy with the structure, apply glue into the trench cuts and gradually assemble the structure, clamping each piece as you go. Use a cloth to wipe away any excess glue, and leave to dry.

Using rivet nuts

Rivet nuts can be used to create a strong threaded connection between the chassis of your van and a structure such as a bed.

1. Mark out the centre position of the clearance hole for each rivet using a centre punch and a hammer. This will make drilling easier, as the drill bit won't slip.
2. Drill a pilot hole, and then increase it using a bigger drill bit to the specified size for the rivet nut you're using.
3. Insert the rivet nut into the hole.
4. Screw the threaded bar on the hand rivet tool into the rivet nut. Whilst pushing the tool into the rivet nut, press the handles down to clamp the nut into a fixed position.

TIP:
We'd recommend using M8-M10 rivet nuts and placing them every 400-500mm to create a stable platform.



Construction preparation

We'd strongly advise using your layout plan to mark out where everything is going before you start building. This way you can be confident it will all fit! Masking tape is useful for this, and you can even leave it in position, building right over the top of it.

Start by building the size critical areas first, such as kitchen units and beds, leaving seating areas and storage units until the end. Size-critical areas are anything that will have a standard object or product inserted into or onto it, such as a mattress or fridge. Regardless of how well you mark out and build everything in your van, you'll never make it perfectly. Everything will have some degree of variation to it, but the challenge is knowing what this will impact when added together.

Building size critical areas first allows you to account for any variation within non-size critical areas such as seating or storage areas. If you have size critical sections over the full length or width of your van, build from one end and ensure you leave a gap at the end.

Bear in mind that your walls are not flat. Most van walls arc inwards slightly, so measuring 500mm out from the wall of the van on the floor won't be the same as if you measure 500mm out from 1m up the wall. Therefore, you should measure how far things will project from the highest point up the van.

Building a bed

All bed structures should incorporate bed slats to support the mattress and let it breathe. You can either use thin wooden battens or pre-made bed slats from somewhere like IKEA. We'd strongly advise against using a single sheet of ply below a mattress. It won't be able to breathe which will cause mould, as water vapour will condense between the cold space beneath the bed and the warm mattress.

OPPOSITE TOP Liz, Wes and Finley marked out all of the structures in their skoolie conversion, making it super clear where everything would be positioned. *@nauticalnomads* **BOTTOM** We used supporting vertical battens below our main structural batten, allowing us to position our bed at whatever height we wanted. *@climbingvan*

Bed slats exist for this very reason, to let the mattress breathe. For some temporary bed structures, using bed slats might not be possible, so if this is the case ensure they have holes or slots cut out of any panel that contacts the foam or mattress.

Fixed bed

A fixed bed is the easiest option to construct due to its static nature and can be attached directly to the ribs and supporting structures of the van walls. The structure will consist of wooden battens fixed to the walls of the van, on which stainless steel midbeams will rest. The bed slats are then positioned on top and fixed in place.

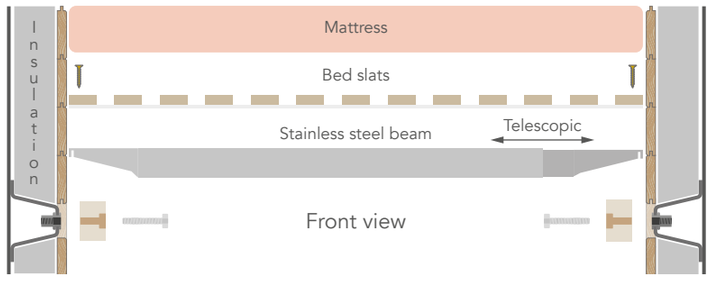
This is one of the most robust and space-efficient fixed bed constructions. We've included steel beams in our design, as they don't require additional supporting pillars, allowing you to maximise storage below. We recommend using a SKORVA midbeam from IKEA as they have been designed specifically for this kind of scenario (and they're only £10 each!). The other advantage is that they are telescopic, so you can extend the beam to fit any width of van.

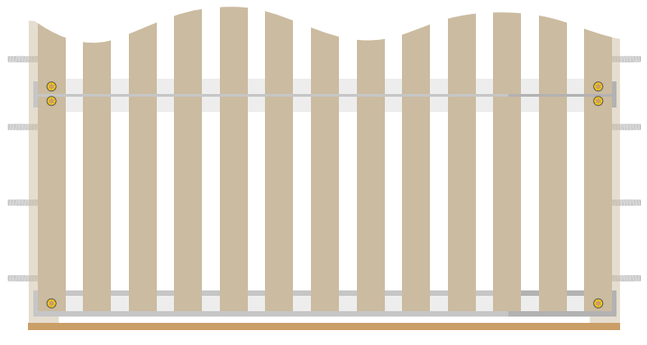
1. The intended height of your bed will affect how you construct it. If you have internal ribs at the desired height, attach the battens directly to these ribs using self-tapping screws or rivet nuts.
2. If you want to position your bed at a different height, build a carcass structure to support the battens.
3. Once your battens are fixed in place, attach the steel midbeams by drilling a pilot hole through the steel and into the wooden batten. Ensure you use an appropriate high-speed drill bit for cutting stainless steel, as you will struggle to cut through the metal otherwise.
4. Once the pilot holes have been drilled, position the bed slats and screw everything in place. The screws connect the bed slats, midbeam and wooden batten together.

Convertible sofa bed

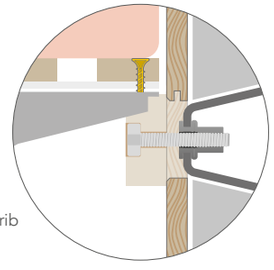
The convertible sofa bed provides easily accessible storage from the main living area and is simple to construct. Ideally, the two side benches should be slightly wider than the gap in the centre.

1. To build the structure, use the carcassing or the cabinetry construction method as detailed in *Techniques* on page 242.
2. To provide access to the bench storage, secure the ply 'lids' to the benches using hinges. An ottoman hinge will account for the additional thickness of the cushions and allow you to fully open the lid, whereas butt hinges will require you to remove the cushion before opening the lid.
3. Alternatively, simply leave the lid disconnected from the box so you can remove it entirely to access the storage (a bit like a giant biscuit tin!).
4. The piece of ply that's used to straddle the gap in the middle of the bench should be fairly thick (around 18mm) so that it will be strong enough to support the weight of someone sitting in the centre of the panel. Use the same thickness for the lids of the benches, to ensure all of the cushions sit at the same height.
5. If you experience too much flex in the central piece of ply, consider adding some battens to the underside that will bridge the width of the panel and add strength. Attach them using a combination of screws and wood glue.
6. Ensure any backboards or cushions used in 'sofa' mode are built on a roughly 10 degree angle, as vertical backboards are really uncomfortable!

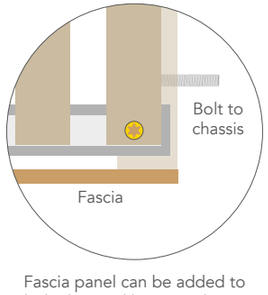




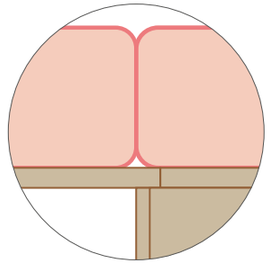
Top view



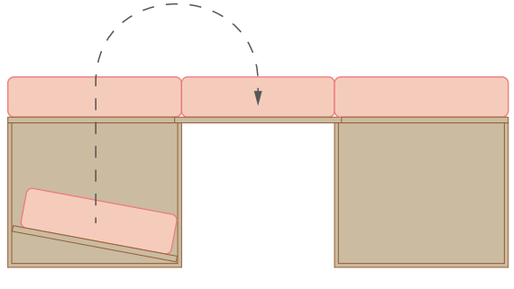
Beam cut into timber support and bolted into van chassis using bolt and rivet nuts

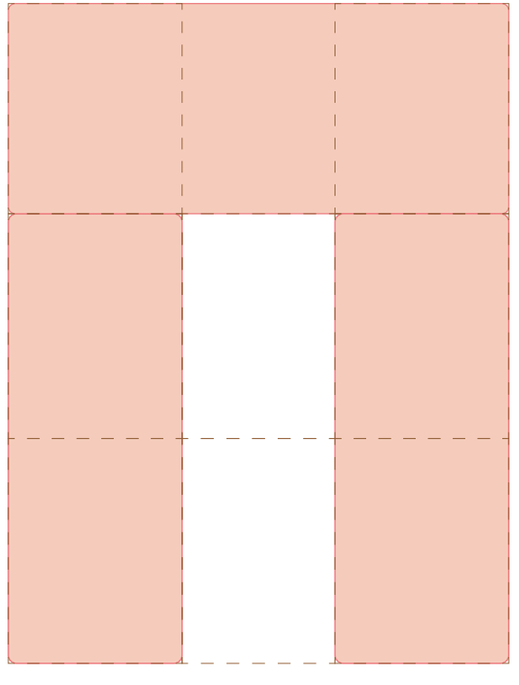


Fascia panel can be added to hide the steel beam and stop the mattress from sliding off



A small overlap needs to be created on either side to slot the additional panel into place

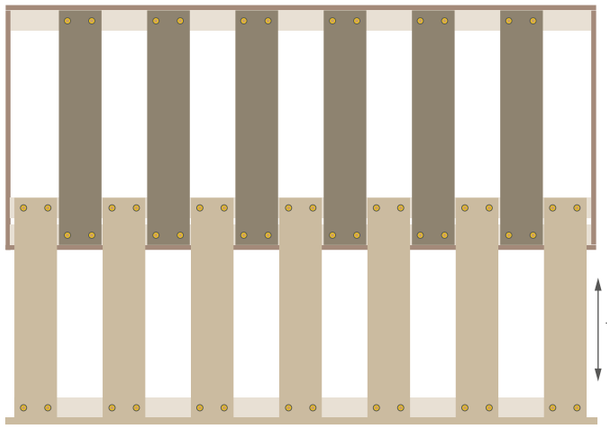




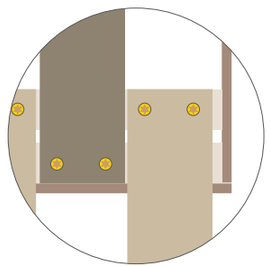
Sliding sofa bed

A sliding sofa bed is the easiest and most versatile option for anyone with a small van. The interlocking slats allow you to easily slide a portion of the structure out, doubling the width. Storage space can be created below the static section of the bed. You will need to use two single mattresses for a sofa bed like this so that it can function as a seating area in the daytime, and allow you to create a double mattress at night. We'd recommend using a daybed mattress such as the MALFORS from IKEA, which is made precisely for applications such as this.

1. Build a box to form the base of the sofa using the carcassing or cabinetry method detailed in *Techniques* on page 242. As this will double as storage space, consider how you will access this, such as via a cupboard front drawer.
2. Once you have built this, start to build the front piece of the moving section.
3. Cut your bed slats to size. Aim to have a fairly close fit between each slat (roughly 1-5mm), as this will allow the front to slide out smoothly.
4. Connect all of the slats on the moving frame, both to the frame at one end and to a floating batten at the other end.
5. Place the sliding assembly over the top of the box. Now you can place the remaining bed slats in the gaps between the existing slats, and screw them into the base box. This process captures the sliding section, allowing you to move it in and out, whilst maintaining its position.

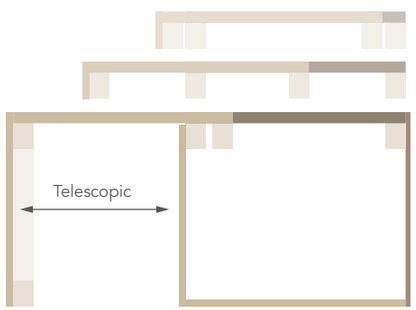


Top view



The fixed and sliding slats are held in place by the battens below weaving them together

Front view



Side section view

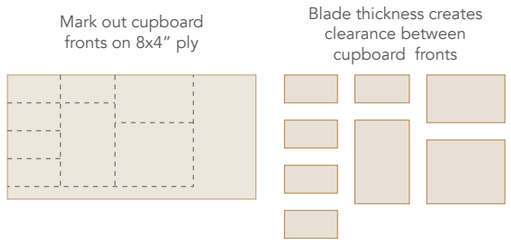
OPPOSITE Shaun checks the fit of their new sliding sofa bed before adding the finishing touches. *@homeroving* & *@goroving*

Kitchen structure

When you come to construct your kitchen units, you can use any of the four methods explained in *Techniques* on page 242. As with many of the other furniture constructions, it's best to build the kitchen units outside of the van, checking your measurements as you build and slotting it into position once it's complete.

Building kitchen units

1. Build your units using one of the four methods detailed at the start of this section.
2. If you're adding feet to the underside of your units, do this now. They create space for cables, pipes and hoses to run. They don't need to be fancy and can simply be made of a few stubby battens, as you can add a kickboard (a panel along the bottom) to the front of the unit to cover the gap.
3. Drill holes for water hoses, gas pipes and electrical cables at this point.
4. Carry your units into the van and screw them to either the floor, walls or other surrounding fixed objects. The last thing you want is for your kitchen sink to go flying when you hit a speed bump!

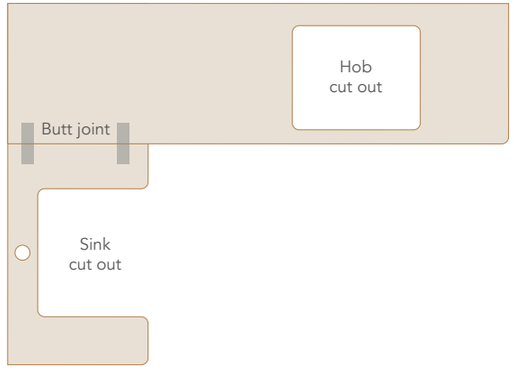


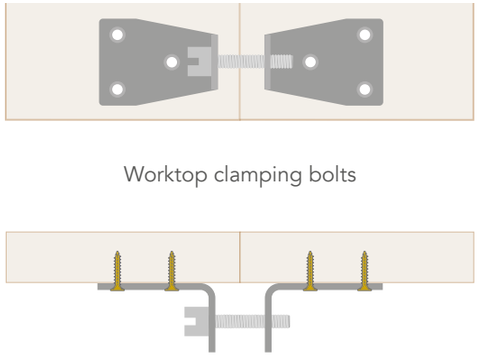
Doors and drawers

1. Measure the total width and height of your kitchen units that will be covered by cupboard and drawer fronts. Mark this out onto a sheet of ply.
2. Measure from the edge of the units to the centre of each ply divider and add this detail onto your ply, repeating the process for all cupboard and drawer fronts.
3. Cut the shapes out using a jigsaw or a circular saw. The width of the saw blade will create clearance between the cupboard fronts, allowing your cupboards and drawers to open.
4. Sand any rough edges until smooth.
5. If you haven't bought pre-built drawers from somewhere like IKEA, you will need to build your drawers now.
6. Fix your drawers and cupboard fronts in place using drawer runners and hinges. For further details, see *Hinges, struts and hardware* on page 186.

Cutting and attaching the countertop

1. Mark out the exact size of your worktop, accounting for a roughly 20mm overhang at any exposed edge.
2. If you have a router, use a straight cut bit and a guide to cut out the worktop. This will give you a crisp, perpendicular edge.
3. If you don't have a router, use a jigsaw or a circular saw to cut out the worktop. In this case, you will likely need to sand the edges. Try to use a brand new blade and go extremely slowly, as this will help to achieve the best result.
4. Bring the countertop inside the van. Fix it in place either using L shaped brackets or if you've used the carcassing method you can screw straight through the carcass into the countertop.
5. To connect the two halves of an L shaped kitchen worktop, butt them up and screw two worktop clamping bolts into the base of both pieces. These allow you to tighten a bolt to draw the two pieces together. Ensure one side of the L shape is fixed in place, but the other is free to move around. Once you're happy with the connection, use mitre sealant to finish the joint and connect the other half of the worktop to the kitchen carcass.
6. You can create a better join for an L shape worktop using a router with a mitre joint guide, but this is fiddly and not recommended unless you already have experience using a router.





TIP:
Mitre sealant comes in lots of different shades, so you can pick the perfect option to match the colour of your worktop.

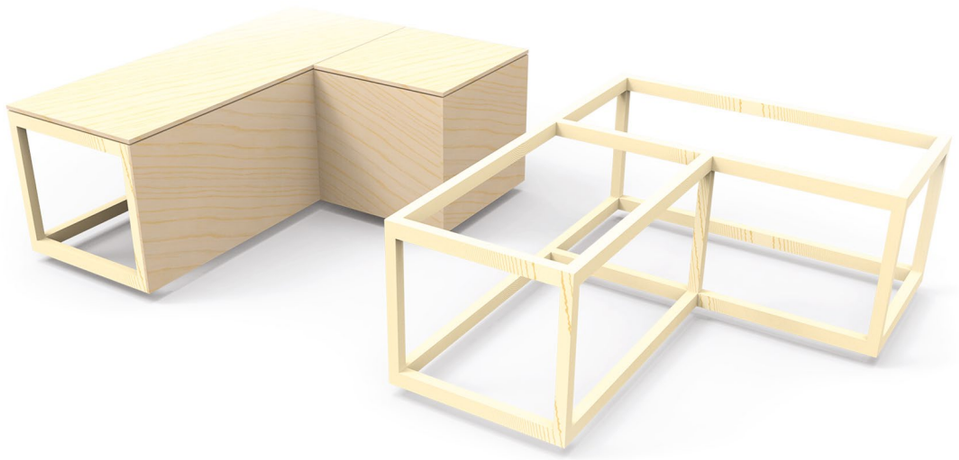
Fitting taps, sinks and hobs

1. Mark the centre position of the tap onto your worktop.
2. From the top of the worktop, use a hole saw of the specified diameter for your tap and drill all the way through.
3. Screw the Flexi tap connectors onto the base of the tap. The connectors usually have an o-ring, but there's no harm in using some pink PTFE tape so that when you screw them onto the tap they're nice and snug. Even if you only have cold water, you still need to attach both connectors.
4. Slot the tap into place, sandwiching an o-ring between the tap and the worktop, and then screw it into position using a tap fixing set.
5. For the sink and hob, mark out their position on the worktop. Most manufacturers should tell you the hole size needed for each product.
6. Once you have drawn a rectangle, decide what hole saw size you will use to create the rounded corners of the hole. Mark out the four corners where you will use the hole saw. Make sure the edge of the hole saw will meet the edge of the rectangle, rather than positioning the centre of the hole saw in the corners of the rectangle.
7. Drill the four corners of the rectangle using the hole saw, and then connect them using a jigsaw.
8. Slot the hob and sink into place. Most products will have a fixing kit provided with them so you can bolt them to the worktop.

Seating structure

The carcassing method is the most common construction method used for building a seating structure. It's simple, allowing you to build the structure in its intended position within the van.

1. Build up the framework for your seats using the carcassing method explained in *Techniques* on page 242.
2. Screw the structure into the floor or walls of the van, as this will provide greater stability.
3. Clad the structure with thin ply using wood glue and screws, or if you want a clean visual face, glue and clamp it in position.
4. Cut your bench tops from 12-18mm ply.
5. The thickness of the ply you need will depend on the number of supporting



OPPOSITE Mark everything out, drill the corners, cut between the holes and drop the hob into place. *@climbingvan*

beams you have. Fewer supports will mean you need the ply to be stronger, and so should use thicker ply.

6. Attach the bench tops using one of the hinge types discussed in *Hinges, struts and hardware* on page 186, depending on the functionality you're aiming for.
7. To attach the backboards, build an angled carcass structure. You can then attach the ply used for the backboards to this triangular frame.

TIP:
Attach the backboards at an angle of at least 10 degrees. This will ensure your seating area is comfy and you don't have to sit bolt upright!

