

# The Van Conversion Guide

Best  
Seller

14th Edition



Nate Murphy

**The Van Conversion Guide 14th Edition**

by Nate Murphy

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This eBook comes with a number of tutorial videos and downloadable schematics. These will help you create the various systems found in a van conversion.

Where you see the following two signs, there is a video, or a schematic, resource available.



### Mini-course Video



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You can access them by following the links below:

[thevanconversionguide.com/solarcalculator](http://thevanconversionguide.com/solarcalculator)

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### The Van Conversion Course

The logo for 'diyhero' is displayed in a white rectangular box. The text 'diyhero' is written in a bold, black, sans-serif font.

We have made the worlds most detailed van conversion course, with over 150 video tutorials, an exclusive online community and one-on-one Electrical System Design consultation included, learning how to build out a van has never been easier!

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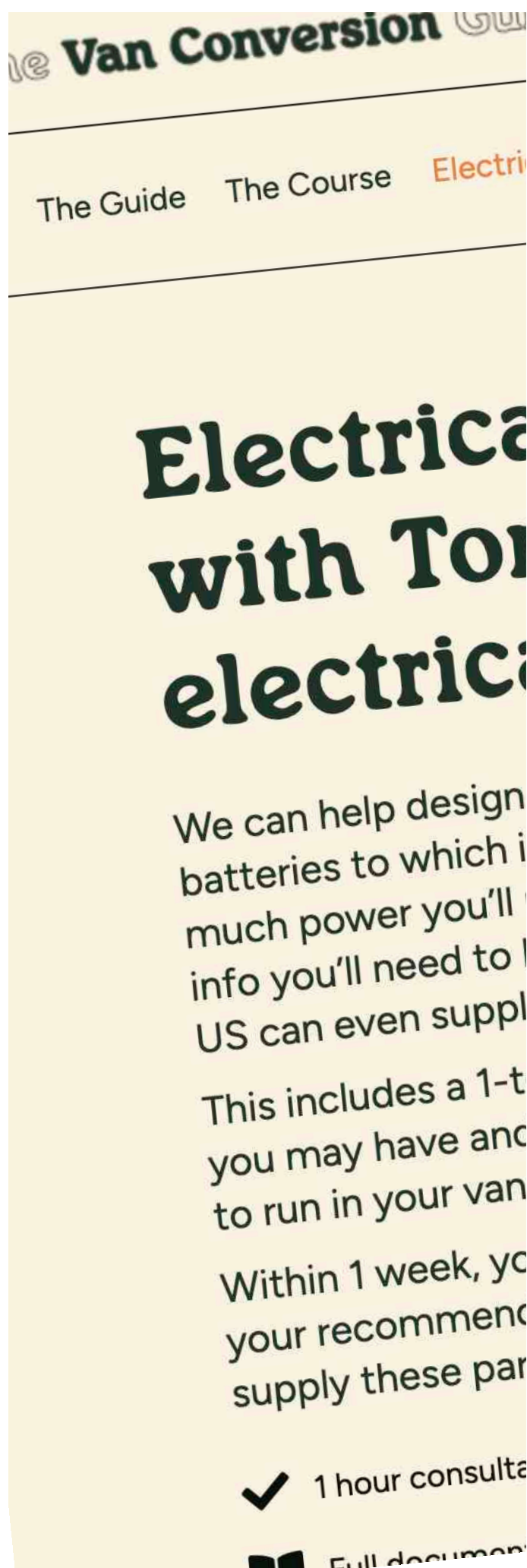
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Do you want expert support in the design of your electrical system? If so, you can purchase a one hour electrical consultation that will result in a detailed system specification.

You can order your consultation here;  
[thevanconversionguide.com/electrical-design-service/](http://thevanconversionguide.com/electrical-design-service/)

We aim to help you install a system that is both safe and fits your needs.





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# How to videos

If the links do not work: which happens on some devices, then copy and paste the link into your browser (chrome, safari, firefox etc..) and it should work fine.

The link **will not work** with in the YouTube App. Always use an internet browser!

## The DIYhero course demo-van



This is my latest van-build. It was built in order to film our detailed van conversion course and is relatively high in specification. This van has various innovative features and space-saving ideas.

This van is featured within various sections of this book, and the schematics featured here (and in the mini-course) are based on this van conversion. It has a king size bed, seating for four, an internal shower and an enormous kitchen.

Van Tour: <https://youtu.be/P1jWAV8Nn-Y>

## Citreon Relay / Promaster van conversion



I built this van to live in while I renovated a house (and for further adventures). This van has a few advanced features – and it's systems are shown later in this book.

This van featured a king size bed, tabled seating for six and a good sized kitchen. It had an out-the-back external hot shower.

<https://youtu.be/RRh1r4c424>

## Ford Transit conversion



I lived in this van for three years and the video about it has been watched more than 11 million times – helping thousands of people work out how to do a van conversion.

Although it looks great, it is still a relatively budget van conversion. It features very simple water and waste systems and low cost solar and electrical systems.

<https://youtu.be/wksm1x1Ms0>

## Small, budget van conversion



I converted a friend's van in a week. It was a much smaller van and we tried a few different things. It is a low cost conversion - befitting of the size and cost of the van.

Van build <https://youtu.be/GH8u9ELlvBA>

Van tour <https://youtu.be/MFH0ndvWP1E>



## Introduction

Thank you for buying this eBook!

Welcome to the 14th edition of this book! This book is never truly finished because there are always new products, systems or ideas coming on to the market that provide better options for converting vans. Because of this, I continuously improve it. This eBook also comes with video and schematics that you can view online - the videos will help you to better understand the 'how-to' parts, and the schematics give you something detailed to follow.

Originally I wrote this book as a guide for *'how I converted my van'* but now, six years, three vans, and a few hundred van-tours later, it now covers a broad range of options for the self-build van converter.

I am confident that the ideas and tips in this book will save you hours of work, help add to your own thinking, and perhaps most importantly, save you making some costly mistakes. I hope you find it useful!

I wish you the best of luck with your project!