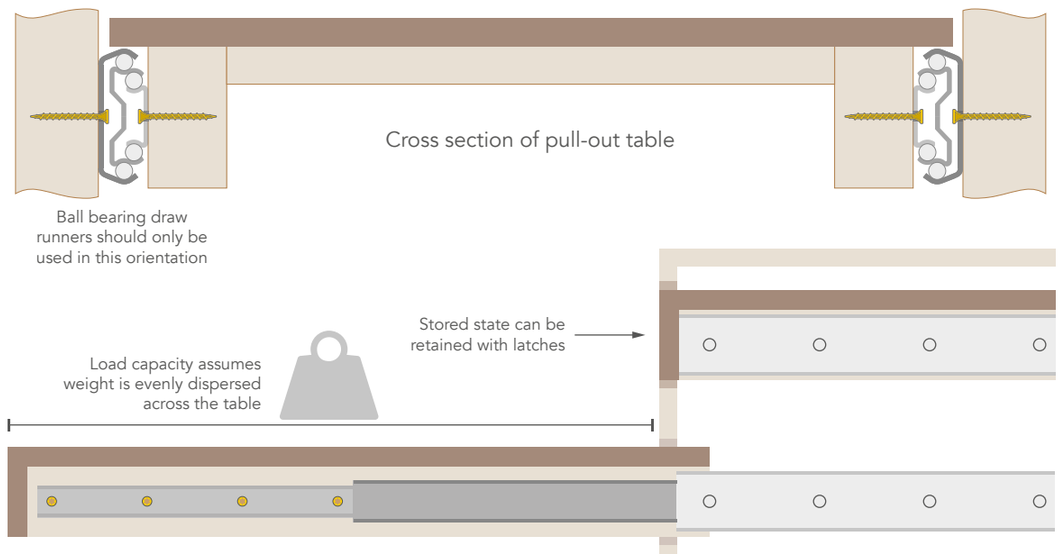
Tables

Build your tabletop out of whatever you like - old scraps of wood, a painted ply sheet - let your imagination go wild! Once you've finished your masterpiece, there are a number of different mounting options.

Slide-out table

In theory, building a slide-out table is easy, but in practice it relies on both the table and structure it's attached to being parallel. If the table is slightly wider at one end than the other, it will either struggle to slide smoothly or simply not work. The trick to avoid these issues is to build the table with adjustable rail mounts so you can make small adjustments when the table is in place.

1. Attach two supporting battens to the underside edges of the table. These need to be at least as deep as your rails. Attach them set back from the edge of the table so the majority of the rail will be recessed when mounted.
2. Mark out where your rails will be mounted, ensuring they are at the same height on both sides.
3. Attach the rails to the structure where you are mounting your table, using only two screws for each. This will allow you to make adjustments as needed. Use a set square or a spirit level app to check that the rail is level.
4. Fully extend both rails and slot the tabletop between them. Use two screws to attach the tabletop to the rails.
5. Slide the table in and out, making any adjustments to its position before securing the rail with the rest of the screws.
6. Add a method of retaining your table. We'd recommend using a rotating toggle or sliding latch, as 'push to open' mechanisms or rails with this functionality built-in can often unlock and fly forwards with the forces of driving.



DALE SAYS:
We made our tabletop out of leftover wooden floorboards. It's a great way to use up leftover material and add some character to your van.

Floor mounted table

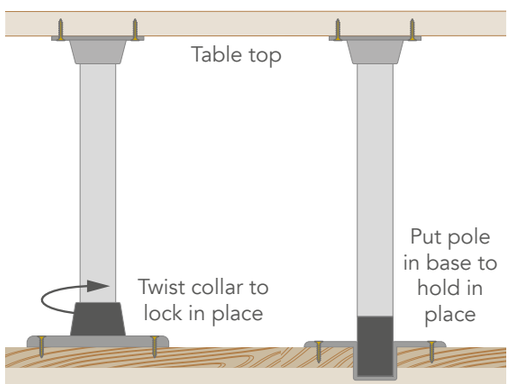
There are two main types of floor mounts for campervan tables. One requires you to cut into your floor, whilst the other can just be screwed in without any prior modifications.

Pedestal mount

1. Attach the table bracket to the underside of your table.
2. Mark the hole positions for each screw.
3. Drill a series of pilot holes, before screwing the bracket directly into the floor.

Floor recessed base

1. Attach the table bracket to the underside of your table.
2. If you have a floor recessed base, mark the centre point of the base.

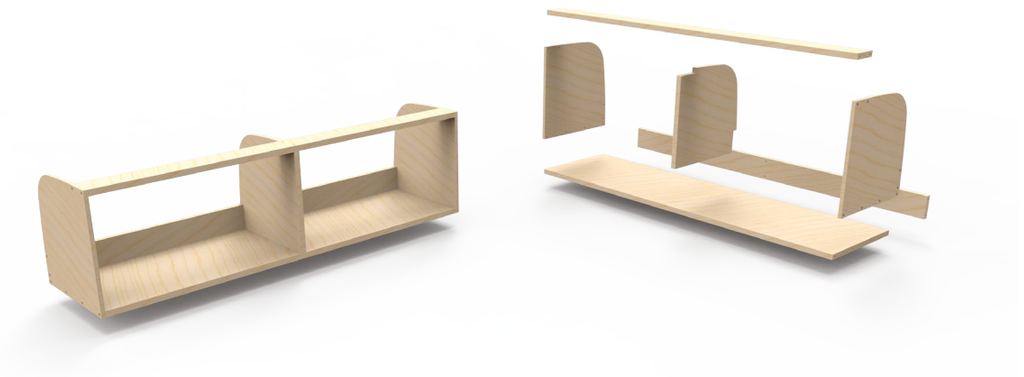


3. Using the relevant hole saw, drill a hole into the floor of your van. Check the base fits and sits flush with the floor, before marking the hole positions for each screw.
4. Drill a series of pilot holes, before screwing the bracket directly into the floor.

Overhead storage

Overhead storage and bookcases are often easier to build outside of the van. Once you have constructed them, you can bring them inside and make minor adjustments to refine the fit. Remember, a standard sheet of ply is 2.4 metres long, so if you are planning on building a unit the full length of your van, and your van is longer than 2.4 metres, you will need to construct it in two sections. Simply repeat the process below for both sections if needed. A bookcase or any other open storage is constructed in the same way.

1. Measure the space where your overhead storage unit will be mounted. Note down the length it will span, its height, and the depth it will project into the van at the bottom of the unit.
2. On a piece of ply, mark out the base of the unit, the end pieces, and a thin strip for the back and the top of the unit. If you are covering a long distance with your unit, you may want to include some dividers. Not only will they make the space more usable, but they will also add strength to the structure.
3. Cut the shapes out of the sheet of ply using a jigsaw and sand any rough edges.
4. Hold one of the dividers or end pieces in the position where the unit will be mounted. Use the scribing method as explained in *Profiling methods* on page 218 to create the curved profile needed.
5. Use a jigsaw to make the adjustments to the piece. Once you have done this, test it in its final position to ensure it fits. You should check it in all positions - i.e. at



both ends, and wherever you will install a divider. If it fits everywhere, you can use it as a template for all of the other pieces, but if it doesn't, you will need to repeat the scribing process for each piece.

6. Build up the unit using either one of the cabinetry methods described in *Techniques* on page 242. Attach the thin strips to the unit ensuring they will be parallel, and as close as possible to the wall they will be mounted to.
7. Hold the unit in position and attach it to the walls and ceiling of the van, screwing through the back and top strips. Screws should be attached at regular intervals. Ensure the screw length is long enough to go through the thickness of the cabinet and the material you're screwing into plus an additional 10mm, but not any longer.
8. Once your storage unit is in place, measure and cut your cupboard fronts. Attach them using suitable hinges and gas struts if you want them to stay open by themselves. See *Hinges, struts and hardware* on page 186 for more information.
9. If you are leaving any of your storage exposed without a cupboard front, add a lip, dowel, or bungee cord to retain any items stored within.

TIP:
When measuring your storage unit, remember that the tapered walls of the van will mean that you end up with much less storage in the top portion than at the bottom. Factor this in when deciding on the size of your units to ensure you're left with a usable space!

Building the bathroom

If you are including an internal shower in your build, you will need to construct a little bathroom. This is typically done by creating a stud work frame that is then clad with ply, waterproofed, and finally clad with a waterproof material or tiling. Shower trays come in standard sizes that make them perfect for campervan shower cubicles, and so this is the method we've suggested for building a cubicle is based on using a standard shower tray.

If your bathroom will contain a toilet, you will have to consider this before you start. You can store a portable cassette toilet in a bathroom, but it will need to be removed when you shower as they aren't fully waterproof. You can purchase campervan toilets specifically designed for wet rooms that are fully watertight, which is what you will need to do if you want a fixed toilet in your bathroom.

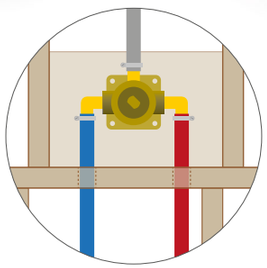
The process for building a bathroom with a fixed toilet is slightly different to what we have explained. You will need to account for the toilet when building and make sure it has a flat wall to sit against to create a good seal.

Building the cubicle

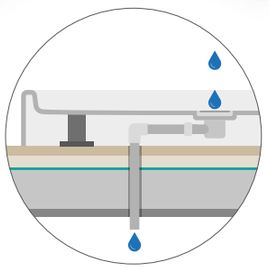
1. Start by marking out your bathroom footprint within your van.
2. Plumb in your shower tray. Fit the grey water pipe to the bottom of the tray via bottle trap (to minimise unpleasant smells) if it is being connected to a grey water tank. For further information, see *Water system - Techniques* on page 265.
3. Build the stud walls for your bathroom, ensuring there's sufficient room to mount your shower controls. You may need to drill holes through the battens for pipes.
4. Mount your shower controls on a wooden board and attach this to the stud work in the required position. The visual facade of the controls won't be attached until you have clad the inside of your bathroom.
5. Once the structure is in place, clad the interior using a thin marine ply, cutting a hole in the ply for the shower controls.

Waterproofing the structure

1. Once you've finished cladding the inside of your shower cubicle, use a waterproof tanking kit designed for a wet room to waterproof your bathroom. Start by applying the primer to all of the walls.
2. Apply the butyl tape to all corner joints and any other joins to create a watertight seal.
3. Apply two coats of the liquid waterproofing compound (included in the tanking kit) to create a flexible and watertight membrane. Apply the compound over the tape and all of the walls.
4. Start to attach the second, waterproof layer of cladding to the bathroom using a



Water hoses can pass through holes in the carcuss and connect to the mixer valve which sits in the cavity of the battens



The shower tray should be plumbed in first then structures can be built around it

suitable adhesive such as Sikaflex EBT.
5. Cut a hole in the cladding material for the shower mixer tap.
6. Seal all of the corner joints using silicone.

CHARLIE SAYS:
Even when you think something looks completely sealed, you will be amazed at how easily water can make its way through the tiniest hole and wreak havoc in your van! If you're not 100% confident you have sealed your shower adequately, add more layers of waterproofing until you're sure it's completely watertight.

Finishing the bathroom

1. If you are building a door for your bathroom, construct the frame by using a simple batten structure.
2. Clad and waterproof the door using the same method as previously explained.
3. To prevent any moisture from escaping into your van, try and create a seal between the door and the walls of the shower when the door is shut. Use a PVC trim around the door and a rubber seal to achieve this.
4. If you aren't building a conventional door, install your tambour door or shower curtain.
5. Mount any brackets needed for your shower head, and a little shelf for any shampoo and soap if you are including one. If these do not come with a seal on the back, apply silicone to ensure any holes drilled for brackets are fully waterproof.
6. Attach the visual facade of the mixer. The shower head itself and the mixer controls will not be plumbed in until *Water System - Connecting outlets* on page 271.

TIP:
You can clad the outside of your bathroom with the same material as the rest of your van, and you may want to use some leftover insulation within the stud walls of the cubicle. However, you won't do this until much later, as you need to have access to the shower plumbing when installing your water system.

Building a DIY composting toilet

The magic of building your own toilet is that you can store it pretty much anywhere you like. You can purchase solid waste and urine containers to fit the space required, and if you're storing it inside bench seating you may wish to avoid including a standard toilet seat to save space. We'll explain the most common method of housing the toilet in a standalone box, but you can adapt the method to suit your situation.

1. Measure the space where your toilet will live, and the size of your waste bucket and urine container next to each other.
2. Build a box to house the containers using one of the methods explained in *Techniques* on page 242. Your bucket and containers should be a snug fit inside the box so they won't be able to move around, but you will also need enough room to remove them and empty them regularly. Ensure it will fit into the space you plan on storing it.
3. Place your toilet seat in the middle of your box lid and draw around the inside of it to give yourself a guide.
4. Use a jigsaw to cut this portion out. We would recommend cutting slightly wide of the circle so there will be no ply visible once the toilet seat is attached.
5. If you have a router, place the urine divider upside down on a scrap piece of ply, and draw around it. Use a jigsaw to cut the hole out of the scrap piece of ply. Place this onto your lid and clamp it in place to act as a guide for the router. Set the router to the depth of the separator and use it to remove a few millimetres from the thickness of the ply. The urine separator will then be able to sit in this recess.
6. If you don't have a router, you can simply screw the separator into the base of the lid. Screw through the plastic separator into the lid, ensuring you use screws long enough to pass through the separator and into the lid, but that won't protrude out the other side.
7. If you want to paint the box or protect it with a varnish, do this now.
8. Attach the box lid to the box using hinges, allowing you to open it and empty the buckets when needed. See *Hinges, struts and hardware* on page 186 to help you decide what type of hinge to use.
9. Attach your toilet seat if you have one using the supplied brackets.
10. Use a hole saw to cut a hole in the lid of the urine container. This should be the same diameter as the pipe you're using. Sand the edges of the hole to ensure they won't snag on the pipe.
11. Place the containers into the box. Cut a length of flexible pond pipe to connect the urine separator to the urine container. Make sure the pipe extends into the container to avoid the chance of any leaks! Once you have cut this, attach it to the urine separator using a jubilee clip and post it into the hole on the urine container lid.
12. Line your bucket with a compostable bin liner and fill it with your composting bulking material. You're ready to use your toilet!

TIP:
Use a mixture of organic bulking material such as coconut coir or sawdust with peat moss at roughly a 3:2 ratio (sawdust or coir:peat moss). The bulking material dries out the contents of the waste bucket whilst the peat moss neutralises odours. Remember to keep a container with some of your bulking material next to the toilet, as a little material should be added each time you use the toilet.

Boot space

Before you start installing your water and gas systems, finish off any layout construction by completing your boot space if you have one. You can install drawers, dividers, hooks... anything that will make storing all of your belongings as easy as possible. You could even include a slide-out floor to utilise every corner of space. This could be achieved using the same method as described in *Slide-out table on page 257*.

Water system

Tools

- Adjustable spanner
- Locking pliers
- Utility knife
- Drill and drill bits
- Hand saw
- Sandpaper
- Hand file
- Bucket & towel!
- Wire strippers
- Wire cutter
- Crimping tool

Techniques and standards

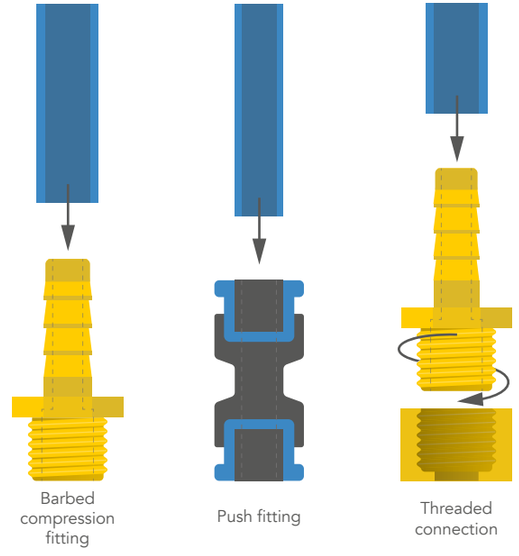
Types of fitting

Barbed compression fittings provide a reliable and easy water connection and seal. A barbed fitting is designed to be pushed onto a length of flexible hose. The hose stretches over the barb, creating the seal and a good degree of retention. Use a jubilee clip over the barb and hose connection to prevent it from ever coming loose.

Push fittings offer a quick and easy way to create a watertight connection. You simply push the tube or pipe into the fitting. As well as offering an easy connection, push fit fittings can be easily disassembled by compressing the collar and pulling the hose or pipe back out. If you are using a hot water hose with these connectors, it's important that you fit the hose with a hot water insert which is pushed into the end of the pipe to stop the hose from deforming when hot and leaking!

Threaded connections use a male and female thread to secure the two sections in place. Crucially, it does not make a waterproof seal alone. Use pipe dope (important you get the words around the right way when googling!) or pink PTFE tape to secure the connection. Simply apply a layer of dope all the way around the diameter and height of the thread, or apply three layers of pink PTFE tape in a clockwise direction over the entire thread. Apply the PTFE tape in a clockwise direction, as the connecting nut will be wound on in the same way and this prevents the tape from puckering. Tighten the connection as much as possible to create a strong seal.

Only use pipe dope or pink PTFE tape for water connections on fittings where there is no sealing component such as an o-ring, olive or a gasket. If you use a sealant on a thread that isn't providing the primary seal, it may stop the nut from reaching its intended sealing position which can create a leak.



Barbed compression fitting

Push fitting

Threaded connection

OPPOSITE Our Belfast sink was one of our few extravagances, weighing almost 30kg! *@climbingvan*

Thread types

For most water hose connections, you will be working with either BSP (British Standard Pipe) or NPT (National Pipe Thread). The two can't be connected to one another because the threads are incompatible.

BSP

To add further complication, as well as many sizes to choose from for BSP connections, there are also tapered (BSPT) and parallel (BSPP) versions. Thankfully, a male BSPT (tapered) fitting will seal happily onto a female BSPP (parallel) and vice versa. The difference is the thread engagement increases progressively from front to rear and sealing occurs towards the end (rear) of the male thread.

If a parallel male is inserted into a tapered female, the sealing point occurs at the front (start) of the male thread, and all the threads behind it have progressively less and less engagement, making a leak more likely.

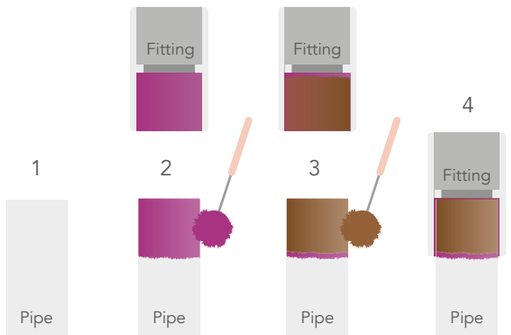
NPT

It's also possible you end up purchasing products that require NPT thread fittings, an American standard thread. It may also be referred to as MPT, MNPT or NPT (M) for male external threads and FPT, FNPT or NPT(F) for female internal threads. A thread sealant must always be used to achieve a leak-free seal.

Solvent welding

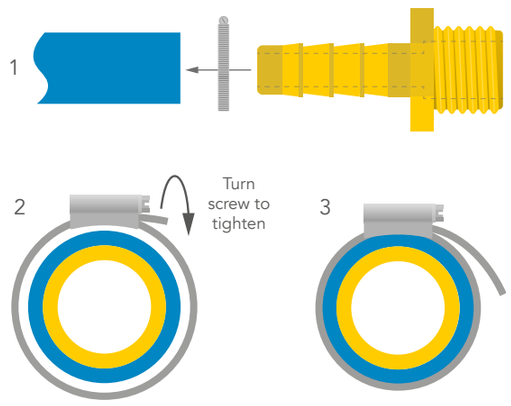
If you are using domestic taps or shower trays in your build, you will need to use PVC pipe connectors and fittings to channel waste-water out of your van or into your grey water tank. Thankfully the welding element is not as tricky as it might sound!

1. Cut the pipe to size and clean the edge.
2. Paint the pipe with a primer on both the inside of the fitting and outside of the pipe.
3. Leave it to dry for at least five minutes before painting solvent weld or cement on to both connecting faces.
4. Insert the pipe into the connector until it bottoms out. Once in this position, turn the pipe slightly to spread the cement and create a reliable connection.



Jubilee clips

Jubilee clips are used in both water and gas connections where hoses are pressed onto barbed compression fittings to prevent the connection from pulling apart. The barbed compression fitting should provide sufficient sealing performance, however the addition of a jubilee clip will improve the seal quality and prevent it from being accidentally dislodged.



1. Slide the jubilee clip over the hose in its fully open state followed by the connector you want to join.
2. Slide the jubilee clip over the covered barb and hose and start to tighten the barrel with a screwdriver.
3. Continue to turn the barrel of the clip until it tightly clamps around the hose.

Connecting inlets and outlets to the tank

Basic water tanks

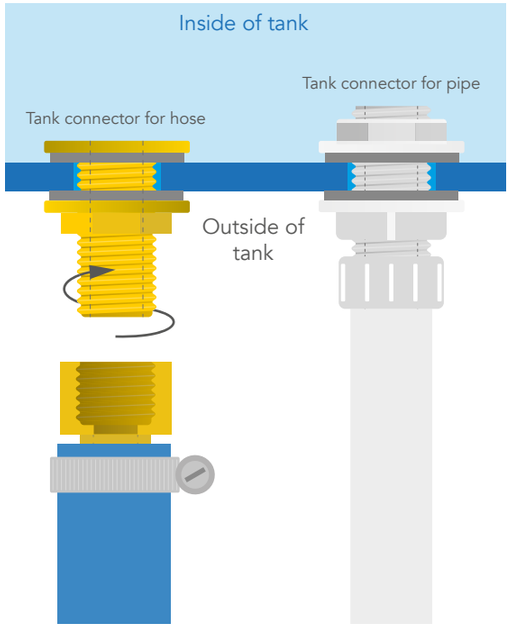
If you intend to use a jerry can for your water tank, you won't need to complete this step. Most jerry cans used for this purpose come with an outlet in the cap, which you can insert a hose into.

Integrated tanks

Whether you are fitting an internal or external water tank, it's easiest to fit any tank connections before it's fixed to the vehicle. If you got lucky and bought a tank with pre-fitted brass inlets and outlets, you can skip to the next section.

This describes the process of cutting holes and sealing connections, but you will need to work out the hole size needed for your connection as there are too many options to try and summarise effectively. If you're unsure about the hole size you're cutting, try making a hole in some scrap material first to check the fit.

1. Start by defining where your tank connections need to go. You don't necessarily need to install the outlets in predefined positions, the tank connections simply need to sit on a flat surface in order to effectively seal.
2. Install the inlet connector on the top face of the tank, and the outlet either on the bottom face or on a side near the bottom face. Cut the hole with a hole saw to ensure a consistent size, using some sandpaper after cutting to clean the edge of the hole.
3. Install any float switches or water level sensors you might be including now.
4. Once all of your holes are cut, thoroughly clean the inside of the tank to remove any plastic residue or dust from sanding. If this is left in the water tank it can block or damage the pump, or even deposit microplastics out of your tap! A vacuum cleaner with a flexible head works well to collect the majority of the plastic but use a damp cloth to collect any remaining debris.
5. Once the tank is clean, install the tank connectors. These typically use a rubber washer and a threaded top hat fitting on the inside of the tank, and a nut and washer on the outside. If you have plastic fittings, be careful not to overtighten the nut as you may damage the thread.



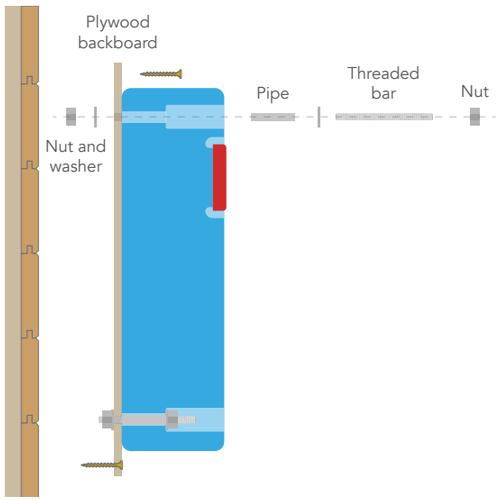
TIP:
Consider making all of your connections visible and accessible once installed so you can check them periodically, ensuring you don't fall foul of a slow leak filling your van with water.

Mounting the water tank

Internal tanks

If you have opted for a jerry can setup, either use simple ratchet straps or build a simple wooden structure to hold the can in place. Many internal water tanks can also be mounted in a similar way, but Fiamma water tanks are typically provided with threaded bars, spacers, nuts and washers. To mount one of these:

1. Create a backboard for the tank out of 9mm ply. The backboard should be roughly 50mm bigger than the tank, allowing you to screw the board and tank to the floor or walls of your van. If you are mounting your pump and accumulator in this area leave extra space on one side of your backboard so you can mount the components.
2. Drill four clearance holes in the backboard for the threaded bars to pass through inline with the tank mounts.
3. Mount the tank to the backboard by screwing the threaded bars into a large washer and nut on the other side of the backboard.
4. Once the tank is positioned on the backboard, screw it into place with washers and nuts.



External tanks

External tanks are often fitted in a similar way to the Fiamma tanks, and typically utilise one of two methods.

Threaded bar

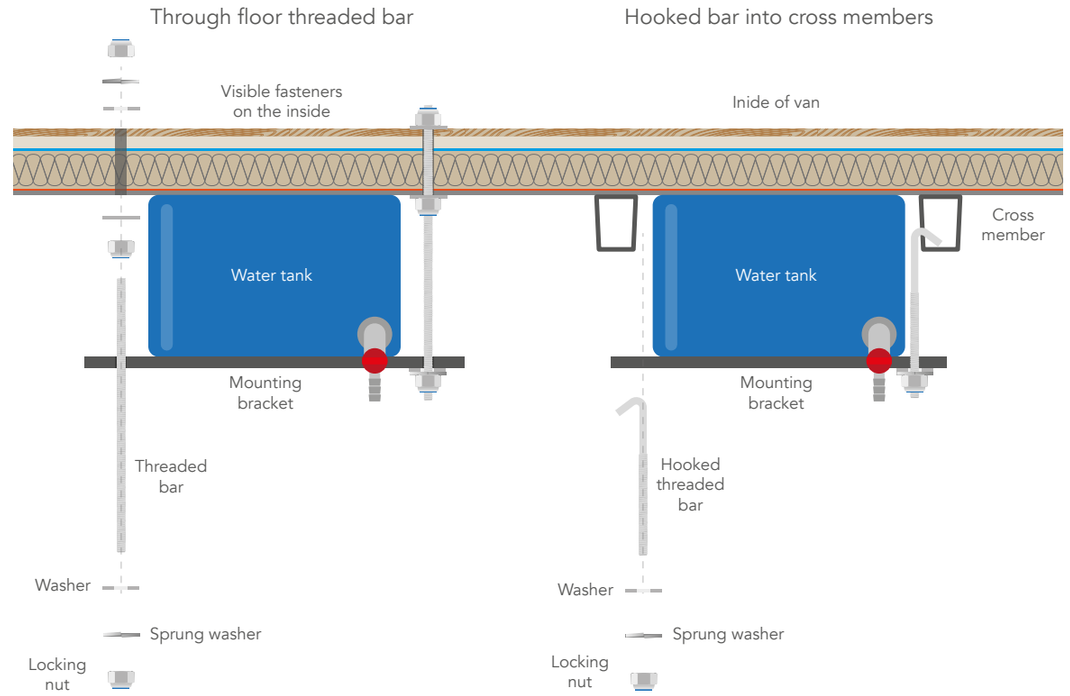
1. Use the tank mounting brackets to mark hole locations on the underside of the van and double check where they will appear on the inside.
2. Drill clearance holes through the internal floor, insulation and floor of the van.
3. Secure the bars with washers and nuts onto the floor from inside the van. Use locking nuts and thread lock adhesive on both the internal and external connections to ensure they don't vibrate loose.
4. Lift the tank and wedge it into position (hopefully not using yourself!) from below the van.
5. Screw up the nuts from below the van to secure the tank in place.

Hooked bar

1. Mark four holes in the cross members (metal beams) beneath the van. The holes should sit halfway up the cross member to create enough space to hook the bar in and fully pass through the hole.
2. Drill holes in the sides of the cross members.
3. Slot the bars into the van's cross members.
4. The tank can then be suspended from these points using the mounting bracket provided and a combination of locking nuts and thread lock adhesive.

TIP:

Use this method if you've purchased a tank specifically designed for your vehicle, so the width of the tank can sit snugly between the chassis beams.



Installing and connecting the fill point

If you haven't already, you will need to install your water fill point, either on an existing internal structure, or mounted on the underside of your van. If you have an underslung tank, position your fill point as low as possible. This will make refilling easier, as you won't have to lift 20kg+ of water above your waist! If you have an internal tank, ensure that your fill point is at least 150mm above your tank inlet so you have sufficient height drop for water to flow.

1. Drill a clearance hole with a hole saw into the surface you will mount your inlet to.
2. Water fill points are typically made up of a rear mounting bracket that screws into the front of the inlet. Place these either side of the hole and sandwich the ply or material it's being attached to between the two halves of the fill point.
3. If you have an underslung tank, the water fill and waste points are usually bolted to the chassis or lowest point of the bodywork. Simply drill clearance holes, insert the bolts, and securely tighten the locking nuts.
4. Use a length of hose to connect the water fill point to the tank.
5. Connect it to the barbed compression fittings with a jubilee clip at both ends to stop the pipe from sliding off or leaking. When you are driving around, water will inevitably slosh back up the inlet pipe and around the transition of the pipe into the tank, so this connection should be sealed to prevent it from leaking.

TIP:

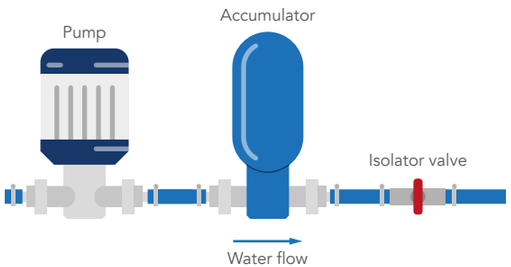
It's important to remember the water system shouldn't be completely sealed. There should be a small breather hole in your system which is typically present on the inlet, so look for a small plug which may need removing before use. This will ensure you don't create a vacuum in your water tank as the pump draws water.

Installing and connecting the water pump and accumulator

1. Ensure the surface you will mount the pump and accumulator on is flat and well secured. Mark out the position of both (water pump closest to tank, then accumulator).
2. Attach the water pump to your ply or cladding, using vibration dampening mounting feet.
3. Attach the accumulator next to the water pump.
4. Connect the hose from the tank to the water pump. Use jubilee clips to secure the hose over the barbed compression fittings.
5. Connect the pump to the accumulator via a short length of hose, using a jubilee clip at either end.
6. Connect an isolating valve directly after your accumulator so you can isolate the water supply if necessary.

TIP:

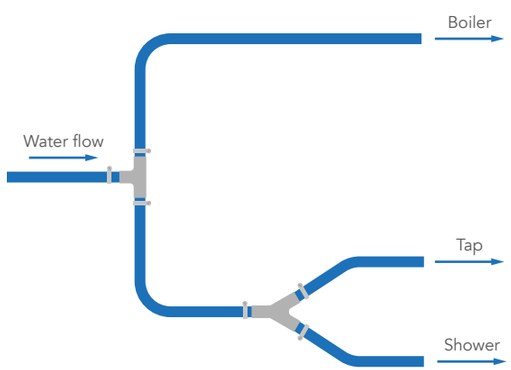
Most water systems use a food-grade water hose which tends to be attached to connectors and appliances with barbed connectors and jubilee clips. The barbed connection should be stiff and hard to push into position. If you can easily push the barb into the hose, you may have the wrong sized fitting, as unfortunately there are lots of wrongly sized connectors floating around online. The barb alone should be sufficient to create a watertight seal, but the addition of a jubilee clip at each connection makes the connection more robust.



ABOVE We originally planned to house our water tank in the corner space of our kitchen, but changed our minds and moved it into our boot space for easier access. *@climbingvan* **OPPOSITE** It's a good idea to place all of your appliances and outlets in their final position as early as you can to check they all fit. *@city2_vanlife*

Connecting outlets

1. After the isolating valve, if you are only installing a cold water tap, split the single cold water feed with a Y or T shaped connector. This will allow you to connect the hose to both the cold and redundant hot Flexi tail pipes leading to the tap. If you don't do this, water will leak from the redundant hot Flexi tail. The other option is to use a threaded blanking cap on the redundant hot Flexi tail.
2. If you're using a domestic tap, you will most likely need to use a barbed connector that steps to a BSP thread size which can then be screwed into the European Flexi tail connectors. These connections don't tend to have an inbuilt seal and require you to use pink PTFE to prevent the connection from leaking.
3. If you are installing a sink and a boiler for a shower, use a Y or T piece connector to split the supply. Use another Y or T piece connector on one of the pipes to create three cold water supply pipes - one to supply the boiler, one to supply cold water to the sink, and one to supply cold water to the shower.
4. If you are installing an outdoor tankless water heater, you only need to split the pipe once to create two cold water supplies.



Installing a boiler or tankless water heater

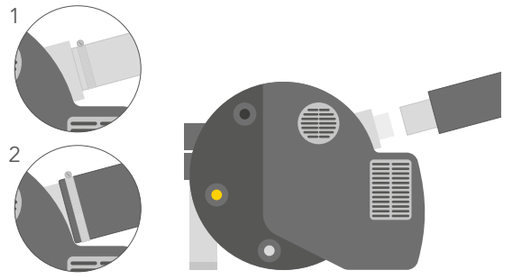
There are a number of different boilers and tankless water heaters available to install in your campervan. Despite physical boilers being fairly complex and expensive bits of kit, there are typically only a few inputs and outputs that you need to connect. Many of these boilers will be installed in a similar fashion, needing a water and gas inlet and a water outlet, as well as a flue outlet and electrical connections.

We'll cover the two most common hot water systems, but you should still consult the installation instructions for further detail. If you are installing another type of boiler, you should consult the installation manual provided with the boiler. As your gas system is not yet installed, refer to *Connecting a boiler or tankless water heater* on page 289 to finish the installation and check the system.

Truma Combi 4

Connecting the flue

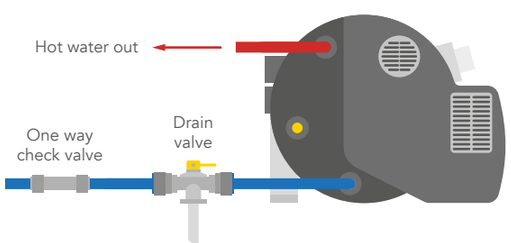
1. Mount the unit in the desired position. On one side of the boiler, there are three connection points - a hot water outlet on the top of the boiler, a cold water inlet at the bottom of the boiler, and a gas inlet in the middle of the boiler. On the opposing side are four hot air outlet ducts and the back of the boiler is where the flue outlet and the electrical connections are found.
2. The Truma Combi 4 uses a concentric flue. This has an inner and outer flue duct that both mount to the same flue outlet on the boiler. The outer flue duct draws air into the system, and the inner duct expels exhaust gases. Connect the flue ducts to the outlet on the boiler using jubilee clips, starting with the inner flue.
3. Attach it at the other end to the flue which you should have fitted near the beginning of your build.



Connecting the cold water inlet

The boiler uses push fittings for its water connections. Refer to *Techniques* on page 264 for detailed information on how to use these types of fittings.

1. To connect the boiler to your cold water supply, join a length of 12mm blue LDPE tube to the boiler using the supplied blue elbow connector, via a one-way check valve and a drain valve.
2. Connect a length of plastic tubing to the safety drain valve.
3. Drill an 18mm hole in the van floor where the safety drain valve will be mounted, so the plastic tubing can go straight out of the hole. Drill a pilot hole from the underside of the van, and then drill out the hole from inside the van using a small hole saw.
4. Mount the safety drain valve in place by using a couple of small screws, and seal the hole with Sikaflex 292i sealant or silicone sealant to stop air infiltration.
5. Connect the boiler to the cold water supply via the check valve and the safety drain valve using the push connectors supplied.



Connecting the hot water outlet

1. Connect the supplied red elbow connector to the boiler. This connector has a discharge pipe connected to it which ensures any air in the system is released.
2. Use a length of clear plastic tubing to connect to the discharge pipe. You will need to drill another hole in the floor of your van for this pipe.
3. Connect a length of 12mm red LDPE pipe to your boiler via the elbow connector.
4. If you are feeding both a sink and a shower, use a Y or T piece connector to split the hot water feed to supply both the sink and the shower.
5. To connect the hot water supply to the sink and shower, use a push-fit to BSP threaded connector which can be screwed into the European flexi tail connector using pink PTFE tape. Make sure you use a hot water pipe insert to prevent the pipe from deforming and leaking.

Connecting the hot air outlets

1. The Truma Combi 4 has four hot air outlets that can supply your campervan with hot air via flexible ducting. The top outlets supply slightly warmer air than the bottom outlets. This means the air outlets in your van mounted furthest from the boiler should be connected to the top outlets to ensure an even distribution of heat.
2. Connect the flexible ducting to the boiler by pushing it into the outlet. The outlet contains a metal clip that acts as a barb to hold the ducting in place. Place a small screw through the designated hole to provide further retention.
3. Run the ducting to the desired output points in your campervan. The flexible ducting can bend around a relatively tight radius, but if you need to achieve a more drastic change in direction, use an L connector for a 90 degree bend.

4. Fit an air outlet vent wherever you require a hot air outlet. These can be fitted to locations such as at the bottom of bench seats or underneath kitchen cupboards.
5. Use a hole saw to cut a hole to fit the outlet vent, and then connect the outlet vent to the flexible ducting.

Connecting the boiler electrics

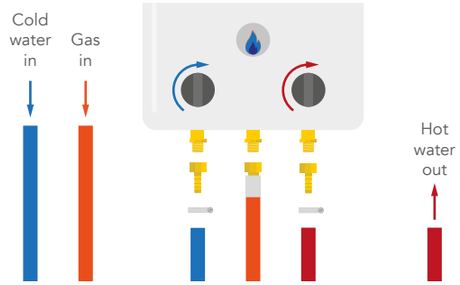
1. You should have already mounted the LCD display for the boiler to your electrical control panel, so you can now connect it to using the supplied comms cable.
2. Mount the room temperature sensor somewhere in your van at eye level where it can sense the average temperature of the room. This can also be connected to the boiler using the supplied cable.
3. Connect the boiler to your 12V fuse box.

As you haven't yet installed your gas system, the gas connection can't be made.

Tankless water heater

1. Mount the unit in the required position. It's important to mount it near a door, as these types of boilers are intended for outdoor use only.
2. The water heater will typically include a mounting bracket or hook so you can place it outside during use. Connect this bracket to your door so you can mount the unit to the door whilst showering.
3. Most tankless water heaters have an ignition powered by a battery which means you don't need to connect them to your 12V electrical system. Simply insert the correct sized battery into the heater.
4. Connect the unit to the cold water supply. Typically this will use a threaded connection.

You won't be able to connect the gas supply until you have installed your gas system in the next section.



Installing waste pipes and connecting to a grey water tank

Waste water pipes are typically made from PVC tubing and match domestic waste connection thread sizes. This allows the waste water to exit quickly and provide sufficient capacity if several appliances are running into the same pipe at the same time. The other advantage of using larger pipe sizes for the waste pipe is that they are less likely to become blocked from food and other lumps of debris.

Most domestic waste pipes will either be 32 or 40mm and can be connected to elbows and other connectors using the solvent welding or cementing process which has been described in the techniques at the start of this section.

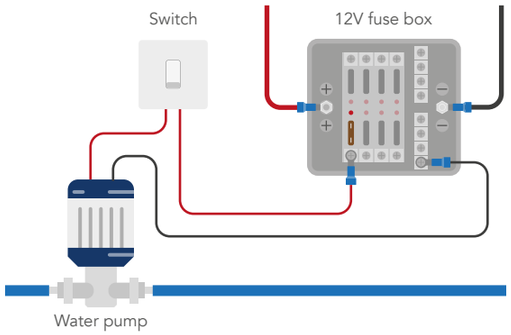
If you are installing a waste water tank, you will need a bottle trap on the outlet of each water appliance that connects to the waste water tank to prevent smells from entering the van. The bottle trap holds a column of water in the pipe and creates a water seal to block any smells, but this isn't necessary if you're simply ducting water outside of the van.

CHARLIE SAYS:
Some good friends of ours who had been intermittently living in their van for 10 years recently discovered an unpleasant smell coming from their kitchen, and on further inspection found the floor surrounding their wooden units was waterlogged and rather smelly. The cause of the problem was a short waste water pipe which would normally protrude just out of the underside of the van, but had somehow been pushed up into the van and was subsequently soaking the inside of the van with grey water!

Connecting water electrics

Connecting the water pump

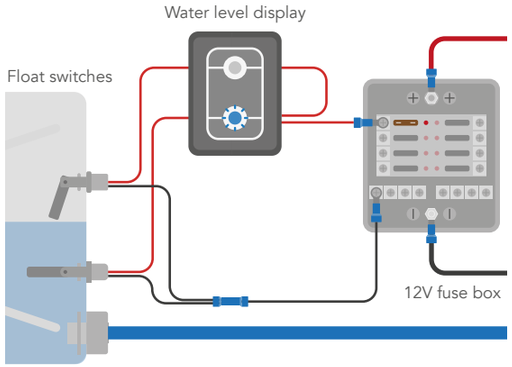
1. To power your water pump, connect it to the 12V fuse box via a switch with the correct gauge cable.
2. Insert an adequately sized fuse into the fuse box. You should now be able to turn the water pump switch on and hear your water pump running.