Nate



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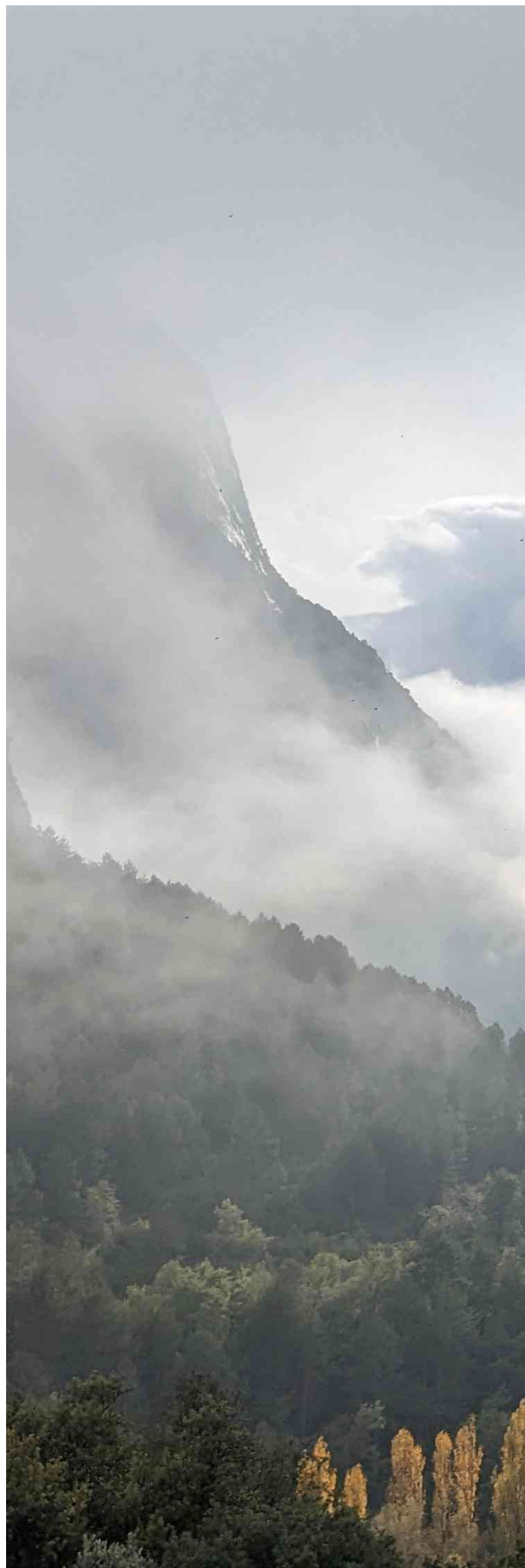
3. You should now be able to access tutorial videos and other schematics

## Get featured

If you happen to make something really beautiful - or interesting - and think it is worthy of touring for the Nate Murphy YouTube channel - get in touch. It is always great to share interesting designs.

## Disclaimer

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# Choices & design



# Choosing a type of van

The first big decision!

My choice of van came down to the fact that I planned to live in the van for extended periods of time - and therefore a bigger van, ideally where I can stand up, was the obvious choice.

If it was just a weekend van, which I used for other driving, or commuting to work, then I would probably go for something smaller and more fuel-efficient.

Typically weekend vans tend to be smaller, but if you plan to live in it full time - or for a very long trip - it is worth converting a larger if you can.

**I chose a long-wheelbase high-top van for the following reasons;**

- » Long Wheelbase; I wanted to have a full size bed so to leave room for other things it made sense.
- » High Top; I am 6ft/183cm and do not fancy having to stoop every time I want to cook - people say parking is an issue, but as I mostly live in natural areas not in city car parks - this has not been a problem
- » Citroen Relays (the same as Dodge Promaster in the US and Fiat Ducatos in Europe) are found everywhere. As a common van it is easy to get the parts should it need repairs.



Citroen Relay L3H2 - the same body as Dodge Promaster & Fiat Ducato

# Second-hand Vans

Most people buy second hand vehicles, but if you are going to put your heart and soul in to your build, you probably do not want to buy something at the end of its life.

**What mileage and how much to spend?**

This obviously depends on your budget but for my van I ended up spending more than I initially hoped - but this was based more on economics than mission creep.

My general aim was to spend no more than half the cost of the van on the conversion. This is based on the premise of the vehicle's mileage-based depreciation.

As an example, if I spend £4k (\$5k) converting a 10-year-old van with 200,000 miles on the clock, after a few years, regardless of the condition quality of the interior components the van will be coming to the end of its natural life. People will not want to spend too much on a van with an engine that might die soon.

This is based on any particular depreciation formula, but it seems to fit fairly well, and I think if you did some further asset depreciation analysis it would probably be in that sort of ballpark.

**My first van (Second Hand)**

I spent £7000 on the base van (2012 model - 4 years old at time of conversion) – in total it cost £8400 including taxes. Unfortunately, it is hard to find non-commercial sales so most of the time you get stung with sales tax. If you have the time you can sometimes find vans for sale privately but it is harder.



The additional benefit of buying a not-too-old van is that it looks fairly modern from the and I did not really have to do any rust repair work.





So, based on my £8400 van - my approximate max-cost for the kit-out is £4200.

This is obviously a lot of money but my aim for my first van was to use the van for a few years and then sell it for same amount I spent on it.

After 3 years of using the van, I sold it for £500 more than I spent building it. If I spent more time selling the I could probably have sold it for more – but turning a profit was not the point – I was simply happy to prove my original thesis that by doing a decent job in the first place I could make van ownership practically free.

The end result was that the van cost me practically nothing – if you add up three years of mechanical fixes (£750/\$1000) the end result was that my van cost me tiny amount of money per year to own. Now *that* is affordable rent!

## My Second Van (Bought new)

For my second van I bought a brand new Citroen Relay L3H2 (Enterprise) This van body is the same as a Dodge Promaster, Fiat Ducato or a Peugeot Boxer.



I bought it through my company – so money from my old van went into my pocket and gave me other tax benefits. If you can justify your van as a business expense it reduces the cost of ownership (it is always worth checking with your accountant).



I sold this van, with 10,000 miles (16,000km) on the clock for £38,000 (\$45k) and made approximately £15k (\$18k) in profit. This money stayed in my company in order to buy my third van as a demo van for the diyhero.me van conversion course.

### Van ownership can be free

As we can see from these examples, if you do a decent job on your conversion, and the van does not have incredibly high mileage, you can make van ownership either free, or even profitable.

This is great news for those of us who commit to building a van ourselves. Of course we commit a lot of time to building the van but even if we sell the van, we still keep new-found skills and experience - and these are intrinsically valuable.

## Layout and Design

The van layouts are always based on two things; a load of research and lots of thinking about what I need.

It is easy to start adding ALL the features, but I do my best to stop the wish list from becoming the shopping list! For me, mostly it would be one to two people travelling in my van but, as the van has three legal seat-belted seats in the cab, I like build in the potential to sleep three if needed.

Designing the layout of a camper is probably the most fun part of the planning process and it greatly depends on the following three choices:

- » Fixed or non-fixed bed
- » Internal shower, or not
- » The position of your kitchen unit

Once you make these basic decisions you can work out the details of their positions and subsequently seating, storage, and areas for electrical, gas and water systems.

I made these videos to help give ideas for different layouts:



10 Bed Designs

<https://youtu.be/1aXUzZCDhm0>



10 More Bed Designs

<https://youtu.be/1aXUzZCDhm0>



10 Kitchen Designs

[https://youtu.be/\\_FA2QI6Y4Po](https://youtu.be/_FA2QI6Y4Po)



## **Bed configuration**

If you are shorter, you can probably sleep comfortably side-to-side in many vans, but for me, a bed needs to be 'long ways' as I am too tall. The best thing is to get in the van and see what will work for you (remembering that you will lose a little width when you fit the van out).