Connecting water level sensors

A water level sensor is essentially a switch. When the water is below the sensor the switch is off, and when the water is above the sensor the switch is on.

1. Connect each water level sensor to your 12V fuse box via an LED. These can be wired in parallel so that you can connect them to a single fuse in your fuse box.
2. Once you have connected the float switches and the LEDs to the fuse box, insert the correct size fuse for the sensor and LED.



Leak testing your water system

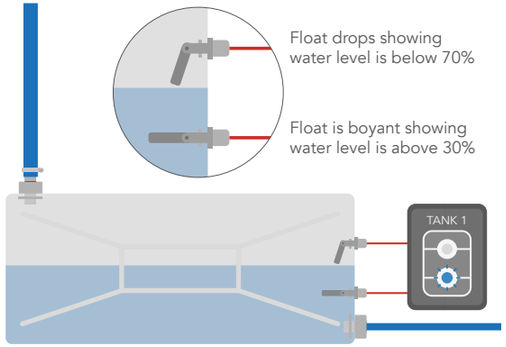
Before you start leak testing your water system, you should ensure you have a few towels and a small bucket to hand, just in case everything gets a bit soggy!

1. Ensure all connections are tight and there are no obvious points for leaks to form.
2. Introduce approximately five litres of water into the tank with the pump and any check valves turned off.
3. Check the tank connections for leaks using a sheet of paper kitchen towel to highlight any slow or small leaks.
4. Turn the pump on but with any subsequent isolation valves and taps turned off.
5. Gradually introduce additional sections of the system by turning on isolation valves and taps one at a time, using the paper towel method to detect any small leaks.
6. Check the waste water connections are sealed and exit the van as intended.
7. Leave each tap running on full flow and check your connections again.

If you encounter a leak and tightening the connection doesn't resolve it, you may need to apply more pink PTFE tape to the threaded connection. To do this, turn the pump off and leave the tap running to drain the system. Next, armed with a towel and bucket, unscrew

the faulty connection and reapply the pink PTFE tape, then tighten the connection and try testing the system again.

NOTE:
If you are installing a boiler, you won't be able to leak test this aspect of the system until the gas system has been installed.



Gas and heating

The following guidance has been established from the BS EN 1949: 2011 +A1: 2013 which details the 'Specification for the installation of LPG systems for habitation purposes in leisure accommodation vehicles and accommodation purposes in other vehicles' (it doesn't get any easier to say the second time around!).

Installing the gas system following these guidelines should provide the foundation to ensure the process is safe, providing you consider yourself competent to complete the work. If you do complete the installation yourself, it needs to be checked by a Gas Safe registered engineer before the system is commissioned. Many insurers will request a Gas Safe certificate in order to insure your campervan for 'gas and explosion cover'.

SAFETY WARNING
Gas is dangerous and can cause harm to yourself and others. If a gas leak goes unnoticed, it can cause carbon monoxide poisoning and kill you. LPG is a highly flammable substance so there are many possible hazards, including fire and explosion. It is therefore imperative your system is either installed by or checked by a Gas Safe engineer before it is commissioned.

Remember:
- A drop out vent should be installed at every gas connection.
- If you are installing an internal gas tank, this must be stored within a metal-lined box.
- Your system should be fully checked using a device such as a manometer before adding any gas to the system to ensure that it is fully sealed.
- A carbon monoxide alarm should be fitted in your van if a gas system is present.
- Your system should be installed or checked by a Gas Safe engineer before the system is commissioned.

Tools

- Adjustable spanner
- Locking pliers
- Pipe cutter
- Pipe bender
- Utility knife
- Drill and drill bits
- Hole saw
- Sandpaper
- Hand file
- Wire strippers
- Wire cutter
- Crimping tool

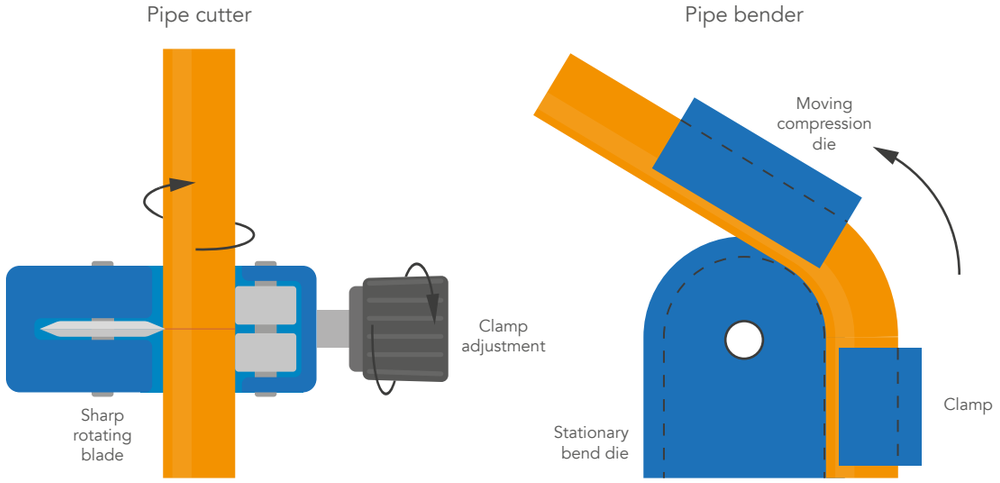
Techniques

We won't cover soldering, brazing or other welding techniques as these are fairly specialised, and are unlikely to be used by a self converter unless they have prior experience using them.

Cutting and preparing pipe

We would strongly recommend using a pipe cutting tool to make all copper pipe cuts. They are inexpensive and easy to use, but crucially allow you to create a very clean cut without

OPPOSITE Ah, the old LPG tank wrestle! To even begin the fight, we had to drive our van up a high curb so Dale could fit underneath for his round with the tank. Luckily, Tom came prepared with a wheeled mechanics seat to make the fight a little easier. *@ittakesajourney*



damaging or denting the pipe. If the copper pipe is dented near the olive or seal location, this can very easily cause a gas leak.

1. Place the pipe inside the pipe cutter.
2. Rotate the adjusting wheel to pass the cutter over the diameter of the pipe, and slowly tighten it until you make contact with the pipe.
3. Once contact is made, rotate the cutter around the pipe, gradually applying more pressure each time you complete a lap. The aim is not to tighten the cutter so much that it's difficult to turn, the blade wheel is sharp enough to make a clean cut with just small incremental amounts of pressure.

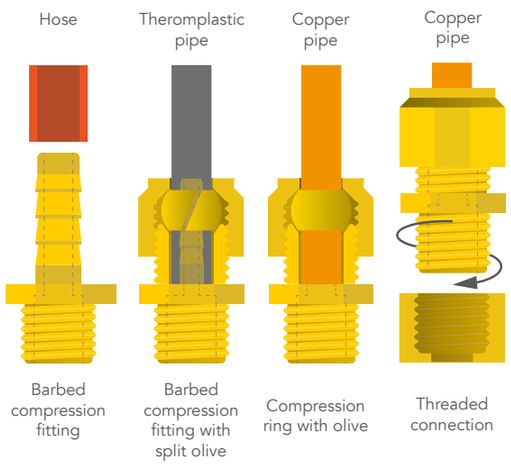
If you are using a plastic-coated pipe, you can also use the cutter to remove the layer of plastic that sits around the pipe, but be careful not to cut into the copper when you finish your cut.

Pipe bending

If you are using a malleable tube you can make very gentle changes to the shape by hand, but anything more than this should be done with a pipe bender, as this will prevent distortion or damage to the pipe. Without using a pipe bender to create a tighter angle, it's very easy to damage the pipe and cause a gas leak. The most common type of pipe bender is mechanical and uses a lever to bend the pipe around a u-shaped former. This protects the sides of the pipe from deforming.

Barbed compression fittings

Barbed compression fittings are less common in gas systems, but some portable stoves still use them. They are fitted in the same way as barbed water fittings, so please reference *Techniques on page 264* if required.

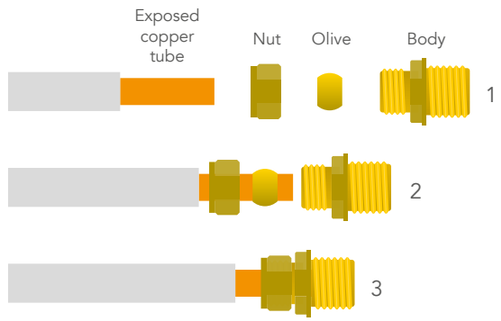


If you are using thermoplastic pipe anywhere in your system, you may find you need to use a hybrid connection method consisting of a barbed connection, a split olive and a sealing nut. The olive and nut substitute the need for a jubilee clip and help to achieve greater sealing forces, which is important with stiffer thermoplastic pipes.

Compression ring fittings

Compression ring fittings are available for both metric and imperial pipe sizes and provide a reliable and relatively easy installation process.

1. Cut the copper pipe to length and strip back a few centimetres of any plastic coating to leave the exposed copper pipe.
2. Insert the nut onto the copper pipe with the thread facing the cut end of the pipe. Push the olive onto the pipe until it nests with the nut.
3. Place the body of the fitting onto the end of the pipe. Screw the nut and olive onto the fitting using a pair of adjustable spanners on both the fitting and the nut.



You shouldn't use any PTFE tape with compression ring fittings, but you should make sure you fully insert the pipe into the fitting and tighten the connection securely. For a belt and braces approach, apply a jointing compound around the outside of the olive before assembling and tightening the connection.

Threaded joints

Gas connections require you to use yellow PTFE tape, as this has double the density of commonly used white PTFE tape. Due to the increased density, you may only need to apply one or two layers of tape around the diameter and up the height of the thread. Do not use PTFE tape on threads where olives or other primary seals are present, as this can interfere with the seal on the olive and cause a gas leak. It's equally important to avoid overtightening olives as they can get crushed and leak.

Thread types

Another industry equals another confusing set of thread types to get your head around!

UNF and UNC

Unified National threads come in both fine (UNF) and course (UNC) versions, and are often used for gas tank connections but are unlikely to be used elsewhere in your build. You should ensure you have a compatible hose to connect with your tank.

SAE

An SAE is a straight thread with an o-ring attached to it. These are often used on gas tank connections as they use parallel threads and seal using an o-ring. This is a highly reliable and reusable thread type. While some thread types require the threads of the male and female end to press together to form a seal, in the case of SAE the o-ring creates the seal.

BSP and NPT

For most copper pipe connections BSP or NPT threads are used, and as mentioned in the water section, they aren't compatible with one another due to their threads being different.

DALE SAYS:

Pipe and thread sizes do refer to physical dimensions, but the plumbing and gas industry standard for the sizes of pipe is not

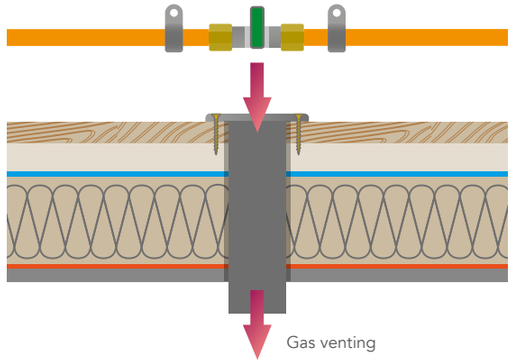
always as straightforward as just physically measuring the pipe. Measuring the pipe will be misleading, and may cause you to choose the wrong pipe or thread size. You should refer to the manufacturer details about an individual product to check the connector size needed rather than measuring the physical product. Lookup tables are available to translate physical measurements into actual connector sizes.

Installing drop out vents

As mentioned previously, every internal gas connection requires a drop out vent. If you have a cluster of connections in a small area, a single 50mm drop out vent should be sufficient. The vents need to sit at the lowest point around the connection as propane gas sinks to the lowest point, much like water.

It's not advisable to position any drop out vents immediately next to or on wheel arches as they will be liable to water spray entering the van from the tyres. Even if your drop out vents are positioned away from the wheel arches the surrounding area may still get wet in damp conditions, so it's important that you protect any newly exposed metal with Hammerite paint to stop it from rusting.

1. Before you start drilling holes, double-check the area on the underside of the vehicle to ensure you're not going to drill into something important, or hit a deep section of the chassis. It may, in some instances, be easier to drill from the underside first, depending on which side is most congested.
2. Drill a pilot hole through the full depth of the floor so you have a reference point on both sides of the floor.
3. Use a hole saw (normally a 55mm hole) to cut through both the internal floor and metal skin of the van.
4. Most hole saws will only allow you to cut a few centimetres deep before they won't cut any further, so once you have drilled from both sides, excavate any remaining insulation with a knife.
5. File the edges of the hole and paint it with anti-rust paint.
6. Insert the dropout vent from the inside out, and screw it in place using the screw holes around the top.



Mounting the gas tank

Internal gas tanks

If you're going to mount your gas tank on the inside of your vehicle, you will need to install it in a metal-lined box. As propane gas is a dense fuel that is 50% heavier than atmospheric air at sea level, in the case of a gas leak it will sink to the lowest point of the van. Dropout vents are required where you install your gas tank to ensure in the case of a leak, gas doesn't build up in your vehicle.

There are a few critical elements to include if you are building a gas locker yourself, as referenced in the design chapter. Whilst some people choose to build their own gas lockers, we'd strongly recommend buying one and saving yourself the hassle of constructing one.

1. If you have bought a pre-built locker, simply mount the locker inside your van in the desired position.
2. Install a dropout vent through both the locker and the floor of your van. Refer to *Techniques on page 279* for how to do this.
3. Once the locker has been mounted in position, fit the gas tank inside the locker and mount it securely using cylinder straps and a wall bracket.

Underslung gas tanks

Where to mount your tank

Deciding where to mount your tank is very much on a case by case basis, as the chassis construction of each vehicle is different and pre-installed water tanks may also impact your decision. Generally speaking, rear or four-wheel drive vehicles tend to have more lengthways structural members, and this tends to mean there's more space at the edges of the van near the sills to mount a tank.

Front-wheel drive vehicles however, don't need a rear drive-shaft as the front wheels do all the work, and consequently, manufacturers tend to position structural members across the width of the van meaning you have more horizontal space to play with. Many modern front-wheel drive vans will position the exhaust in the centre of the van to keep it safe from uneven terrain, so fitting your tank behind the exhaust may be a sensible location. Ideally, you want to mount your tank as high as possible so it's not visible from the outside or at risk of being damaged when driving over uneven ground.

Mounting methods

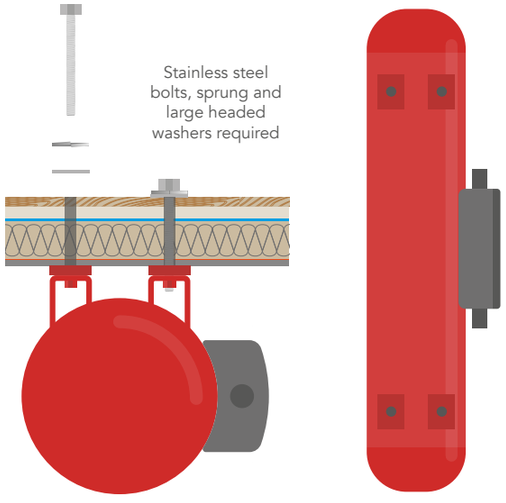
Once you know where you will be mounting your tank, you will need to decide whether to do so by drilling holes through the floor of the van or by using cross member brackets. This will very much depend on what's located above the tank and inside the vehicle. If it's below a seat or in the boot, through floor brackets should work well; however, if your tank sits below a visual area inside your van, you may need to use cross member brackets.

Through floor mounting

1. Using the same spacing as the holes on the gas tank for guidance, drill four holes all the way through the floor of the van.
2. Use long stainless steel bolts and large-headed washers to connect to the captive nuts on the gas tank. Remember to take your time marking out the hole positions and spacing, and ensure you're confident that you aren't going to drill into anything important on the inside of the vehicle! Check the size and length of bolts required for your tank, but typically many manufacturers use M10 stainless steel bolts for this application.
3. The real fun and games start when you try to connect your tank, as you not only need to wrestle it into position under the van, jack it into position and align it, but also screw it in from the inside!

TIP:

You're best asking for some help at this point. Otherwise, you will need to come up with an elaborate scheme to hold your tank exactly in position, allowing you to wriggle out and screw it into place from the inside.



Cross-member brackets

1. Fix the bracket to the predefined mounting points on the tank.
2. Bolt the four brackets through two of the vehicle's cross members.
3. Drill four holes through the cross members, allowing you to pass a bolt all the way through both sides.
4. Attach a washer, a Nyloc nut and thread lock to the nut to secure the tank in place.

TIP:
All fixtures should be stainless steel to prevent them from rusting, or at the very least you should coat them with several layers of underbody coating spray to protect them from stone chips breaking the protective layer. It's also important to use Nyloc nuts and thread lock in these applications, as the vibrations from driving around will cause normal nuts to work their way loose!

Cross-member brackets allow the cylinder to be connected to the cross members once holes have been drilled

Painting the tank

Either before or after you have mounted your tank, protect the tank and associated mounting system with a rubberised underbody coating spray, even if it's already painted. Stones and other debris will inevitably chip the underside of the tank, removing small amounts of paint, exposing the steel to the elements and allowing the tank to rust.

You'll notice on many modern vehicles that the underside of the van has already been coated with an underbody spray, as this allows the manufacturer to use cheaper non-stainless steel and simply apply a protective coating at the end. The underbody coating spray should be topped up once a year to provide ongoing mechanical and rust protection.

This may turn into a bit of an ordeal if you don't have access to a vehicle lift, as being flat on your back spraying something 30cm away can get really messy. It's more than possible to end up with better coverage on yourself and the driveway than the underside of the vehicle!

Connecting the pressure regulator

1. The pressure regulator should be connected directly to the gas cylinder and not via a length of pipe, as everything between the tank and the regulator is high pressure. Identify what connection type your specific regulator requires. This can vary between tank types, so make sure to check the manufacturer's guidelines.
2. If you have an underslung tank, drill an entry hole to feed your malleable copper or thermoplastic pipe from the regulator into the van. Drill a hole roughly one and a half to two times bigger than the diameter of the pipe you are using, and ensure you remove all sharp edges from the metalwork by filing the sides.
3. Secure the pipe on either side of the hole with pipe clips to prevent any movement and wear on the pipe.

TIP:
It's a good idea to secure the pipes on the underside of the van with anti-vibration clips to prevent wear or snagging on anything you drive over! You can use a small amount of expanding foam or another packing material to hold the pipe clear of any sharp edges if needed.

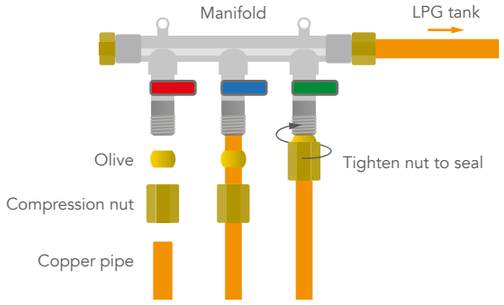
OPPOSITE Weighing in at 80 pounds, this 100L LPG tank is a monster! It's Sam's turn in the ring to wrestle with this beast. Ding, ding, ding! *@thedixietribe*

Installing the manifold

If you are simply using a gas tank connected to a single appliance, you won't require a manifold unless you want a more easily accessible on/off check valve to isolate the appliance.

Your manifold should ideally be positioned somewhere readily accessible so that you can turn off the gas supply to appliances when they're not in use, but also ideally near an existing drop out vent location to limit the need to drill additional holes in your van.

1. Mount the manifold to a static surface and screw or bolt it into position.
2. Connect the input pipe using a barbed or compression ring fitting connection.
3. Once each appliance has been installed, connect these to the manifold using the same method.



Connecting the fill point to the tank

1. With the gas fill point already installed on the side of your vehicle, connect your high-pressure hose to the rear of the inlet using the required connection method. If a tight bend is needed in the pipe, use a pipe bending tool to achieve this.
2. Fix the high-pressure pipe to a stable structure every 500mm. If you're installing an underslung fill point, you should have been supplied with a mounting bracket to bolt to the chassis.
3. Make the connection from the fill point to the tank. This will typically require an adjustable spanner to tighten an SAE thread against an o-ring to create the seal.