## **Windows**

Where you put your windows will define some of the other elements of your design.

Windows are a mixed blessing – it is great to have more light, nice views and perhaps ventilation but if the window is single glazed (most bonded windows are) they can cause a lot of heat-gain when in the sun, and heat-loss when it is cold.

Because double glazed/skinned windows tend to be expensive and small I mostly use bonded windows. They are good value for money and can let much more light (and scenery) into the van.

## **Kitchen unit**

The next major decision for your van is where you put your kitchen - this determines what space is left for seating.

## **Bulkhead**

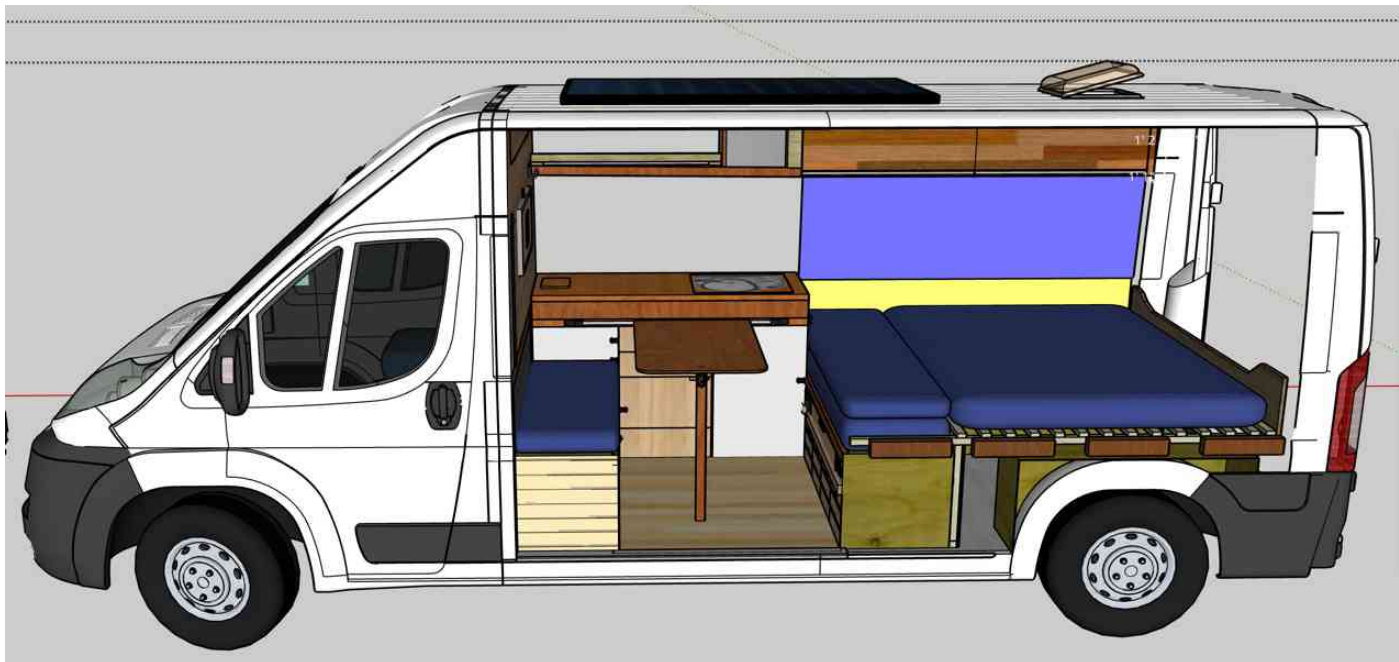
The bulkhead is the bit that separates the body of the van and the cab. Most panel vans have one made of sheet metal in place.

On both vans I have built I have separated the cab from the main living space although many people keep this open - and have a swivelling 'captains' chair (or two) giving them more seating and giving the van a larger area.

When done well this can make the whole van feel more spacious and can be a good option for a van conversion.

By removing the bulkhead (or perhaps your van does not have one) you can have swivelling seats which make the entire living space much larger - this can be a big advantage especially for shorter wheel-base vans.





## Featured Design 1

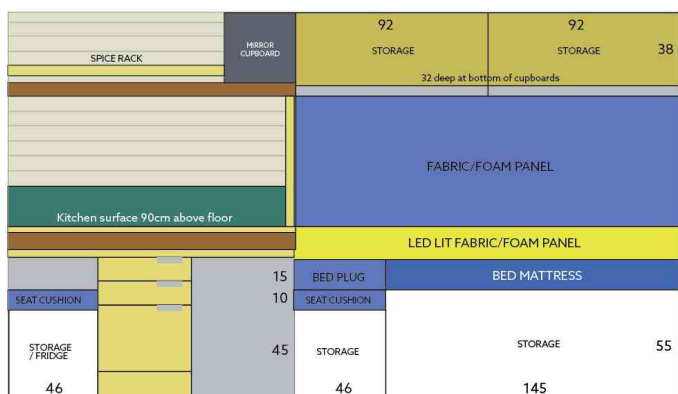
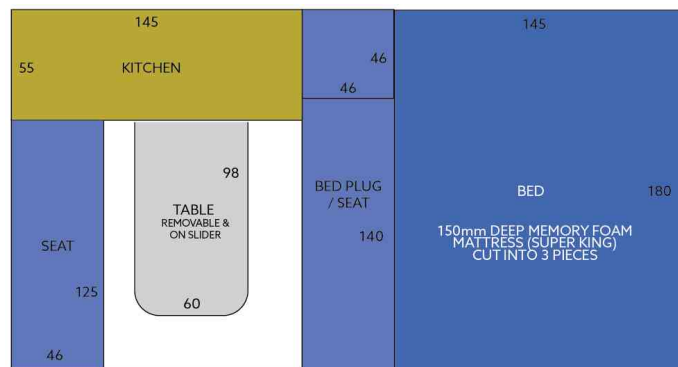
I lived in this van for two years (while I renovated a house) and another year I used it for trips. The spacious design made living in the van with my partner feel comfortable and not cramped, even when cooped up in bad weather.

This design features;

- » King-size bed (or double)
- » Seating for (snug) 6 around the table
- » Decent kitchen workspace
- » External hot shower
- » Ample storage under the bed
- » 70litre water tank
- » Fridge (slides out from under seat)

To the right are the basic measurements (in centimetres). If you want to copy it – feel free to do so. I really liked this design, the only thing I would add would be small windows by the bed (to allow airflow over the bed when the fan extracts).

Based on requests we created a 3D model of this van which you can get [here](#).





## Featured Design 2

This is the van that I built as a demonstration van for the [diyhero.me](http://diyhero.me) van conversion course.