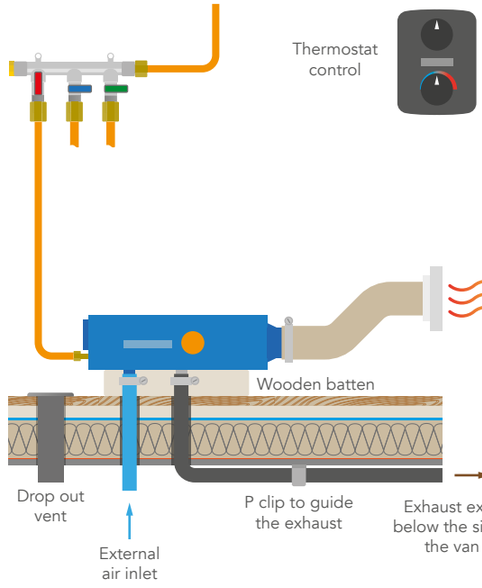
Installing a heater

There are a number of different types of heaters available to install in your campervan as previously mentioned in the planning and design chapters of the book. Most of these heaters only have a few inputs and outputs you need to connect. Many of these will be installed in a similar fashion, needing a gas or diesel inlet, a fresh air inlet, a hot air outlet, an exhaust outlet and electrical connections. We'll cover two of the most common heaters, the Propex HS2000 LPG heater and the Eberspacher Airtronic diesel heater, but you should still consult the installation manual provided with the unit for further information. If you are installing another type of heater, refer to the installation instructions provided with the heater.

Propex HS2000 LPG heater

Mounting the heater and making connections

1. Identify where the heater will be positioned and mark the air inlet and exhaust pipe locations so you can drill holes through the floor of the van. The heater unit needs to maintain a gap of at least 25mm on all sides from any other objects, and also needs to be positioned clear of any important areas below the vehicle.
2. Drill holes in the floor of the van for the fresh air inlet and exhaust pipes. Firstly, drill a pilot hole for each pipe, and then use a 40mm hole saw to increase the diameter of the holes.
3. File the edge of the holes and paint them with anti-rust paint.
4. The heater will be supplied with a 22mm stainless steel hose for the exhaust and a length of black pipe for the fresh air inlet. Feed these through the holes in the van, and connect them to the spigots on the underside of the heater using the blue connector and hose clips provided. The exhaust spigot is grey and the fresh air inlet spigot is blue.
5. Screw two wooden battens into the floor of the van in line with the metal brackets on the bottom of the heater.
6. Mount the heater to these wooden battens to create an offset between the heater and the floor providing access to the spigots and jubilee clips.



Fixing pipes under the van

1. Fix the end of the pipe to the underside of the vehicle using a P clip. The stainless steel hose has a special end cap which should be ducted towards the edge of the vehicle on the underside of the van.
2. Position the end of the pipes on the underside of the vehicle at least 50cm away from each other pointing in opposite directions. Position both pipes on a slight downwards slope to prevent the possibility of water pooling in them.
3. Once you have positioned the inlet and outlet pipes, seal the holes entering the van with a high-temperature red silicone along the pipe throughout the hole depth.

Connecting hot air outlets

1. Mark the point where you plan on mounting your hot air outlet and drill a pilot hole.
2. Drill out the hole with a hole saw from the visual side and fix the vent in position.
3. Attach the ducting to the heater using the hose clip provided.
4. Run the ducting to the vent and attach it to using another hose clip.
5. If you are installing more than one hot air outlet, use a Y splitter on the ducting coming out of the heater to split the ducting in two.

TIP:
You can install a maximum of three hot air outlets, providing the combined length of hot air ducting is less than 5m and the length to the first outlet is less than 1.5m.

Connecting the gas supply

1. Run a length of 8mm copper pipe from the manifold to the heater.
2. Make all connections with compression ring fittings and copper olives.
3. Secure the pipe between the heater and the manifold using P clips.

Connecting the electrics

1. Mount the thermostat in a suitable location between waist and shoulder height that's exposed to average temperatures (i.e. not above a cooker or in direct sunlight).
2. Connect it to the heater using the supplied 6 core cable.
3. Connect the thermostat to your 12V fuse box and insert a 5A fuse. Once you have connected the power supply, you can reattach the electronics cover on the heater.

NOTE:
Ensure all electrical connections are completed before connecting to the 12V power supply. It's important to connect the thermostat before the 12V power supply. If you don't, an internal fuse will blow and will need to be replaced.

Testing the heater

Before you attempt to use the heater, visually check all aspects of the installation to ensure it has been installed correctly, paying particular attention to the flue. A full gas test must be carried out, as well as a functional check of its operation. Pay particular attention to the exhaust outlet and the fresh air inlet to check that neither has been blocked or damaged.

Eberspacher Airtronic diesel heater

A diesel heater is installed in much the same way as a gas heater, but with a diesel inlet rather than an LPG inlet. Refer to the previous instructions for how to connect the inlets and outlets, but you should also refer to the specific instructions with your heater for detailed instructions in case of any small variations in installation. Next we'll explain how to mount the heater and how to install the diesel inlet.

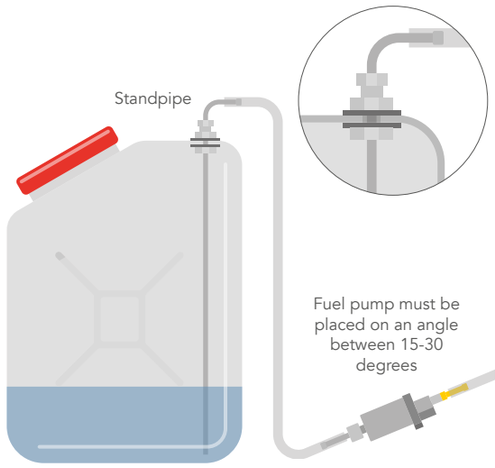
Mounting the heater

The Eberspacher heater should be mounted to the floor of the van as it comes with a rubber gasket on the base. Ensure the rubber gasket makes a seal with the floor of the van when it's fixed in place.

Installing an additional diesel tank

Before you connect your diesel inlet, you will need to decide whether to tap into your existing diesel tank or whether to install an additional, smaller diesel tank specifically for the heater. If you wish to tap into your existing diesel tank we'd recommend hiring a professional to do this for you, as it's a difficult job to perform yourself that has significant consequences if you get it wrong. We'll explain how to install an additional diesel tank if this is the option you choose for your heater fuel.

You should ensure the diesel tank you are installing is made of a material designed for storing diesel and has a one-way vent on the lid so air is able to enter the tank as the fuel level decreases. Also, make sure the lid has an opening big enough to fit your hand in so you can install a standpipe. A standpipe is a pipe which fits inside the tank and is connected to the diesel tank via a fuel line.



1. Mark out where your standpipe will be mounted by holding it against the outside of your tank and measuring around 1cm up from the bottom of the tank. Cut it to length using a pipe cutter.
2. Drill a hole in the top of your tank using an appropriately sized drill bit. This should have a snug fit with the standpipe when you insert it into the tank. Ensure the rubber o-ring is on the standpipe before you insert it into the tank. You should also remove any debris from cutting the hole before proceeding.
3. Insert your hand into the tank with the nut and from the outside, push the standpipe through the hole and the nut. Screw up the standpipe using an adjustable spanner.
4. Mount the diesel tank near a door so it's easy to refill when you are low on diesel.

Connecting the diesel inlet

1. Connect the blue fuel line supplied with the heater to the fuel pump using the connectors and clamps supplied. The fuel pump should be mounted on a 15 to 30-degree angle using the mounting bracket supplied. Check the manual supplied with your heater as to the specific angle you should mount your fuel pump at. Make sure you install the pump the right way around by locating the arrow indicated on the pump.
2. Connect the blue fuel line to the other side of your fuel pump and then run it to your diesel tank, connecting it by using a connector and the clamps provided.

Testing the heater

Visually check all aspects of the installation before attempting to run the heater to ensure it has been installed correctly.

Installing a log burner

SAFETY WARNING

If you're installing a log burner in your campervan, there are a number of important safety requirements. It's your responsibility to ensure you meet them. There isn't a regulatory standard for installing a log burner in a campervan, but there is in a marine setting, "BS 8511:2010 Code of practice for the installation of solid fuel heating and cooking appliances in a small craft" (much like the gas standards, not a catchy title!). We'd recommend adhering to this when installing your stove, and this is what we have referenced throughout this section.

Many insurers won't cover you if you decide to install a log burner, and any accidents relating to it certainly won't be covered. We have provided some general advice and considerations rather than installation instructions. If you decide to install a log burner you do so at your own risk and should follow the installation instructions provided with your log burner.

ABOVE The cosy ambience a log burner creates simply can't be beaten! Whilst this flue might not follow the boat standards, it sure is whimsical! *@jakecoleman* & *@rochelleallen*

You must ensure that you fit a smoke alarm and a carbon monoxide alarm in close proximity to the log burner, and we'd recommend finding a professional to check your installation before using it. Once in use, your chimney should be swept once a month.

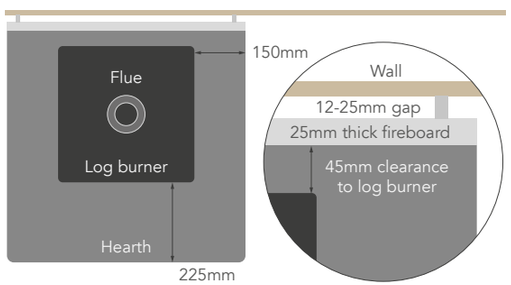
Positioning the stove

Stoves normally burn at 650°C inside, and can get up to a roasting 1,100°C! This is why it's very important to position your stove correctly. Your stove should be provided with details of the safe distance it needs to be from any combustibles. For a small log burner, this is normally around 600mm, but the addition of heat shields can reduce this.

To make your installation easier, ensure there are no combustible materials anywhere near your stove. First, build a hearth on which to position the log burner. This needs to project at least 225mm in front and 150mm to each side of the stove, and be made from a sturdy, non-flammable material. The hearth should be fixed firmly in place.

Making a heat shield

Stoves and uninsulated flue pipes can heat up enough to set fire to paint, wood and other combustibles a considerable distance away. This means that a heat shield cannot be mounted directly to a surface in your van, it must have a gap behind it. It's important to offset it from the wall a minimum of 12mm, but ideally 25mm to prevent heat transfer into the combustible wall.



One way of creating an effective heat shield is by using a 25mm thick calcium silicate fireproof panel spaced at least 12mm away from your van wall, and at least 45mm away from the back of your log burner. The fireproof panel can then be tiled or clad with a polished or painted metal. A polished metal will reflect radiant heat, whilst a painted metal will conduct the heat and dissipate it over a large surface area. The shield must extend to the hearth's edges or beyond, and at least 300mm above the top surface of the appliance. The heat shield should be bolted to the floor to fix it firmly in place.

Mounting the stove

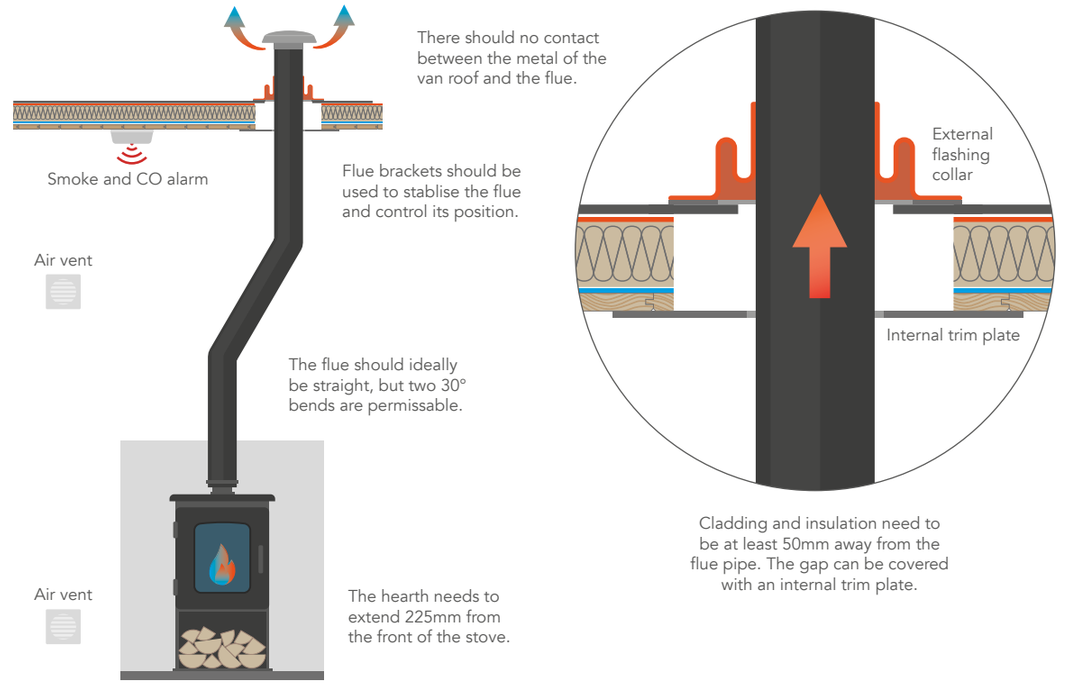
Once your heat shield is in place, you can mount your log burner to the hearth. You will need to ensure that this is bolted firmly in place.

Installing a flue

You should ensure that you're using an insulated flue. Hopefully, you followed our earlier instructions and left a gap in your cladding and insulation for your flue. If you didn't, you may need to get excavating before you can continue! The flue needs to be positioned at least three quarters its own diameter away from any unprotected combustibles, including the insulation and cladding in the ceiling. The gap can later be covered by a trim plate.

You will need to drill a small hole from the inside to define where your flue will exit on the outside of the van. When you use a hole saw to expand this, you should ensure there is a gap of at least 25mm between the flue and the metalwork of the van. This will help to isolate the flue from the panels of the van and limit any heat transfer. The flue and rain cap need to protrude as much as possible from the van roof to promote an effective air draw and expel the burnt gases effectively.

The marine standard states that a log burner flue should have an external height of 600mm. This is extremely high and can be difficult to



achieve on a van, as the taller you make your flue, the more susceptible to wind, low trees and bridges it becomes. You must ensure your flue is high enough to provide an effective air draw for your log burner.

Once you have cut the hole in the roof of your van, position the flue. On the roof of your van, push an external flashing collar over the flue. This is typically in the form of a bellowed EPDM sleeve which creates a watertight seal. Apply a bead of heat resistant silicone 20mm from the edge of the flashing base before you push the flashing onto the roof of the van. Use self-tapping screws with plastic caps every 50mm around the edge of the flashing to secure it. Apply Dicht-Fix sealant to the base of the flashing and screw heads to protect it from water ingress. The top of the flue should be capped using a chimney cowl with open sides.

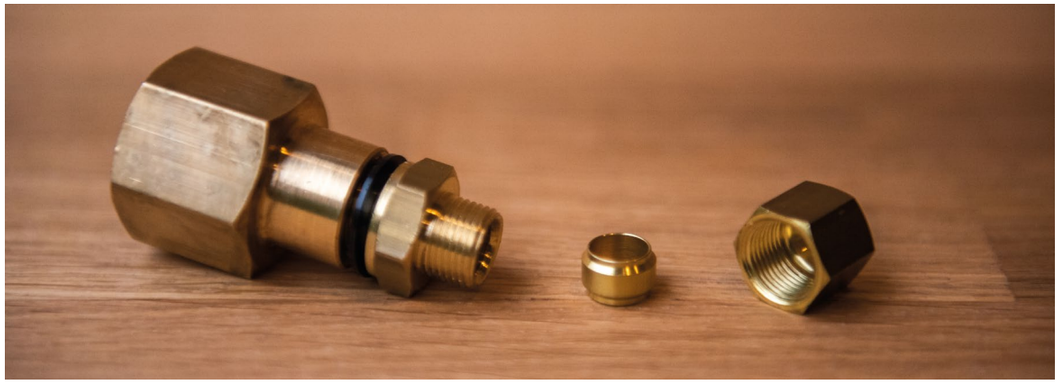
With the flue installed, connect it to the log burner using the manufacturer's specific instructions. If there is an uninsulated pipe connecting to the log burner, ensure it's at least three times its own diameter away from any combustibles, (e.g. 100mm flue pipe = 300mm from combustibles). The flue pipe should ideally be straight, but a maximum of two 30° bends are permissible.

Before lighting your first fire, ensure you have a fire extinguisher, smoke alarm, carbon monoxide alarm and adequate venting in the floors and ceiling. This is especially important as your insurance is very unlikely to cover any damage due to fire.

Connecting appliances to the manifold

Connecting the hob and oven

Now you have installed your gas system, you can connect your hob and oven. For most domestic fixed-position hobs and ovens, an NPT threaded connection will be present, but



please check the appliance first before buying the relevant connector. Some motorhome and caravan hobs and ovens use a bulkhead fitting (looks like a barbed fitting but more bulbous) or a barbed compression fitting as standard, as this allows flexible hose to be pushed over the connector and held in place with a jubilee clip.

If you are fitting an oven with a connection at the rear or in an inaccessible place when it's in its final position, use a braided cooker supply hose. To work out the hose length required, measure the distance between the appliance and the last accessible position from which a static pipe can be fixed. Add at least 100mm to the distance to allow for movement and shifting of the appliance to give you the connector length needed. Ensure the connector is neither too long nor too short, as this will encourage the hose to bend and kink. Use one of the connection methods described in *Techniques* on page 277 to connect the hose at either end.

Once everything is connected, ensure your hob or oven has LPG nozzles installed. Most domestic hobs and ovens have larger natural gas nozzle outlet holes as standard, and these require about 2.5 times less oxygen to burn than propane. To change the nozzles, simply unscrew the brass nozzles using a socket set and replace them with the more restrictive LPG nozzles. These are usually supplied with your hob or oven. If you don't do this, the outlet will deliver an uneven fuel dosage which can cause the flame to glow orange indicating the presence of carbon monoxide!

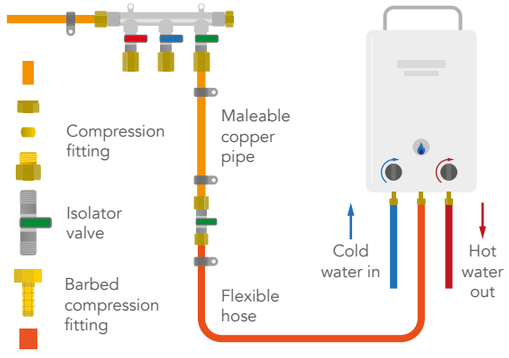
Connecting a boiler or tankless water heater

Truma Combi 4

The Truma Combi 4 has a gas inlet point on the front of the boiler. It's important you make a fixed rigid copper connection to this point. Connect the boiler to the gas manifold using a length of 8mm copper pipe and a compression nut with an olive. Ensure you have a gas drop out vent situated next to your boiler. Refer to *Techniques* on page 278 for how to do this.

Tankless water heater

Connect a length of gas grade flexible hose to the barb connection on the tankless water



ABOVE It took us three eBay orders and two trips to Toolstation before we finally found the right connector for our hob! If you're fitting a domestic hob, this is the golden ticket to getting it working. *@climbingvan* **OPPOSITE TOP** Laurie working late into the night fitting the flue for their log burner. *@camperdreamin* **BOTTOM** Dale inspecting our manifold. *@climbingvan*

heater using a jubilee clip. The European standards for gas installations within a motorhome, BS EN 1949, state, "Flexible hoses shouldn't be used inside the van unless it's for moveable appliances, in which case the hose length should be no longer 750mm and there should be a check valve before the flexible section which can be used to isolate the appliance." This means you need to install a check valve between the manifold and the tankless water heater.

1. Connect copper pipe first to the manifold, and then to an isolator valve using a compression fitting.
2. Connect the flexible hose to the isolator valve using a barbed compression fitting.
3. Secure the copper pipe using P clips no less than 500mm apart, although in this scenario you should secure them much closer together to ensure the pipe isn't able to move.

Protection against mechanical damage

Protecting your pipes and appliances from vibration is incredibly important in a van, as driving around translates a lot of vibration through the chassis and into the living space. This vibration can cause pipes to wear and degrade and eventually leak. Therefore, it's wise to carefully hold any pipes in place using pipe clips both inside and outside of the van.

It's also important you allow pipes to make gradual changes in direction and don't strain them by manually forcing a tight bend into the pipe, as this can damage the pipe.