This design is a modified version of the previous design that also incorporates an internal shower and toilet.

This design features:

- » King-size bed (or double)
- » Seating for 4 around a table
- » Huge kitchen workspace
- » Internal hot shower
- » 140litre twin water system
- » Fridge (slides out from under seat)
- » Safe (also under seat)

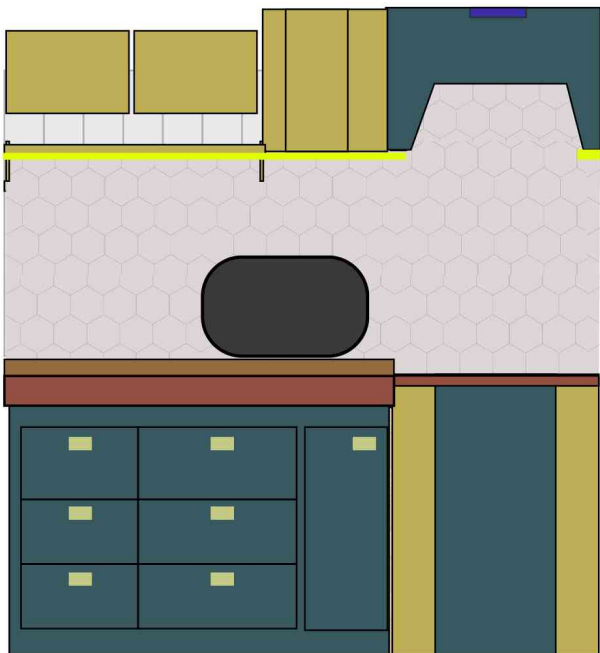
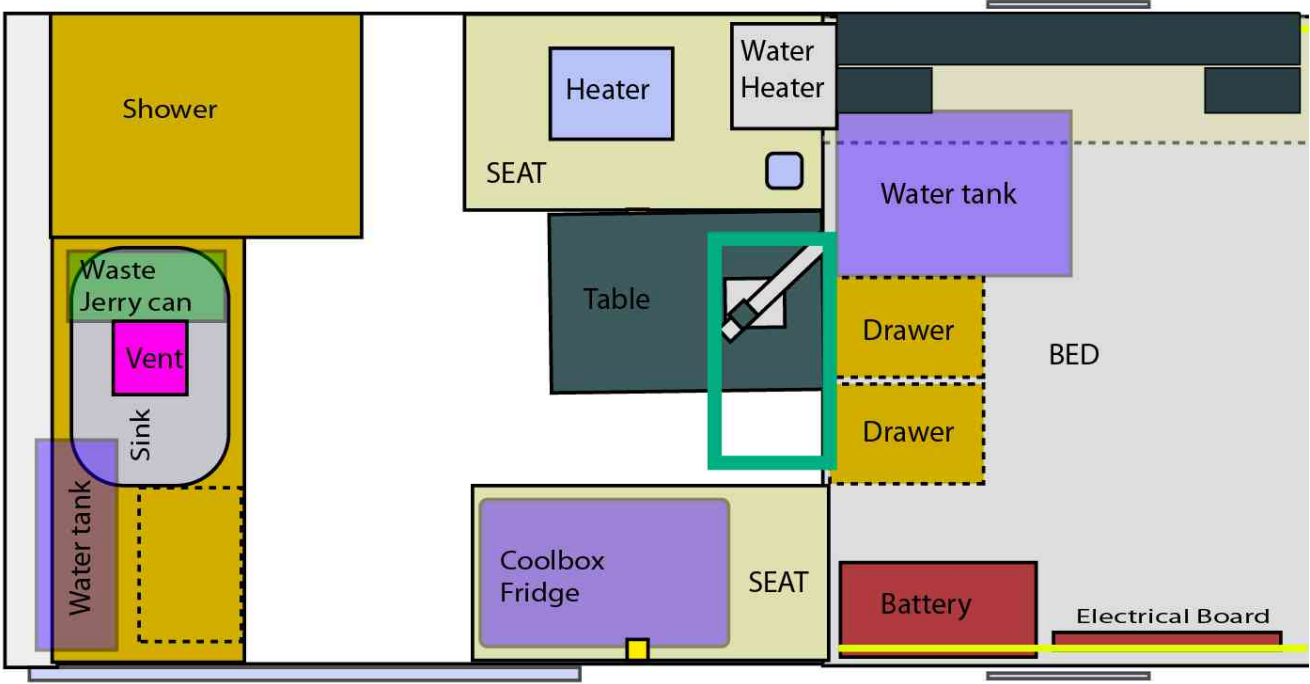


The images (on the following page) show my to-scale 'blocked out' shapes of various items and my general thoughts on where they should go. When the van arrived, I adapted some of these to match the reality of the van and it's structure.

The top cupboard and shelves around the shower changed from my designs (I added a shelf and removed a corner cupboard). Personally, I find it is best to have my overall design worked out, and then build around the appliances and van structures. This also leaves me with some creative freedom as I do the build.:

As with the previous van design, you can see that it is not very detailed, it is simply *enough* to work toward.

In the second and third images, I have 'gone over' the shapes in the above image and added colours, textures and even fabric designs to get a feel for how things will look. This was very useful because it helped me understand the final destination for the interior.





## Colour schemes

Having a background in design makes you go a little over-the-top in the planning stage.

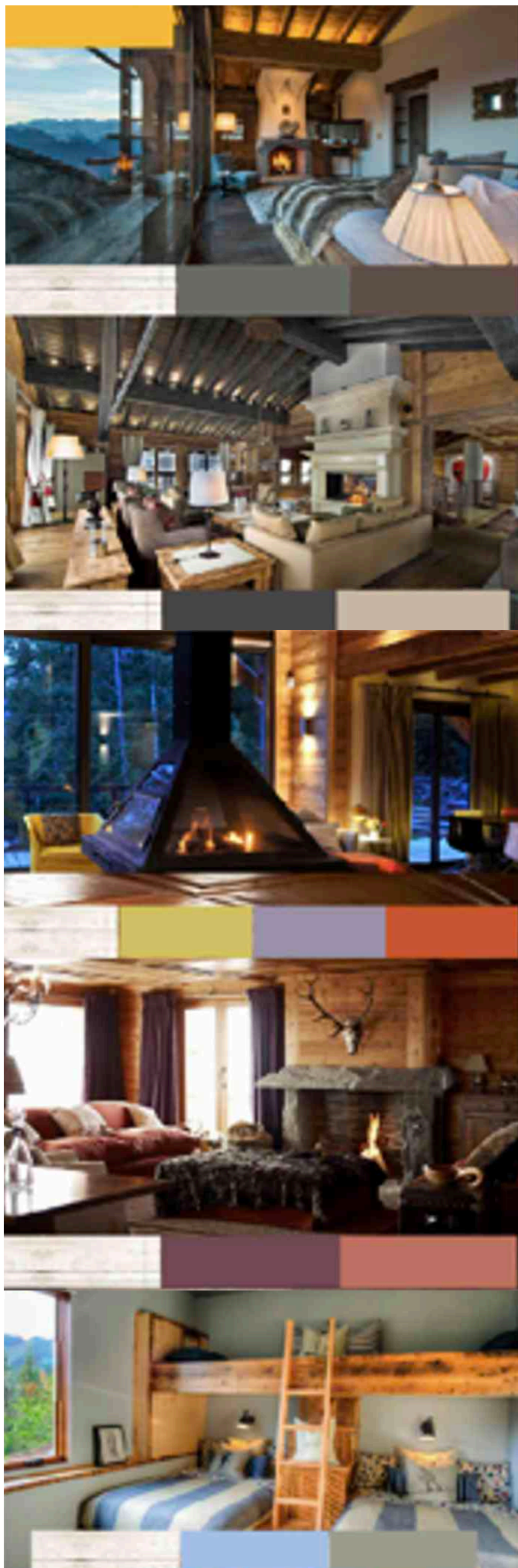
As the primary color in the van is essentially the colour of pine cladding – I looked for inspiration from ski chalet designs to find what sort of colors work well. I noticed the use of neutral colors with a tendency to have a warm, but slightly muted, color as an accent.

I liked the warm lighting effects – so when it came to my design I looked to recreate this in some way. I played with lots of colors in the design file – it seemed right. The hard bit was finding reasonably priced and suitable upholstery fabrics to fit my design ideas.

I usually use three colours in my vans:

- A main colour (for example blue)
- A highlight colour (say gold/yellow)
- Neutral colours (greys)

To the right is an example mood-board with various chalet interiors and the basic color schemes that guide them. It might help you think about how to 'borrow' colour ideas from the experts!





## Bulkhead

The bulkhead is the separator which, in many commercial vans, prevents things in the back from flying forward into the cab in an accident.

People often remove this, add curtains and a swivel chair and effectively make your van bigger and add extra seating. Others, like me, like to keep the bulkhead in for security, temperature management, and aesthetic reasons.

### Open Bulkhead Pros & Cons

- » More space
- » Adding a swivel chair means your seating area includes the cab
- » Easy access to the cab when its raining or in an emergency
- » Condensation on the windscreen (need to use foil protectors)
- » Privacy is more work to maintain
- » Van seats remind you that you're in a vehicle
- » Heats the van up faster in summer
- » Cools the van down faster in winter

### Closed Bulkhead Pros & Cons

- » Heats up slower in summer
- » Cools down slower in winter
- » Feels less like a van and more like a cabin
- » Less condensation on windscreen
- » Less space
- » Harder to access the cab (you can include a door/hatch)
- » More secure - harder to access the van interior via the front doors

In my first van, I made a large sliding hatch, and it was possible to go through it to access the cab without going outside.



In my second van (pictured in header image) I just had a small hatch - this would be really hard to climb through - it was more for additional light and to pass things back and forth (towels to dry for example).

In my third van, it was totally closed off. This is fine for me, a man who generally does not have to worry about the prospect of creepy men lingering around outside.

### A safety note for women

If you are a solo female traveller, I would suggest having a way to access your cab from inside the vehicle. I know of three women who have had incidents, where men behaved in such a way that they felt it was better to just get into the cab and drive away. Needless to say, having to leave your van and walk around it, in such a situation, is not ideal.





## Feature choice

This section will take you through all the key features - what options exist and their pros and cons. It will cover, heaters, showers, toilets, gas tanks, vents, split charge (or battery to battery chargers) and lighting.

First, a few of my perspectives on the big feature choices: heating, toilets, showers and fridges.

### Heating

When I was converting my first van for full-time living, a family friend assured me that adding a heater would be a waste of money. Thankfully, this time, I didn't listen to the advice.

In general, I like to be warm, and certainly I don't want to be cold all the time. Also, on a practical level, I have never dated someone who is warm all the time. I imagined being somewhere cold for a couple of months, with a cold grumpy girlfriend who wore every single layer she owned 24/7. Then I imagined how the world could be made much better place with the flick of a switch.

This thought process added a few hundred bucks to my build cost but, after living in that van for three years, I can tell you that it was one of the best decisions I ever made.

### Toilets

The reality is, if you are living in the mountains you are pretty OK to 'go' into the woods, dig a hole (far from paths or water-ways) do your business, bury it and take your toilet paper with you. Because of the places where I spend almost all my time (in fairly quiet locations) a fixed toilet was not really necessary.

In cities or towns there are toilets pretty much everywhere but not having a toilet can lead to problems if you have an emergency or forgot to plan ahead. Therefore, if you are going to spend time in towns or cities (or popular vanlife locations) I would strongly advise that you have some sort of toilet inside your van. This will make city-living less stressful and, in popular locations, it will also reduce the impact you have on the environment, and the communities, that host vanlifers.

My system consists of a couple of pee bottles in the van - kept under the sink - for when you cannot be bothered to leave the van (an old Nalgene for the girlfriend). Pee-bottles are a little gross, but you quickly get over that.

I have also purchased a small cassette toilet for the above reasons. It is fairly easy to use and dispose of waste (e.g. into a public toilet). You can read more about toilet options later in this guide.

For normal circumstances, I have a trowel.



## Showers

An internal shower takes up a lot of space and it requires a more complex and expensive system. It might feel like you *simply must* have an internal shower, but the true answer is that 'it depends'.

It depends on when and where you travel, it depends on how hardy you are, and the sort of travel you do.

*Here are three systems I have I installed:*

### Van 1 - Shower bag

For three years I washed in lakes and rivers or, when these were not available (or too cold), I used a solar shower bag - which I heated up in the cab of the van during the day. If the day was too cloudy I would add a saucepan of hot water to take off the edge.

I had a set-up with magnets and a shower curtain between the back doors. It was fine, not amazing, but it worked.



*Above; the solar-shower system I used for 3 years. The bag provides enough for two, fairly brief, showers.*

### Van 2 - External hot shower

In my second van, I built in a gas powered shower to replace the solar shower. Like the shower bag, it was fitted out the back of the van.

This required more kit (pump, accumulator, bigger water tank) but being able to have an instantly hot shower felt like a real luxury after three years of using a solar shower.