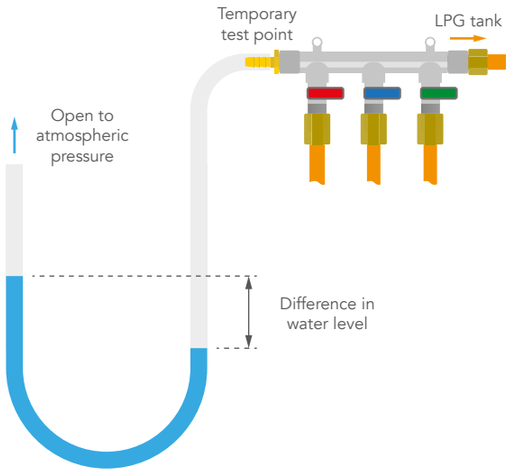
Checking connections

It's very important that you check your system for leaks, as a gas leak can cause carbon monoxide poisoning and create a fire and explosion risk. Even if nothing is obviously leaking and you can't smell anything, you must check your system thoroughly. Whilst the high pressure side of the system can easily be checked using soapy water, the low pressure side will need to be checked using a specialist tool such as a manometer.

Pressure testing with a manometer

To be confident in the integrity of the gas system, all elements of the low pressure system should first be tested at the normal operating pressure of the system (30mbar). Once you are confident there are no leaks, you should test the system again at five times normal pressure (150mbar). This is because an increase in temperature will increase the pressure in the system, so it's important to ensure your system is capable of withstanding these pressures.

To pressure test your system you will need to use a manometer. The most common types of manometer are water and digital. Water manometers comprise of a u-shaped tube filled with water. This is connected to the gas system via a test point on the manifold. When connected, the water inside the manometer is displaced by the system pressure. After leaving the manometer for a few minutes, a change in the water level will alert you to a leak.



A digital manometer will display pressure in mbar, allowing you to see the exact pressure of the system. These are calibrated against water manometers, and simply display the pressure numerically. Both are achieving the same thing, it's just that the water manometer will alert you to a leak, but the digital manometer will indicate exactly how much of a leak you have. It is possible to work out the leak rate using the water manometer, but this can be confusing due to differences in imperial and metric measurements. Ultimately, you should be trying to achieve a leak free system, so the accuracy of the digital manometer isn't necessarily needed.

The following process will check for any leaks at the normal operating pressure of 30mbar. It will help you to address any leaks, before moving on to test the system at five times the normal pressure (150mbar). The instructions assume that one side of the manometer tube is open to the air, and a source of positive pressure (the gas system) is connected to the other side.

Performing the pressure test

1. Turn off all shut off valves, check valves and manifolds.
2. Locate the spare port on the manifold and attach a temporary barbed compression fitting to serve as a test point. This should be installed using yellow PTFE tape.
3. Press the manometer hose onto the port, ensuring you create a solid connection (you don't want this to be the source of a leak!).
4. If the pressure is different between the two ends of the tube, the liquid will move away from the source of greater pressure. At this stage, everything should be level and displaying a reading of zero.
5. Open the valve on the gas tank, leaving all other valves off. The water in the manometer will be displaced (or if you are using a digital manometer, this will show a reading of 30mbar, depending on the ambient temperature). Once the water has been displaced, close the valve again.
6. Leave the system for five to 10 minutes and check if there's any change in pressure after this time. If you see a change, this means you have a gas leak within this part of the system. Refer to the corrective measures to resolve this.
7. Once you're happy with each section of the system, open the next check valve or a single valve on the manifold, and repeat steps five and six.

Corrective measures

Following the systematic approach above will allow you to isolate any leak down to a fairly precise location within your system, so you shouldn't need to check many connections to identify the source of a leak.

How much of a leak is too much?

The British Standard states a 10mbar loss in pressure is acceptable, however, this does mean that your system is leaking! Therefore, we'd strongly recommend aiming for a starting and finishing pressure that has not changed after 10 minutes.

Reducing or removing a leak can be achieved in one of a few ways. Try the suggestions below and then repeat the testing process to verify whether the change has resolved your issue. Isolate all connections before performing these steps, especially the tank valve.

1. Tighten the connection with a pair of adjustable spanners.
2. Apply more yellow PTFE tape or potting compound to the connection.
3. Disassemble the connection and check the pipe for any kinks or damage. If you identify any deformations in the pipe, recut the end with a pipe cutter and reattach it.

Once the full system has reached a satisfactory leak rate (ideally zero!), it's time to test the whole system at a higher pressure of 150mbar, which

is five times the typical operating pressure. This can be achieved by adding a small hand pump into the system. Once this pressure has been reached, take a reading from the manometer. Wait for 10 minutes before taking a second reading. If you see no change, your low pressure system is gas-tight.

Checking the high-pressure system is much easier, as the pressures are nearly a thousand times greater, meaning a leak will be easily detectable. Simply apply a leak detector spray or soapy water over each connection and wait for 30 seconds to see if any bubbles form. If you detect a leak, follow the corrective measures above, ensuring you isolate the tank before undoing any connections.

You should install a couple of carbon monoxide alarms around any high-risk areas such as manifolds and appliances, as this will alert you in case a leak ever occurs in future.

Decorating and furnishing

Oiling and waxing surfaces

You will need to treat any wooden surfaces that you're going to leave exposed such as cladding, kitchen worktops and tables, as this will protect them against any condensation or dampness causing mould to grow. Any surfaces such as kitchen worktops or tables that will see a lot of day to day wear should be treated with a specific oil or wax to protect the surface from water and dirt stains.

1. Sand any surfaces you plan to wax with a random orbital sander to remove any marks and imperfections.
2. To apply the wax, use a cloth to rub it completely into the surface. Apply several coats to completely protect the surface.

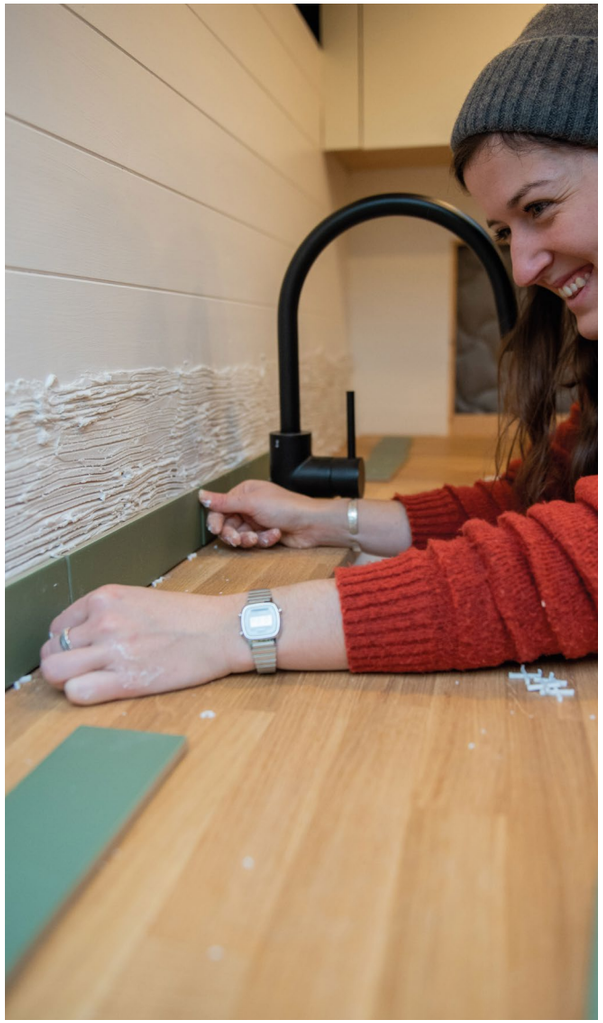
TIP:
For any surfaces that won't see as much wear such as cladding, use a protective oil such as a Danish oil. This is a wood stain that will also protect the wood against moisture ingress.

Tiling

When tiling in a van, you need to ensure you have a flat, rigid surface to tile onto. If you've carpeted your walls, this should be cut back to provide a smooth surface that the tile grout can adhere to.

1. Before you start applying your flexible tile adhesive, cut any tiles that need cutting with your tile cutter. Lay out all of your tiles as they will be positioned on the wall to check which you will need to cut.
2. Once you have a surface to work on and you've cut your tiles to size, mix your flexible tile adhesive with the amount of water specified on the packet until it's the correct consistency.

ABOVE There's no better feeling than finishing your gas system and cooking the first meal in your van! **OPPOSITE TOP** Sanding down our worktop to prep it. **MIDDLE** We used Osmo Oil wax on most of our exposed wood. It's a clear, matte wax that protects your surfaces and has a lovely, natural finish. **BOTTOM** Charlie giving our cladding its first coat of paint. *@climbingvan*



3. Apply the adhesive to the ply surface you will be tiling onto by using a trowel, spreading it evenly over the surface and ensuring good coverage.
4. Use your notched trowel (or fork!) to create ridges in the adhesive, creating straight horizontal lines.
5. Begin to apply your tiles, starting from the inside corner and working outwards. Make sure you use tile spacers between your countertop and your first tile, and between each tile. Press each tile in as you apply it to ensure it's adhering to the surface properly.
6. Keep checking all of your tile spacers as some of them may have moved whilst you applied other tiles. You may need to wait for a few hours, or even overnight before you are able to grout your tiles. Refer to the guidance on your tile adhesive to check how long you will need to wait for it to set.
7. Remove your tile spacers and then mix up your Flexi-grout according to the instructions on the packet. Apply it over all of the gaps between your tiles using a grout float (or a similar small, flat object).
8. Use a grout finisher (or a similar rounded object) to smooth the grout between the tiles, and ensure it has filled all of the gaps.
9. Use a wet sponge to remove excess grout from the tiles before it sets.

TIP:
It's important to use a flexible adhesive as there will be a lot of movement and vibration in your van, and if you use normal adhesive you risk the tiles cracking as you drive down bumpy roads!

Painting

Now that you've finished most of your build, you can start the fun bit! Painting inside your campervan will instantly make it feel a lot more like a little home. To achieve a much more even finish, we'd recommend using a roller brush, and using a small brush to reach any awkward areas and edges.

Finishing awkward areas

Once you've finished painting, you may find you have a few untidy spots in the corners of your van where cladding doesn't quite align. There are a few different materials you can use to tidy these up, such as a quarter dowel moulding, hemp rope, lengths of hemp bag chopped up and stuck onto thin strips of ply, or pretty much any other material you can think of. Simply cut a piece to length and use small nails or adhesive to cover any awkward areas.

Edging the step

Finishing the step into your van is a really simple job. Purchase some stair nosing, a piece of metal, plastic or wood in an L profile, that can be used to cover an unfinished step. Cut it to the right length and attach it in place either using screws, or the correct type of adhesive depending on the material you're glueing.

Upholstering seat cushions

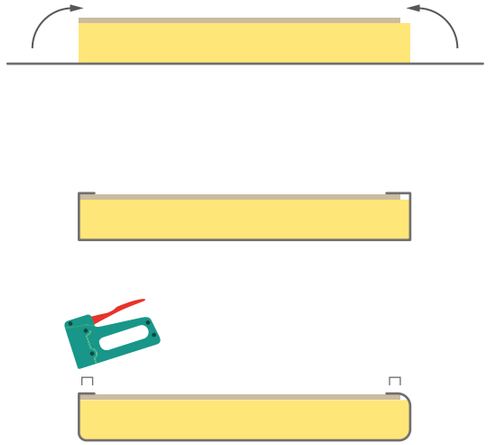
There are a couple of different ways to make your seat cushions, the first of which is the same way a sofa cushion cover would be made. This achieves the same aesthetic as you would have on a sofa, but is fairly fiddly and time-consuming. The second method involves stapling the material onto a ply backboard, and this is the method we'll explain as it's a quicker and easier way to approach upholstering, especially if you don't have much sewing experience or access to a sewing machine!

1. Start by measuring your seating area and draw the shape onto some thin sheets of ply (around 3mm).
2. Use a jigsaw to cut out these shapes, which will be used as your backboards.
3. Place the backboards over the foam and use them as a stencil to draw around.
4. Use a bread knife to cut the foam to size.
5. Place your material over the top of your foam and ply backboards to work out how

OPPOSITE You might decide, like us, it's not worth investing in specialised tools for a single tiling stint. Instead, get creative in what you use. We used a fork, some cardboard and even got our fingers involved! *@climbingvan*

much material is needed. Ensure you have enough to cover both the top and sides as well as wrapping around onto the bottom of the ply. Draw a guide onto the material and then cut it out using fabric scissors.

6. Use the staple gun to attach the fabric onto one side of the cushion, stapling the fabric to the bottom of the ply backboard. Staple approximately every 10cm to ensure the fabric doesn't become bunched.
7. Pull the material tight across the foam and then staple the material to the other side of the backboard.
8. Staple the sides, making sure to pull the material tight across the foam as you do so. When you're doing this, go slowly to ensure the corners are neat, folding the material in on itself if necessary.
9. Repeat this process for all of the cushions and backboards.
10. Attach the ply backboards to your seating area by using strips of Velcro in case you ever need to remove them.



Putting up curtain rails

There are a few different ways you can choose to hang your curtains. If you're attaching curtains to a tapered side wall of your van, whichever method you choose will require you to attach a curtain track at the top and the bottom of your curtain so it doesn't hang away from the wall.

Curtain tracks

If you don't want a visible curtain rail you should use curtain tracks, as you can mount them in a hidden position. Depending on where you're mounting the curtain track (on your ceiling or on a side wall), you will either need to order a top mounting or side mounting track.

1. There are already some holes in the curtain tracks for mounting purposes, but you may need to add a few more. If you do, select a suitably sized drill bit and drill holes at regular intervals.
2. Screw the curtain track into place.
3. Attach one of the stoppers at the end of the track. Slide the curtain into place by pushing the runners onto the track and securing the other stopper.
4. If you are installing curtain tracks at the top and bottom of the curtain, repeat this process for the bottom track.

CHARLIE SAYS:
We attached our curtain track on the back of the cladding on our sliding door so it would be hidden from view, although this did make it a bit fiddly to screw in! Once in place, the curtain tracks are completely hidden from view, creating a nice, clean aesthetic.

Net curtain wire

Do you remember those not so stylish net curtains that used to hang in everyone's windows in the '80s and '90s? Well, the curtain wire used to hold those up can be useful for hanging the curtains in your van conversion!

1. Screw some screw eyes into the wall or ceiling you're attaching the curtains to.
2. Thread the curtain wire through the eyes.
3. Attach the hook on each end of the wire to the two screw eyes at either end.
4. Thread the curtain track hooks onto the curtain wire.
5. If you're installing curtain wire at the top and bottom of the curtain, you will need to repeat this process for the bottom wire.

Curtain rails

Standard curtain rails or repurposed alternatives (e.g. a length of dowelling, a copper pipe, etc.) work well on flat walls such as by the back doors. You can attach them using generic curtain pole brackets. Simply attach the curtain rail brackets on either side of the wall you wish to mount your pole, and then attach the curtain rail to the brackets.

Making curtains

Making curtains is a very simple and quick job to tackle if you have a sewing machine. You can either use some custom material from a haberdashery, or you might choose to buy curtains from somewhere like IKEA and then modify them to the correct size. Depending on the type of curtain rail you're installing in your van, you will need to finish your curtains in a slightly different way.

To make your curtains, you simply need to hem the edges of the material you're using on all sides, or if you're modifying existing curtains, cut them to size and then hem the edges that you have cut.

For curtains which will attach to a curtain pole, you will need to attach tabs to the top of your curtains or create eyelets, or you might just wish to use the method of modifying premade curtains as they will come with these already attached. If you're using curtain wire, you will need to hand sew the curtain track hooks to the top of your curtains at regular intervals. If you're using curtain tracks, you will need to hand sew runners to the top of your curtains at regular intervals.

ABOVE Net curtain wire is a simple but effective way of hanging curtains in a van. @we_who_roam

Making thermal blinds

You may choose to buy ready-made thermal blinds for your windows specific to the make and model of your van, or you may choose to make them yourself. If you have an open cab, it's extremely important to have thermal blinds for your front windows to avoid any additional heat loss. We use thermal blinds behind our curtains in our van to both keep the heat out on a hot day and keep it cosy and warm inside on a cold day.

1. Start by making a template of each of your windows by using a large sheet of paper, or several sheets of paper taped together. Hold the paper up to your window and draw around the shape of it, creating a stencil. Make sure to draw outboard of your window by a few centimetres (the thermal blinds will stay in place with magnets attaching to the side walls of your van, so you need the blind to be big enough to overlap with the walls as well as the windows).
2. Cut out the shapes you have drawn, double-checking they're the right size and shape by holding them against the windows.
3. Once you're happy with the stencils, draw around them onto the thermal blind material. It's easier to do this using a marker pen rather than a Biro.
4. Cut out the thermal blinds templates.
5. At this point, if you aren't having curtains in your van and the thermal blinds will be visible, you can choose to attach a patterned material to the thermal blind material (on the non-reflective side). Use the same stencil to cut out the patterned material and pin it to the thermal blind material. Use your sewing machine on the straight stitch setting to go around the edge of the material (make sure you're close enough to the edge that the stitch will be hidden by your bias binding when you attach it).
6. Take the bias binding tape and use your pins to pin the tape to the edge of the thermal blind material. This can be quite fiddly, so depending on the width of your bias binding tape, you may find it easier to cut out some of the internal layers of the thermal blind material at the edges where you're pinning the tape to make it easier to attach. If you don't, it's very easy to lose your patience trying to keep the edge of the bulky thermal blind material inside the bias binding! If you have already attached some patterned material it should make attaching the bias binding a little easier.
7. Use a straight stitch to sew all the way around the blind.
8. Sew your PVC coated magnets at intervals around your blind. We'd recommend having at least one in each corner, and one or two on each side, but you may wish to include more than this depending on the strength of your magnets.

Once you have finished, you should be able to easily attach your thermal blinds to your windows by placing them next to the window, as the magnets will attract to the metal body of your van.

OPPOSITE Sewing the thermal blinds really tried my patience. It wasn't until the end when I had unpicked them at least four times that I realised cutting out some of the internal layers made it miles easier! *@climbingvan*

SIX

Van life

Introduction

When we spent our first night in the finished van, we were overwhelmed with emotions. Pride, that we'd created this rolling home all by ourselves. Relief, that we didn't have to spend yet another weekend working on it! Excitement, at finally being able to hit the open road. Converting a van is a roller-coaster, but it's one that opens the door to adventure for years to come.

We decided to convert a van because we wanted to rewrite what normal meant to us. We were tired of daily commutes, spending our lives office-bound, living for weekends and holidays. We worked out that living in a van - no mortgage payments, minimal bills, no need for multiple vehicles and expensive holidays - meant **we could earn 60% less** (i.e. work 60% less!) **and save the same amount** as when we were living in a house. This allowed us to redefine the way we lived, putting meaningful experiences ahead of material possessions and swapping our work-life balance from 5:2 to 2:5 (bring on those five day weekends!).

Because what do we really need? Food, water and a place to live? Van life gives you all of that and allows you to live affordably, simplistically and sustainably. Living in a van is a life with less. Less 'stuff', but also less stress, less complication, less impact. Van life allows you to create your own normal, whatever that means to you. Whether you've converted your van so you can spend your weekends in the wilderness, or you're committing to full-time van life and a more simple way of living, van life is an achievable dream for anyone who's up for the challenge.

For the weekend van lifers, gone are the days of hotels and Airbnbs tying you to a time and a place. Instead, you can check the forecast, the snow conditions, the surf report on a Friday afternoon, pack the van and hit the road. You can finally explore the places you've wanted to visit for years and make the most of your valuable free time.

For those planning a longer adventure, van life enables you to have an incredible experience, travelling for months at a time, for what many would spend on a two week holiday! It's all too easy to put off the trip you've always dreamed of, but it's never too late. A campervan enables a slower pace of life with new experiences and adventures, without it costing the earth.

And for the long-termers, full-time van life gives you the freedom to live life on your terms. You can live free from the monotony of the nine-to-five, and centre your life around your passions, whether that's hiking, surfing, climbing, or simply exploring your surroundings and immersing yourself in new cultures. Van life allows you to live a more minimalist lifestyle, travelling only with the things you need and value, fitting everything you own into the tiny space you call home. No longer are you tied to one location: discover farm life in the French Pyrenees, explore secluded beaches along rugged coastlines, or embrace the digital nomad lifestyle with a different view from your 'office' every day.

So with that, dive into these final few pages and make sure you're ready to redefine your normal and hit the road on your first adventure.