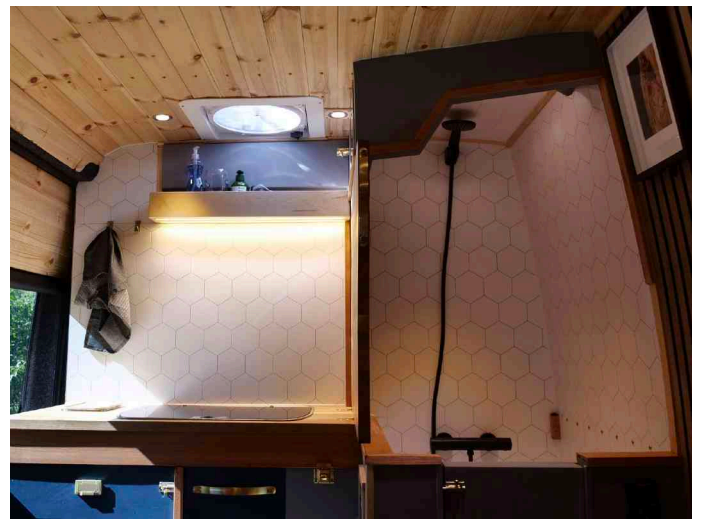


*The gas-powered shower being installed (it can only be used when the back doors are open).*

### Van 3 - internal hot shower

I wanted to demonstrate a full shower install for the van conversion course so I installed an internal shower into this van. It has a tanked gas powered water heater (you just turn it on a little while before you want a shower).

The shower wall is made from the counter top (I could not bear the idea of losing all that space - or the spacious feel that I like. It has a half-height shower curtain to stop splashes escaping.



This feels like a good solution for 'the shower problem' but it does add some complexity to the build. If building the van solely for my own use, I would be quite happy with the previous system - but I have to be honest, this internal shower is rather nice.

## Fridges

If there was ever an appliance that seems over-expensive it would be 12V fridges. My current van-fridge costs more than the fridge in my house. (Well it would have if I did not buy a refurbished unit, half the price of a new one!)

In my first van that I used for 3 years I did not have a fridge at all. As a climber, I spent most of my time chasing Autumnal conditions, so I could get away with out one. I found that the food storage area, being under the bed, was generally cooler than the rest of the van. Not eating meat, or buying soft cheese, made this pretty alright.

In my second van, I bought a Dometic cool box-style compressor fridge. This was expensive, but unfortunately cheap cool boxes can be very poor when it comes to energy efficiency which really takes a toll on your battery levels.

I did the same in my third van, it is currently my favoured fridge system, as it can easily fit in a slide out drawer under a bench.

We will go into fridges, and the different options, a little later in this book.

## What you don't install

Deciding what you don't install is perhaps just as important as figuring out you do. It is very easy to get carried away and end up with a van that requires a second mortgage.

If we are seeking adventure, this might not be so wise. We humans are pretty adaptable creatures, we can often make do with less. Not only that, but our desire to have *all the shiny things* might ultimately make our project so expensive that it stops us getting out there and experiencing the world.

Primarily, we need warmth, shelter, food, water, and friends. If your designs have got out of hand and you now 'need' \$150,000 in order to have a few months travelling - get back to the basics and start your thinking again.

Of course, you might be somewhat wealthy - good for you - build that fancy van! But for those of us who are not, we shouldn't let other people's luxuries build a barrier to living our dreams.

## Desire

We need to be careful about desire! When we are talking about desire, we are talking about an intellectual appetite for *things that we lack* and that *believe to be good*. In this sense, **a desire** is different from **a need**.

According to the post-war French social theorist René Girard, desire is not something that comes '*from within*' it is the product of a social process.

Girard called this *mimetic desire* (mimesis is the Greek word for imitation) and, as such, he saw these **mimetic desires** as desires we have because of our social influences. He recognised that it is human nature to be drawn to *what other people want*.

It is likely that if I perceive a product or lifestyle to be desirable, it is because someone I am exposed to has 'modelled' it in such a way that it appears desirable. The closer the people 'modelling' desires are to being *like us*, the more we are likely to pay attention, and internalise what they want. It is often the case that these social influences can drive our desires, without us being aware of the fact - it is always worth trying to understand where our desires come from.

So, really, this is a quick warning about social media (and those lovely influencers). We are easily led astray into other peoples desires, and these are *desires* - not *needs*.

As it is very easy to spend the equivalent of a year's worth of travelling budget on a bunch of luxury systems - I challenge you to stay mindful about *actual needs*, and keep check on your desires.

By all means, install some luxury items, just don't let them stop you getting out on the road.

# Fridges

Why have a fridge?

A fridge is fairly essential if you eat a lot of fresh meat, want to store soft cheeses, fresh milk or need a cold beer at the end of the day. Or, simply, if you spend a lot of time in hot places.

If you are mostly vegetarian or vegan you might be OK without a fridge especially if your food is stored low in the van and you stay away from very hot places - a standard non-powered cool box may be enough depending on where you travel.

For three years I did not have a fridge at all and for those on a tight budget, a standard cool box may do the job.

Otherwise, there are three main options for refrigeration:

- » **Thermoelectric Cool box**
- » **Compressor Fridge**
- » **Gas Fridge**

Which you choose will largely depend on your power system and what the van is for. If you are living off-grid full-time you will have different requirements than those building a van for weekend use.

## Thermoelectric cool boxes

Thermoelectric cool boxes that run on your 12V system can be a good budget alternative to the more expensive options that follow.



If you turn it on in the day while the van becomes warmer (and you have plenty of solar) it can then stay cool enough throughout the night.

These are typically not very efficient and this poor performance is reflected in the lower

prices.

**Best used for:** Occasional Road Trips / Vegetarian travellers

**Search for:** Electric cool box, travel fridge, TropiCool

**Powered by:** 12v/24v DC and sometimes with 240v AC

**Cools to:** Around 20°C to 30°C below the ambient temperature (cold enough).

**Power consumption:** 30 – 80W

**Price:** Ranges from \$100 (£80) to \$500 (£400) depending on size and quality.

## Compressor fridges / 2 way

Compressor fridges use a compressor to circulate the refrigerant and can be powered by 12v or by mains power (hence 2 way). They come as normal style fridge units, cool boxes or as drawers. Basically, these are like a normal domestic fridge but smaller.



**Best used for:** Long-term van living & self installation

**Search for:** 2 Way, Compressor Cooler

**Powered by:** 12v/24v DC and sometimes or 230v AC

**Cools to:** Below freezing – down to about -10°C

**Power consumption:** 50 – 75W

**Price:** Ranges from £270 (\$350) upwards

If you have a decent solar & battery system (around 300W solar, 150 usable AmpHour battery) then you are probably going to be able to run a fridge like this. A long spell of warm & cloudy weather could be difficult to keep it



running though.

This is probably the happy medium for most people who need a fridge; it is easy to install – does not need external ventilation and has a reasonable price point.

### **Absorption refrigerators / 3 way**

If you like to camp off-grid or away from campsite electricity, these fridges offer you an alternative to compressor fridges.

On the downside, this type of fridge requires ventilation through the external side wall of your van and it needs to be level to work correctly.



Gas powered fridges do run silently – this is a big pro for those who sleep lightly but they do have a more complicated installation process and should be installed (or at minimum checked) by a qualified gas fitter.

If you need a fridge, and have the budget, these do allow you to run off-grid long-term pretty effectively and if you are using refillable LPG then it is a good value way to keep your food cool.

**Best used for:** Long-term van living, those with refillable LPG systems

**Search for:** 3 Way, Absorption Fridge, LPG/ Propane fridge

**Powered by:** Gas, 12v/24v DC and sometimes or 230v AC

**Cools to:** Below freezing – down to about -18°C

**Power consumption:** 50 – 75W

**Price:** Ranges from £350 to £1500 (\$500-\$2000)

### **What I use**



The Dometic Waeco CFX35 (I have previously used the smaller CF26). They both worked well, have a decent capacity and are fairly quiet when the compressor is running. (It comes on and off to maintain the temperature you set).

# Gas systems options

**WARNING:** Your gas system could kill you. Get your gas system checked by a qualified gas fitter. It is really worth it. Regulations are different in different countries and this will probably define your installation – find out what they are before starting.

**ADVISORY:** Install a Carbon Monoxide alarm and a Gas Leak detector. It is worth it.

## Gas system options

Do we all need under-slung refillable gas systems with remote sensors and copper pipe fitted throughout the van? Of course not - as always it comes down to what you are using the van for and what budget you are working with.

**These are the main options:**

**Budget; disposable canisters (cooking only)**



The cheapest easiest system is essentially a cartridge style camping stove. For weekend use this might be enough.

## Exchangeable vs Refillable



Exchangeable canisters are popular and are good for domestic or short overseas van-trips. Campingaz and Calor have a range of different cylinders which can be used and replaced in garages or similar.

Canisters do not tend to be swappable in different countries so, for longer overseas trips, I would lean toward a refillable LPG system.

## Refillable gas system (LPG/Propane/Autogas)

This is my system of choice, I can fill the tank (without removing it from the van) via a fill point on the exterior of the van at gas stations that sell LPG/Propane.

### Why LPG/Autogas?

If you use normal propane/butane tanks you need to exchange them when you run out of gas. This is fine, but as cylinders can vary from country-to-country it means that, depending on where you travel, you may need more than one cylinder. You may also end up being given a tank which is in bad condition and hard to exchange again when home.

LPG (Autogas / Propane) however, the gas that some people power their cars with, can be filled up at many gas-stations throughout the world. This is not *all garages*, but considering how infrequently you will need to fill it up this usually is not a problem.

There are various apps that help you find gas-stations that have LPG/Autogas top-ups.

It costs me around £18/\$22 to fill up my 20kg tank. Over a year my gas bill is approximately £100/\$125 which is not bad as an annual heating & cooking bill.

### What size tank do I need?

To give an example based on my experience:

» In summer, 11kg of gas lasts about 3-4 months in summer

» In winter, 11kg of gas lasts about 1 month in winter (using the heater quite a lot)

If you are running other systems from your gas (fridges, other hot water systems or frequent showers) it will run out faster. Therefore, the more systems you have the larger the ideal tank for you.

In my experience, filling up the gas once a month for 3 months of winter is not a big deal.

### Types of refillable systems

The two main options for a refillable gas system is to have a canister inside the van (in a vented, sealed, gas locker) or fixed to the underside of your van in an under-slung system.

## Gas tank inside the van

If inside the van, your Gas Canister should be in a vented sealed locker.



You can buy lockers that fit the gas-canisters from various suppliers, or you can make one yourself, the key thing is that it must be sealed and vented through the bottom of the van.

The gas bottle must be vertical, it cannot be laying down (always follow manufacturers guidance).

You can use a smoke pellet (usually purchasable through hardware stores) to test your gas-locker to ensure that it does not leak anywhere but out the the bottom of your van.

If you are going to rent out your van or think you might want to do so in the future, I would strongly recommend having your gas system installed by a qualified gas engineer who can sign it off as gas-safe at the same time.

It will cost a bit of money but if the end result is that you can profit from you van then the cost will be fairly negligible in the long term.

## Under-slung gas tank

Under-slung gas systems are typically more expensive and more complicated to install. They do have the advantage of not taking up precious space within your van and can be safer because all high-pressure systems are on the outside of your van.



Under-slung gas systems will have a fill hose that attaches to the side of your van (or can the wall of the van) and the regulator, and hose that connects it to your tank, will also be fixed to the underside of the van.





## Heating systems

You essentially have three options for heating your van; **Gas, Diesel** or **Wood**.

Heating takes a lot of energy and you won't get enough from a solar system (that you can fit on your roof) to heat your van – especially considering that on cooler weather often you have less sun. So – electric heating is not an option.

### Gas heaters



These work well in combination with a refillable propane or LPG tank. They are not too expensive (£450 ish) and not too hard to install – ideally this is installed by someone qualified to do so and at minimum checked by a gas engineer.

### Gas heater pros & cons

- » Cheap to run if using refillable LPG/Propane
- » Fairly easy to install
- » Runs on thermostat

» Fan can be a little noisy

### Diesel heaters



These generally need to be installed by someone who knows what they are doing and cost around £800 or more – they tap into the fuel line and are a reliable way to heat your van.

You can find *Chinese Diesel heaters* for about £150 (\$200). They usually require a little Diesel tank to be filled somewhere in the van and tend to be quite noisy (more for those outside your van) but they do work.

Both proper Gas and Diesel heater options takes air from outside, burns fuel and vents the exhaust outside the van. Gas heaters that don't can be dangerous!

### Diesel heater pros & cons

- » Runs from diesel tank and on that basis you will not really run out of fuel
- » Can be mounted entirely outside of the van so saving space

- » Runs on thermostat
- » Typically uses more electricity to run than Gas heaters
- » Needs servicing from time to time
- » Fairly expensive

### 'Chinese' Diesel heaters



These came onto the market several years ago and are a popular budget option

- » Pretty cheap (£150)
- » Easy to install
- » You need to fill a separate internal tank with diesel – this can mean you have an additional small diesel tank in the garage (and diesel smells if you spill it)
- » Typically uses more electricity to run than Gas heaters
- » These tend to be quite noisy (esp outside the van) which might annoy your van neighbors or near-by campers

### Wood burners

Some care needs to be taken to avoid fire risk & carbon monoxide poisoning but can be a cheap option even if it does take up quite a bit of space.