Van life essentials

You will need to adopt some level of minimalism when you're living in a campervan. Some will see this as a compromise, whilst others will see it as an opportunity to focus on what's most important. Either way, you simply can't fit everything you would have in a house into such a compact living space, and so you will need to prioritise.

Vehicle essentials

Let's start with your van. To avoid any sticky situations, and to ensure you can have a comfortable night's sleep, we'd recommend investing in:

- A key safe (can be attached to the underside of your van with a spare set of keys)
- Jump cables
- Levelling ramps (drive onto these if you're parked at an angle)
- Thermal blinds
- Safety essentials

Make sure your campervan is fitted with the essential safety equipment in the case of emergency:

- Smoke alarm
- CO (carbon monoxide) alarm
- Fire extinguisher and blanket

Kitchen and storage essentials

When you're living in a campervan no bigger than seven square metres, every centimetre of space counts. You will need to adopt a new perspective, as it's not only bulky and heavy items that are a no go in a campervan. Even standard kitchen crockery is inadvisable, as it's unlikely to survive a drive down a bumpy, potholed road! And unless you have a pretty sizeable inverter, plugging in a kettle or toaster is a no go. We've listed a few recommended items that will help you maximise your space and reduce the risk of breakages.

To maximise storage:

- Collapsible bowls/colanders
- Nesting cookware (pots and pans with removable handles to allow them to stack into one another)
- Drawer separators

To maximise wall space:

- Hooks
- Storage nets/bungee cord
- Shelves/IKEA spice racks

To minimise breakages:

- Storage boxes
- Anti-slip matting
- Felt/rubber (to sit between plates)

230V alternatives:

- Stovetop kettle
- Stovetop toaster
- Omnia oven
- Aeropress/moka pot

Travel essentials

Most van owners will have dreams of driving up winding mountain passes, taking in spectacular views from their back doors, coffee in hand. But before you hit the road, it's important to make sure you're fully prepared. Legal requirements vary from country to country, but it's a good idea to have:

- Country code sticker
- Warning triangle
- High vis jacket
- Breathalyser
- Vehicle first aid kit

If you're travelling between Europe and the UK you will also need:

- Headlight adapters
- LPG fill point adapter

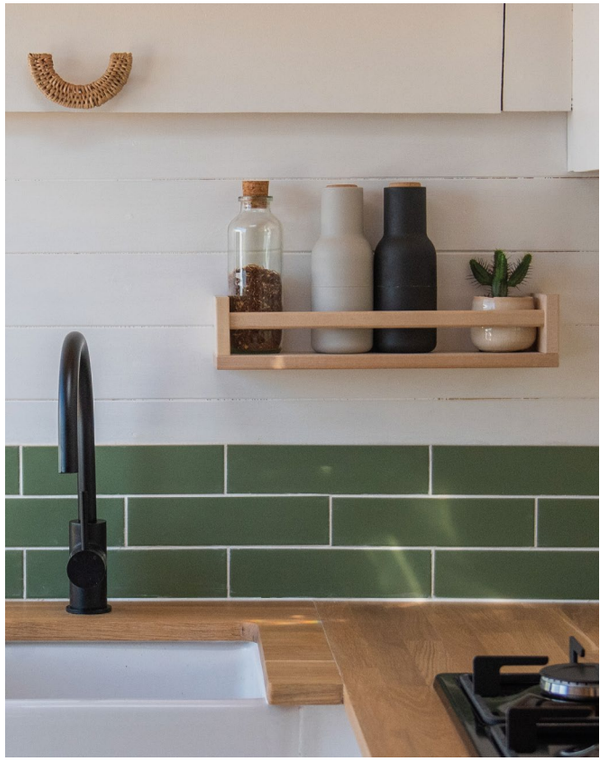
We won't mention the dreaded 'B' word, but remember that if you want to hop over the channel for more than 90 days, you will now need a visa on your list of essentials.

Remote working essentials

If you've decided to swap the dreamy laptop screensaver for the real thing, we have a couple of must-haves to help ensure you can work wherever takes your fancy.

Portable screen

Although this won't be essential for everyone, if you have a more technical job requiring you to multitask, whether you're a web developer,



OPPOSITE FIRST Stovetop kettles not only look lovely, but also don't rely on electricity! **SECOND** One of our favourite van staples, the almighty Aeropress. **THIRD** The age-old question - is it even a van if it doesn't have an IKEA spice rack? *@climbingvan* **FOURTH** Dom and Marie utilise every inch of drawer space with nifty storage solutions. *@vanlife.sagas*

a designer or often have your head buried in a spreadsheet, you might struggle relying on a small laptop screen. A second screen immediately gives you twice as much space to work, increasing productivity and ease of working. For anyone used to working on a big monitor, this is likely to be a prerequisite.

WiFi

When working remotely on the road (or if you just want to binge Netflix on a rainy day!), it's key to have a good internet connection wherever you're parked up. It can be a dangerous game hotspotting from your phone, as you can quickly eat through your data, and often in more remote spots, you may struggle to get sufficient signal.

For those who don't need constant WiFi access, internet cafés and coffee shops can provide a good solution. But for those who need a permanent connection in their van, it's worth investing in a portable WiFi router. These routers (sometimes known as a MiFi hotspot) do exactly what it says on the tin - they are a WiFi router that can be used with or without an antenna to boost signal, and they require their own SIM card and data plan. Think of it as your internet router at home - your phone or laptop connects to the router to access the internet.

The portable WiFi router works by using an internal antenna to find a mobile signal and then produces a WiFi hotspot that a number of devices can connect to, including laptops and mobiles. It is able to acquire a much better signal than a mobile phone because it has a much bigger antenna built into it. The units are relatively small and come with a built-in battery, lasting around six to 10 hours depending on the unit, or they can be used whilst plugged in to charge.

If you're not familiar with what a Faraday cage is, your first few van trips are likely to see you experience its effects. A Faraday cage is a metal enclosure that blocks electromagnetic fields, such as cell phone signal and WiFi. A van - a metal enclosure - often acts as a Faraday cage, limiting the signal that can reach any devices. If you have a lot of windows you may be able to manage, but if not, you may struggle to get signal when using a WiFi booster positioned inside your van in areas of low signal.

If this is the case, you can either install a 4G antenna on the roof of your van, or just put your WiFi booster in your skylight or window! This is a low-tech solution but works just as well. We live in our van full-time and if we're anywhere with patchy signal, we just pop our dongle in our skylight and this usually does the trick!

WiFi comparison

	Tether from your mobile phone	Portable WiFi router	Portable WiFi router with 4G antenna
Cost	Cost of existing mobile data plan	£70 + additional data plan	£270 + additional data plan
Signal strength	Low	Medium	High
Ease of installation	N/A	N/A	Medium

Luxury 'essentials'

Okay, we know this isn't really an 'essential', but it's fun to have a little slice of luxury in your campervan. For us, a projector means we can have a cinema-like experience on a rainy day, and it beats huddling around a laptop screen whenever we want to watch a film.

Projectors

Many people won't include a TV in their campervan because it can feel quite intrusive in such a small space when it won't be in use 99% of the time, and they don't weigh an insignificant amount either. A good alternative is to use a little portable projector.

OPPOSITE If you thought working from home gave you freedom, try working from a van! *@climbingvan*

Portable projectors usually have a small, built-in battery as well as a speaker and a number of ports for different connection options, and can be plugged into a power source to recharge. They're used to project an image against a white background from your phone, laptop or a USB stick. You can either project the image against the wall of your van if you have white walls, or you can purchase a projector screen.

We bought a projector screen from eBay and installed two hooks in the ceiling of our van to attach the projector screen to. It rolls down and provides a good, clean surface to project the image from the projector onto when the projector is sat on our slide-out table. It makes the van feel like you're in a little cinema, as the picture is so much bigger than watching something on a TV at home! Lots of projectors also come with the option of connecting to an external speaker to improve the sound quality, so you can make some popcorn, grab a drink, and enjoy your own mini cinema.

Projector comparison

	ViewSonic M1 Mini	ViewSonic M1+	ViewSonic M2e
Cost	£130	£250	£549
Battery life	2 hours	6 hours	None
Picture quality	480p	480-1080p	1080p
Keystone angle correction	Vertical	Vertical	Horizontal & vertical
Lumens	120	300	1,000
Connectivity options	HDMI, USB	HDMI, USB, micro SD, WiFi, Bluetooth	
Speaker quality	Low-medium	Medium-high	High
Weight	0.3kg	0.8kg	1kg
Size	11 x 10cm	14 x 16cm	18 x 19cm

Security

Between April 2018 and March 2019, over 150,000 vehicles were stolen in the UK, which equates to one every three and a half minutes. Vehicle-related-theft (which is defined as "theft of a vehicle" or "theft from vehicles") currently accounts for one in seven of all reported crimes! We're not trying to scare you with these statistics, but it's important to be aware of the risks so you can ensure you have adequate protection for your campervan. Because after all, your campervan is more than just a vehicle!

Anti-vehicle theft devices

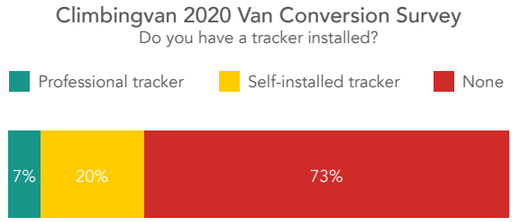
After spending months building your dream home on wheels, the last thing you want is for a thief to steal it. One of the more primitive security measures you can use to protect your vehicle from thieves is a physical steering wheel, pedal or wheel lock. Steering wheel locks are particularly favoured by many campervan owners, because not only is it physically harder to steal your vehicle (without the assistance of power tools which may quickly alert others to what they're doing!), they're also a physical deterrent. A steering wheel lock shows any would-be thief that you've considered the security of your vehicle.

Trackers

One of the most important security measures you can include in your campervan is a vehicle tracker. Many insurance companies require a tracker to be installed before they will insure you. There are various types of tracker available, from very basic DIY trackers to professionally installed Thatcham approved systems with 24-hour monitoring. Whilst only 43% of vehicles without a tracker are ever recovered by the police, vehicles that do have a tracker have recovery rates as high as 98%.[15] Although more

15 smartrack.eu. 2020. SmarTrack Global Telemetrics Recovery Statistics.

OPPOSITE The ViewSonic M1+ will turn your campervan into your very own mobile mini cinema. *@climbingvan*



basic trackers will provide you with a base level of protection, Thatcham approved trackers are able to boast almost perfect recovery rates. It's therefore shocking to hear that 73% of campervan owners have no tracker installed!

Basic

A very basic GPS tracker can be purchased online for around £25. It comes with its own SIM card and will need to be connected to your 12V power. You can text the number on the SIM card with specific codes and it will reply with GPS coordinates of its current location. It's important to position these close to a window if possible to ensure they can acquire a good enough signal.

They also come with a suite of extras you can choose to install, such as tapping into the fuel tank and even installing a microphone! Unfortunately, most of these extras can be quite tricky to implement as the devices don't typically come with very good instructions.

PROS

- Very cheap
- Relatively easy to install
- No monthly subscription fee

CONS

- Often struggle to pick up a signal
- Very basic functionality
- Rely on you texting to check the location
- Not Thatcham approved

Mid-range

A mid-range tracker is connected to your vehicle's OBD (on-board diagnostics) port. They cost around £50 and have a monthly fee for their app, which not only enables you to see the location of your van in real-time, but can also send you alerts any time your vehicle starts, or even if it detects any unusual vibrations (such as power tools being used).

They can be a good option for those who are looking to protect their campervan without spending too much money, but they also have a big downside. By simply connecting them to the OBD port, they can be very easily located by a thief. Typically this is one of the first places a car thief will check before stealing a vehicle, and it won't be very useful for recovering your campervan if they have removed the tracker before taking it!

PROS

- Fairly cheap
- Very easy to install
- Easy to track via the app
- Alerts to notify you of any disturbances

CONS

- Monthly subscription fee
- Easy to find and remove by a thief
- Not Thatcham approved

High range

High range trackers are Thatcham approved, which means they have been assessed for their features and functions and awarded a certification by Thatcham Research. Many insurers may require you to fit a Thatcham approved tracker in order to insure you, or you may find you have a cheaper insurance premium if you have a Thatcham approved tracker fitted.

Most Thatcham approved high range trackers will need to be installed by a professional. You can pay anywhere between £150 to £650 for a fully fitted tracker, plus a yearly subscription cost upwards of £100. Most companies will be able to come and do a roadside installation at

OPPOSITE The van life dream, a tranquil camp spot beneath the mountains. *@sheisthelostgirl*

your preferred location, and this usually only takes around 20 minutes. Many high range tracker companies have private operating centres which provide 24/7 monitoring and work closely with police, giving you the best chance of getting your campervan back.

PROS

- Thatcham approved
- Easy to track via the app
- Alerts to notify you of any disturbances
- Monitored by a 24/7 operating centre
- Nationwide police support

CONS

- Expensive
- Monthly subscription fee
- Not possible to self-install

Tracker comparison

	Basic	Mid range	High range
Upfront cost	£25	£50	£150-£650
Monthly subscription	£0	£6	£10-£30
Ease of install	Medium	Easy	Professional install only
Level of coverage	Low	Medium	High
Alerts?	No	Yes	Yes
Example	GPS TK103A	Carlock Basic	SmarTrack Trident

CHARLIE SAYS:
We initially installed a basic tracker, but we found it often wasn't able to pick up enough signal to respond to our messages with its location, which ultimately rendered it fairly useless. We've since upgraded to a Thatcham approved tracker for peace of mind.

Anti-burglary devices

Chances are you won't need to worry about this, as thankfully the percentage of vans that are broken into is pretty low. But it's still important to protect your van in case the worst happens, so there are a number of deterrents we'd recommend to protect your valuables:

- Motion sensor alarm
- Security camera
- Safe/security box
- Deadlocks/slamlocks

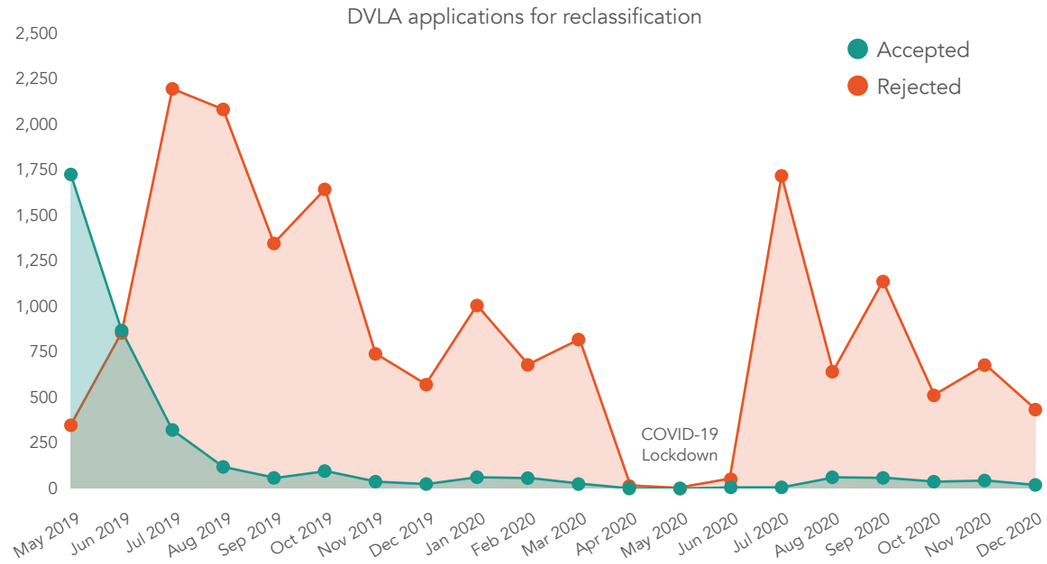
At the risk of stating the obvious, the best security measure you can implement is not leaving anything valuable on show in your van!

Should you reclassify your van?

If you live in the UK, once you've converted your campervan you may be thinking about officially reclassifying it as a 'motor caravan'. This used to have benefits such as lower insurance premiums and cheaper ferry and toll prices. However, as of mid-2019 the DVLA changed their reclassification requirements, and the reclassification process is now incredibly difficult, if not impossible!

Chances of reclassification

Before you decide to sink time into trying to reclassify your campervan, let's dive straight into the likelihood of an application actually being approved. We submitted a freedom of information request to the DVLA in January 2021, requesting historical data about approved and rejected reclassification applications. Before June 2019, over 80% of applications were approved, but after this, the tables started turning. Between August 2019 and December 2020, only 5% of applicants were granted reclassification to a 'motor caravan'. That's only 806 approved applications out of almost 15,000!



The reason for this shift in application approvals is supposedly due to the requirement for the exterior body to "look like a motor caravan in traffic". This is used to assist the police and other enforcement agencies to identify a vehicle in the case of an incident. It seems that they're forgetting that every vehicle has number plates for exactly this reason!

The DVLA has declined to provide an explicit description of what constitutes "looking like a motor caravan". The requirements provided on the government website for the exterior of the vehicle are very ambiguous and up for interpretation. Anecdotally, the only applications we've heard about being approved since August 2019 are either panel vans that have had the sides removed and box constructions added (essentially what motorhome manufacturers do), or vehicles such as library buses whose body types already resemble motorhomes.

ABOVE Ringo is a campervan in all but name. *@climbingvan*

Do you need to reclassify your campervan?

The short answer is no. Most insurers have adapted their policies to the change in reclassification requirements, and will now insure a van as a campervan without it being classed as one on its V5C (vehicle registration certificate). Adrian Flux, an insurance company specialising in campervan insurance, say, "We are able to provide full cover for camper conversions and conversion projects based on almost any vehicle, including cover for vans, coaches and buses in the process of being converted. We can cover professional and amateur conversions of any van or coach."

In the past, reclassifying your van meant you were able to access cheaper vehicle insurance, as well as potentially cheaper ferry fares. However, due to the new difficulties of reclassification, most insurers have changed their rules on what they require for insurance policies, and so there will be no price difference in quotes based on classification on the V5C alone. The estimated final value of your conversion along with your driving record (i.e. if you have had any driving penalties or accidents) are much more likely to be the main factors in the cost of your insurance. You're also unable to use your no claims discount on more than one vehicle, so if you own a car as well as your campervan, you will need to start afresh with the second vehicle.

Similarly, most ferry companies price their tickets based on the height and length of your vehicle rather than the classification, so it shouldn't make much if any, difference to the price of your ticket. There's also a misconception that there's a higher speed limit on single carriageways and dual carriageways if you're registered as a campervan. However, this is only the case if your vehicle is under 3.05 tonnes which won't be the case for most medium to large-sized campervans once they're fully laden with the weight of your build, all of your belongings and yourselves! This means most campervans won't see a change in speed limit by reclassifying.

CHARLIE SAYS:
The purpose of the body type information on the V5C, according to the DVLA, "must describe what a vehicle actually looks like. This description, in addition to other distinguishing features, enables the police and other enforcement agencies to identify a vehicle." On our V5C, our van Ringo is described as a 'yellow panel van' which perfectly describes how he looks from the outside, and could easily be used to identify him.

Speed limit for different vehicle types UK

	Built-up areas (mph)	Single carriageways (mph)	Dual carriageways (mph)	Motorways (mph)
Car-derived van	30	60	70	70
Goods vehicles (less than 7.5 tonnes)	30	50	60	70
Motor caravans (more than 3.05 tonnes)	30	50	60	70
Motor caravans (less than 3.05 tonnes)	30	60	70	70

OPPOSITE Proof that van life is still possible with kids! *@slowly.salty*

How to reclassify your campervan

If, after reading this, you still want to do battle with the DVLA and attempt to get your van reclassified, you can check the government website to find the latest requirements. You will find a list of required internal features, the accepted body types, and the previously mentioned ambiguous list of external requirements. It's very unclear as to whether some or all of the features listed are required.

To request reclassification, you must submit a completed 'motor caravan' conversion checklist, a V5C showing one of the required body types, and photos of your campervan showing the required internal and external features. For full details on what to include and where to send the information, you can check the DVLA website.

DALE SAYS:
If your van doesn't already look just like a conventional motorhome, save the time gathering all of the information and pictures you need and spend it somewhere nice in your 'panel van with windows'.

Insurance

Insurance, as you probably well know, can be a minefield. It's no surprise that getting a sensible insurance quote for your campervan can be just as difficult as dealing with any other type of insurance company. More often than not, you will receive a ridiculous quote, and you will need to go through the painful process of contacting several companies and pitting them against each other to achieve a sensible price. It's worth noting that insurance prices, companies and rules are constantly changing, and so everything in this section is correct at the time of writing.

If you're not based in the UK, you can skip this section and move on to something more exciting! However, it's still important that you make sure your campervan is adequately insured, wherever you live.

Campervan vehicle insurance

Insuring a campervan is more complicated than insuring a standard panel van because as well as a vehicle, it's a little home that you've poured months of your life into creating. You will need to ensure that it's insured for the estimated value of the finished build rather than just the value of the vehicle itself, otherwise you could run into problems when trying to claim in the case of an accident.

It's also important to insure your van right from the very beginning as a 'camper in conversion'. This means that if something were to happen partway through your build, you would be covered for the time and money you had invested up to that point. Some companies will set a time limit for when the conversion has to be completed by and will require regular progress updates, whereas other companies are much more relaxed and only require you to update them once the conversion is complete.

Once you've finished your conversion, look for an insurance company that will provide cover for the estimated value of the completed build. Some insurers will require you to send photographs of your campervan to prove its campervan status (rather than relying on the V5C). Others will ask you to fill in an 'agreed value request form' to confirm the estimated value of your campervan. Most insurers will also require you to have a tracker fitted.

There are a few insurance companies that specialise in insuring campervans, and the following companies insure campervans that haven't been reclassified:

- A Plan
- Adrian Flux
- Brentacre
- HIC
- Greenlight

OPPOSITE Travel insurance is critical if you plan on shipping your van off to Mordor (or Iceland!). *@land_roamers*

These aren't personal recommendations, they're just companies that specialise in campervan insurance at the time of writing. Insurance is often complicated and confusing, and each company will have their own set of rules, so it's important to check the details of each policy to ensure you will be fully covered.

Contents and valuables insurance

If you're planning on living in your campervan full time, it's important to have contents or valuables insurance, the same as you would have if you were living in a house. Some van insurance policies will offer you a certain level of cover for your vehicle contents, but you should check what this value is and if you will need to take out additional insurance.

It's up to you whether you opt to take out contents insurance for everything in your campervan (this would cover clothes, plates, cutlery, bedding etc.) or just valuables insurance. For more specialist equipment such as cameras and drones, you might want to take out specialist insurance specifically for those items. It's important when taking out valuables insurance to make sure both the total sum of your valuables is insured, and also the individual item cover will cover each of your items.

Travel and health insurance

If you're planning on travelling abroad in your campervan, you will need travel insurance. Travel insurance is typically used to cover you in case of any delays or cancellations to your trip, lost or stolen passports, as well as covering any expensive medical bills.

Weighing in

Once you've finished your build, it's time for the all-important weigh in! The easiest way of weighing your campervan is to find a local weighbridge. Most weighbridges are commercial (e.g. a waste disposal centre or farm) but will let you use it to weigh your van for a small fee (or if you treat them to a van tour, they might do it for free!).

If you weigh your campervan and find out it's over the crucial 3.5 tonnes, you have a few options. If you're only a small amount over, you should start stripping some weight out of your build. Did you use any extravagant materials or install any heavy items you could remove? Of course, it's not great to do this at the end of your build, it's much better to think about it before so you don't end up in this situation!

If you're ***weigh*** over the 3.5 tonne limit (sorry, couldn't resist the pun!), you will upgrade your suspension to deal with the extra weight, and take your category C1 licence. Unfortunately, both of these are quite expensive. To take your C1 test, you need to take at least a few lessons as your test will be taken in a 7.5 tonne lorry. You can expect this to cost upwards of £515 (£50/hr for lessons and £115 for the test) depending on your experience level. A GVM suspension upgrade can cost anywhere from high hundreds for a DIY spring suspension upgrade to several thousands for professionally fitted air suspension!

The 'boring bits'

Emptying toilets

Toilets may be up there with one of the most boring and least 'sexy' parts of van life, but for anyone who's included a toilet in their van, it's important to know where to empty it. The contents of a composting toilet can be disposed of in a regular waste bin if a composting heap is not accessible. However, a portable toilet requires a little more forethought. Portable toilets use chemicals which means the contents need to be disposed of at a chemical waste disposal point. These can typically be found at campsites, and in some Aires in Europe (we'll explain what these are shortly).

ABOVE With van life, it's important to strike the perfect balance between fitting in all of your gear, having enough space to live, and keeping under that crucial weight limit! *@fenimoreadventuremore*

Filling up water

Many van lifers will pay to stay on a campsite every few nights to give them a chance to fill up their water tanks, empty portable toilets and grab a shower. Water is also available at many fuel stations, although this is regularly advertised as 'not for drinking', so if you do fill up here you will need to boil the water before consuming it or only use it for showering.

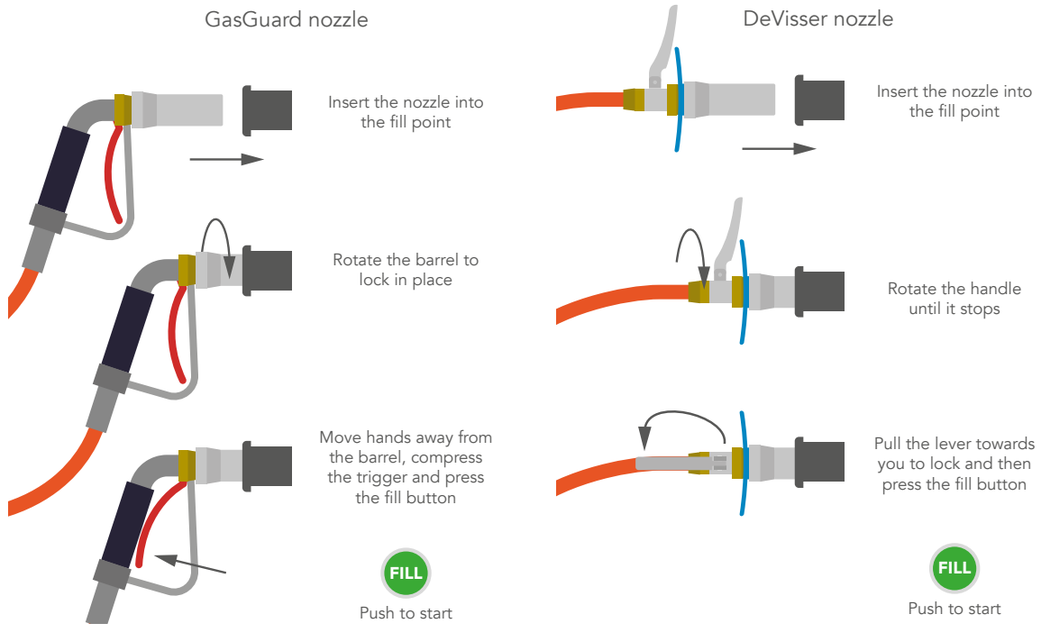
You could also consider purchasing a water purifier, as this will allow you to fill up your water from pretty much any water source. Water purifiers run water through a filter to make it suitable for drinking, and some models will be able to purify pretty much any water source!

If you're travelling in Europe, it's much easier to fill up your water. You can stay at an Aire, as they often offer free or cheap water refill points, and many town squares have water fountains with free drinking water available.

Filling up LPG

If you have a replaceable gas bottle, you will need to locate a petrol station that offers replacement gas bottles. You can simply give them your old, empty bottle and they will replace it with a new, full one. You will be able to spot a petrol station with this facility as they usually have large cages containing the bottles on the forecourt. They're widely available across the UK, but will be much harder to locate in mainland Europe.

If you have a refillable LPG tank, mylpg.eu has an interactive map of fuel stations that offer LPG refilling. All LPG tanks are fitted with an automatic stop valve at 80% of the volume of the tank to prevent overfilling. When you come to fill your LPG tank for the first time, there are two types of nozzle that might be in use at the LPG refill point, the Gas Guard or the De Visser nozzle. When filling, you should ensure the nozzle is correctly fitted and clamped.



OPPOSITE The size of your van won't limit the size of your adventures! *Sarah & Carl Oscar* *@ifyoudrift*

Washing clothes

However much you love your luxuries, you're going to struggle to fit a washing machine inside a campervan! This means getting a little more creative with how you wash your clothes. For an easy life, and perhaps in colder climates when you may not be able to hang your washing to dry, find a local laundrette to get your washing done quickly for a small cost.

Washing comparison

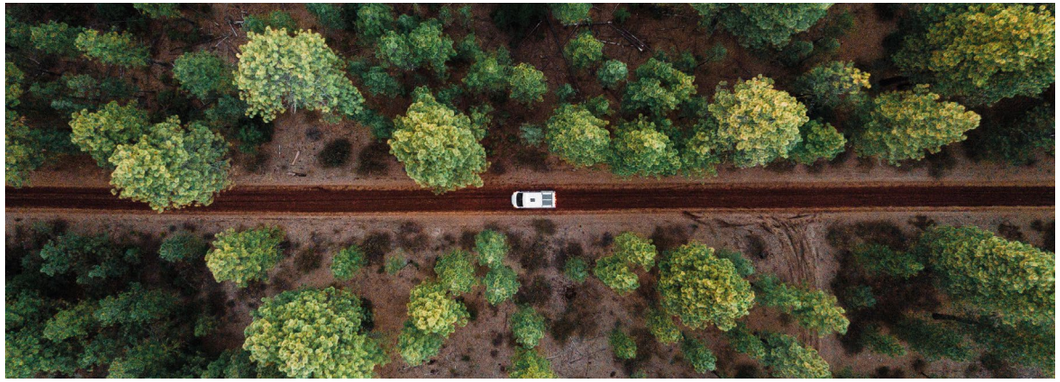
	Collapsible 230V washing machine	'Scrubba' wash bag / dry bag	Bucket & washboard
Cost	£80	£42	£40
Water usage	15L	5L	10-20L
Capacity	0.3kg	0.5kg	1-2kg
Power usage	0.4Ah / load	None	None

Alternatively, you might choose to wash your clothes yourself to save money. If you want as much luxury as you can manage without a full-sized washing machine, you can buy a collapsible version that can be hidden away when not in use. It will only be able to manage a measly 0.3kg load per wash (where a small domestic washing machine will manage 8kg), so you may need to run it a few times to wash everything. Or you can go for the low tech approach and use a bucket and washboard, or a dry bag. The 'Scrubba' wash bag is especially designed with little nobbles inside to help agitate the dirt (and stink!) from your clothes.

How to travel

As adventure draws ever closer, where will van life take you? In your new campervan, the possibilities really are endless. But before we dive into the options for your first trip, we wanted to share something important…"The Rules of Van Life".

ABOVE There is no better feeling than reclining in a camp chair next to your campervan with a beautiful view. *@vanlife.sagas* **OPPOSITE** Life is all about perspective. Van life happens to elevate that perspective. *@cascadecustomvans*



The Rules of Van Life

With great power, comes great responsibility... when travelling in a campervan, you have to set a precedent. The rise in popularity of campervans has unfortunately seen a few irresponsible people giving 'van life' a bad reputation. It only takes a handful of perpetrators to litter, park irresponsibly and annoy locals before it means restrictions or bans are imposed.

Take Portugal for example; wild camping was recently banned throughout the entire country, meaning it's no longer possible to park up anywhere. Instead, you have to stay on a campsite or in a specified parking spot. This is such a shame, as there are some truly beautiful spots around Portugal, and 99.9% of van lifers staying there treat the area with respect. But all it takes is a few people to disrespect the places they visit to affect everyone.

This is why it's so important to make sure you're considerate, and lead a good example for others. We've come up with 'The Rules of Van Life' below, to make sure we protect our freedom to travel and enjoy the world:

1. **Leave it better** - Rather than just following the Leave No Trace principles, why not go one step further? Wherever you stay, leave it as you would like to find it. As well as taking away all of your rubbish, spend some extra time leaving areas pristine, as a way of giving back to the beautiful places you're lucky enough to enjoy.
2. **Plan ahead** - Wherever you plan on staying, make sure you check the local rules. While it may be okay to 'wild camp' in some places, in other areas it may be banned. And if you see a 'no overnight camping' sign, don't ignore it!
3. **Be considerate** - Whether it's playing loud music, dumping grey water on a campsite pitch, or blocking a farmers gate, don't do something that will give the van community a bad rep. Respect others and their experience as much as your own.
4. **S**t responsibly** - If you don't have a toilet in your campervan, make sure you dig a hole at least 15cm deep and 50cm away from any water sources before going to the toilet outdoors. Take away any toilet paper and dispose of it properly in a bin.
5. **Be a force for good** - Van life and the slower pace of life that comes with it will give you an opportunity to live a more sustainable lifestyle. Use natural products that don't contain harmful chemicals, cut down on excess packaging, and support businesses and communities wherever you travel by buying local.
6. **Give back** - Van life is an amazing community, so give as much as you take. If you see someone in need, give them a hand. Empower others to do the same.

Where to stay

Official camp spots

Campsites

We'll start with the obvious. There are numerous campsites throughout the UK and Europe in stunning locations. A quick google will bring up a number of campsite directories you can use to find sites in the most idyllic places. Searching Google Maps is also a good way to find them, as you can read public reviews and see customer photos of every campsite in an area you're interested in visiting.

Pub car parks

Many pubs will allow overnight stays for campervans if you eat a meal or buy a drink in the pub. This is a great option if you're looking for a stop on the way or way back from a trip. You can use websites such as searchforsites.co.uk or Facebook groups to find pubs that specifically cater to this.

Aires

An Aire is a motorhome stopover and is a European concept, being found in many European countries. They're typically public parking areas which are either free or cost a small fee, and are typically viewed as an on-route stopover rather than a holiday destination. They're useful if you're travelling through a European country and are flagging slightly from a long drive! Aires typically have a service point to fill up your water and dispose of your waste. Some Aires in rural locations may have free parking, but a small fee of €2-3 for refilling water. Aires are for campervans and motorhomes, but caravans and tents are not allowed. There are not many good websites detailing locations of Aires at the time of writing, so the best way to find them is to buy a guidebook on Aires for the location you plan on travelling to.

'Wild' camping

Countryside 'wild' camping

If you plan to live in your van full time, staying at a campsite every night could get prohibitively expensive quite quickly! Depending on where you are, the rules may differ. Whilst some countries will allow you to park up pretty much anywhere that isn't private land, others (England in particular!) are much stricter on this. If you're wild camping, it's important that you check any local rules, and look for any 'no overnight camping' signs before spending the night. Campervan parking is currently quite a sensitive issue, so it's important to think back to The Rules of Van Life: ensure you're allowed to stay wherever you are parking, and leave the spot better than you found it.

Covert city camping

For those planning on living in their van full time, staying in a city covertly might be necessary now and then, or for some, it might be what they do the majority of the time! As long as you are parked in a legal spot, it's technically legal to sleep in your vehicle in that spot. However, you should try and be fairly covert if you are. Keeping thermal blinds over your windows to block out light, not parking too publicly, and not emptying your sink if you don't have a grey water tank are all good ideas.

Tools

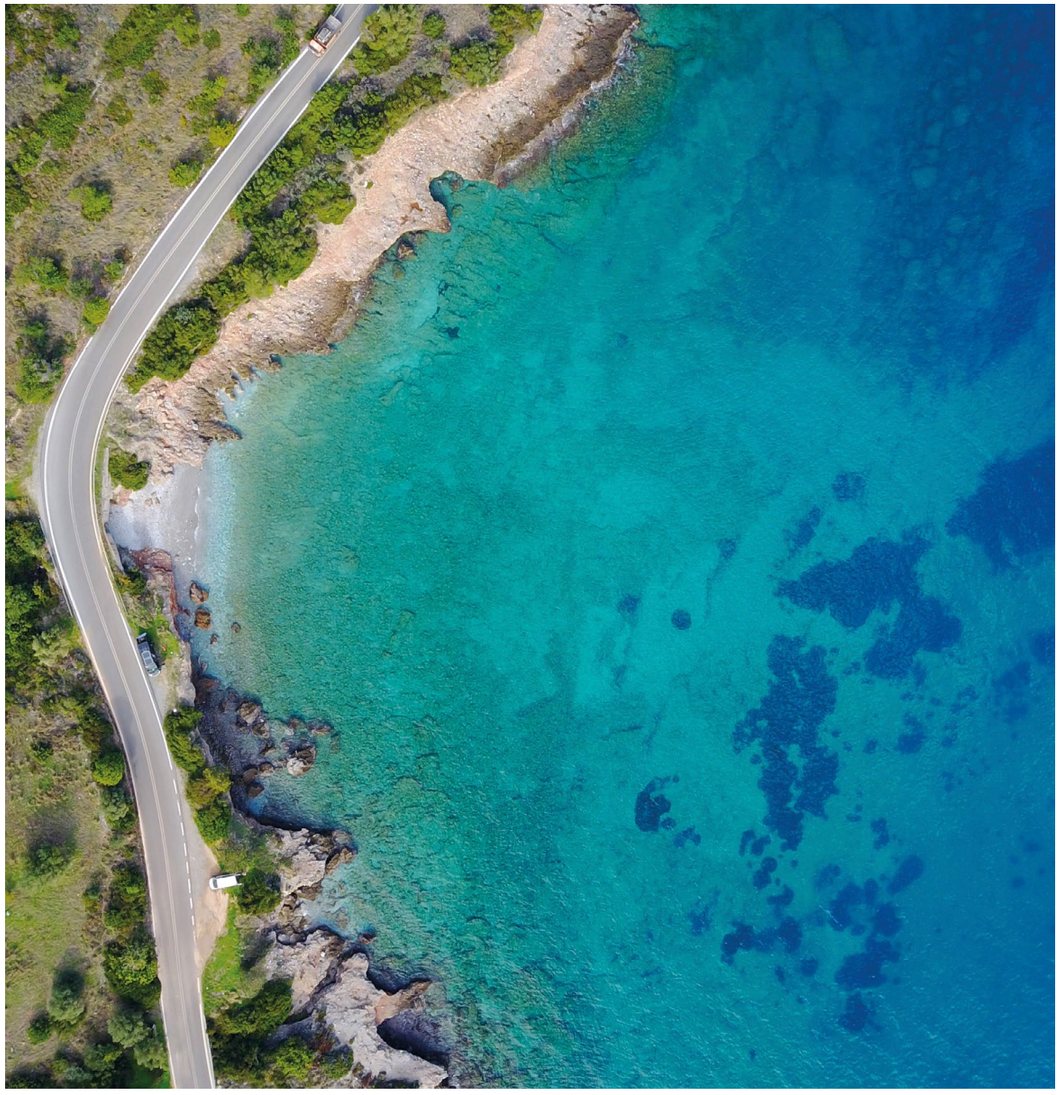
Park4night

Park4night is the holy grail of mobile phone apps for anyone with a campervan. It allows you to search a Google Maps style interactive map for van spots across the globe. Users can search for spots to spend the night, or add their own spots to share with others. You can search around your current location, or for a specific spot you plan on travelling to, and favourite any you're interested in. You can copy the coordinates into Google Maps to get directions to the spot.

Google Maps

Everyone has heard of Google Maps, and most will use it for its navigation function, for getting from A to B. But satellite view on Google Maps is an incredibly powerful tool. Scouring an area you're heading to and looking for areas that look like they have a potential camp spot, and then scoping them out on street view to check for any 'no parking' signs is a great way of finding park up spots. Obviously, it might not always go to plan - you can find a spot that looks perfect on Google Maps, and when you arrive it is absolutely not suitable, but equally, you can find some absolute gems. We always think it's worth a punt to try and find a new gem!

If you do try this method, you should always ensure to check local regulations, as some areas have laws against overnight vehicle camping.



ABOVE Rachel and George found this dream van spot on the edge of the Aegean. *George Sanderson* *@snowdoniaadventureactivities* **OVERLEAF** Convert a van, travel the world. *@we_who_roam*

Living your best van life

If you've made it this far, congratulations! You've battled through planning, nailed your design and conquered your build. Pack the van, escape the daily grind, it's time to hit the open road. We'll leave you to fill in the rest…

Safe travels, peace and love!

Charlie, Dale & Ringo

Afterword

Thank you so much for taking the time to read this book. We have poured thousands of hours into writing it, and really appreciate each and every one of you who has bought a copy. If you've found it useful, it would mean so much to us if you let us know. We would love to hear your thoughts and feedback, so please do message us on Instagram **@climbingvan** or drop us an email **hello@climbingvan.co.uk**. We would also really appreciate it if you could leave us a review on our website or Amazon, as we love reading every single one of them.

If you have used the book throughout your build, make sure to send us photos of your van and tag your photos on Instagram with **#vanconversionbible**. We are so excited to see your creations!

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