### Wood burner pros and cons

- » Can scavenge to get free fuel
- » Takes up a lot of space
- » Requires storage of wood inside the van (to keep dry)
- » Requires finding/buying wood for burning
- » Takes time to light/get going
- » If in very cold weather, either you need to keep feeding it overnight or wake up to a cold van
- » Can make things smell a bit smoky
- » The chimney sticks out above the van (another thing to cast shade on solar panels)

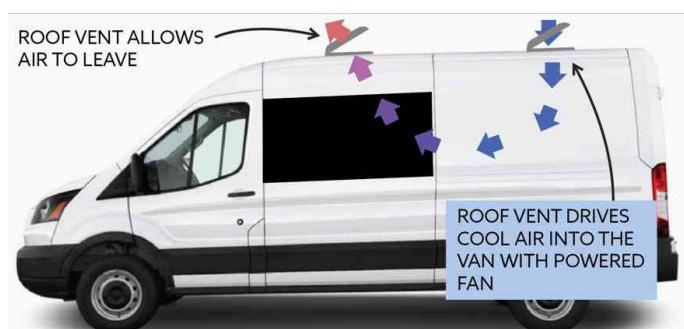


## Roof vents

A roof vent is useful for extracting air while cooking, for helping to cool the van, enable airflow during the night, and to let natural light enter the van. There are a few brands of roof vent (Fammia, Thule, Maxxair) with different models and price points.

### Dual roof-vents for hot weather

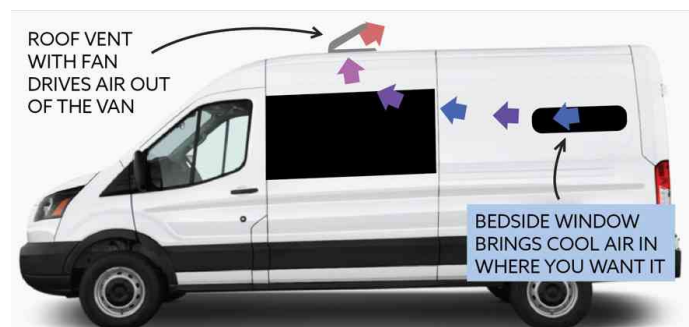
A good and commonly used system for cooling a van at night is using a dual vent system. Ideally one (or both is powered) enabling a circulation of air.



Through the use of windows (usually by the bed) or two roof-vents you can create a circulation of air that can quickly bring the temperature of the van to match the cooler night time temperatures outside.

The downside is that two roof vents does take up valuable solar panel space! To avoid this you can have one powered fan and a couple of opening side windows - see the following

image. (I have used this system, and love it).



### Powered fans

Having a roof vent with a powered fan gives you a few advantages;

- » Ability to draw in cold air at night – or to help the van stay cool during the day
- » Ability to extract cooking steam or stuffy hot air

There are a few powered roof vents on the market, but the fans I have direct experience with, and therefore can review are as follows:

- » Thule Omnivent this fan has more of a broad effect, it sort of distributes the air all around the van. The wind-up and down handle is stiff and a bit awkward to use. It is not too expensive. I would give it 2 stars.
- » Maxxfan Deluxe (with remote) more expensive, but it boasts some great features. It can be used in the rain, the remote control is excellent and it opens and shuts electronically. I give it 4 stars and think it is worth the money.



## Mushroom vents / Extraction fans

If you have installed a skylight (especially if it has a powered fan) you probably do not need a separate extraction fan for cooking. If however, you are not installing a large roof-vent then it is worth adding some form of extraction fan for use when cooking.

I installed one on my first van. I cut a hole in the roof for the extraction fan (it has to fit within the roof runnels else the rubber seal will not work).



The extractor fan simply has to fit in to the hole and be screwed to the vent part. I had to find some longer screws for it to reach. The insulation and cladding meant the screws that came with the unit were not quite long enough.



This mushroom vent cost about £30 (\$35). It is one of the few 12V vents I could find online – and it is not the greatest product. It is quite loud but it does work.



## Shower design

There is nothing like a missing shower or toilet in a van tour video to get people commenting! On a practical basis however, adding one – or both – can add quite a bit of complexity to your build.

Here is a short film with ten different camper van shower systems:

<https://youtu.be/VZkYE1K43cM>

### Simple, non-built-in shower solutions

Built in showers take up space, need special systems for water heating, a larger water tank and probably a grey-water system. Typically, a built in shower stores a toilet, either built-in, or cassette.

If however, you do not want to take up a lot of space - that you only use for a few minutes a day - then here are a whole range of other options!

### Option 1. Solar shower



I used this for 3 years in my first van. I would leave the Solar Shower in the front of the van to heat up during the day and if I want a shower, I would hang it on the back doors, use a shower curtain held on by magnets and have a shower.

It is OK. In winter, if the weather is bad or it is cold, than it is less than ideal. You can always put a saucepan of hot water into the shower bag to take the edge off the cold.

### Option 2. Weed killer bottle

You can use a pressurized weed killer bottle and shower using the spray. Do not use a used one for washing your body – weed killer tends to be incredibly toxic. Again, with this option you can put in warmed up water.

### Option 3. Solar roof rack



These are pretty good if you are travelling in warm and sunny places. They can be a really effective ways to deliver hot water for showering.

### Option 4. Bucket / battery powered showers



This electronic product simply pumps it up to the nozzle from a bucket. You could also use a metal bucket and warm the water-up direct from the hob. This is a simple and cost effective system and the unit charges via USB.

### Option 5. Portable gas-powered shower

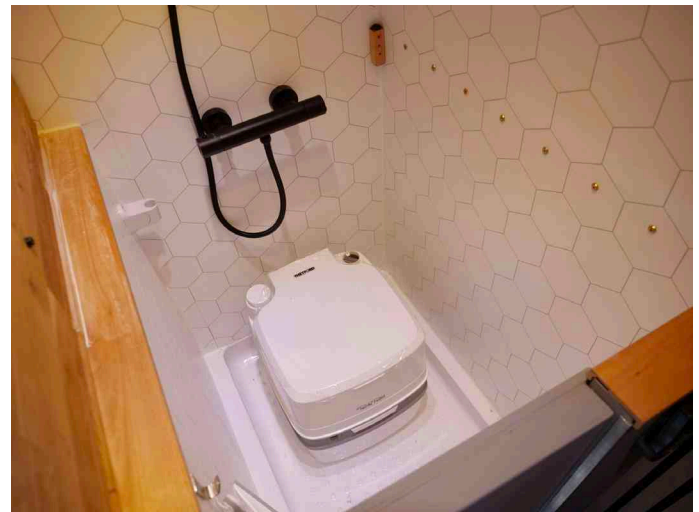


These systems can be fitted to the back of your van and can be connected up to a gas bottle and are for outside use only (not suitable – or safe - for permanent internal shower)

Above is is the Costway gas heater. If you search for 'gas shower heater camping' you will

find many options.

### Built in shower – pros, cons and installation basics



It probably seems crazy to a lot of people why you would not have a shower and toilet in the van. So if you decide you want a full on shower room in your van - fair play!

Pros of a built-in shower:

- » Get a warm shower in any weather
- » You can build-in or contain a toilet too
- » As close to house-life in a van as you can get

Cons of a built in shower:

- » The system you need; water heating, larger water tanks, add significant work and cost to your build
- » The shower 'cupboard' can take up a lot of space in the van
- » Waste water – you can add a grey-water tank (or let it just pour out under the van – when using organic-friendly soaps away from others)
- » Having your van level becomes more important





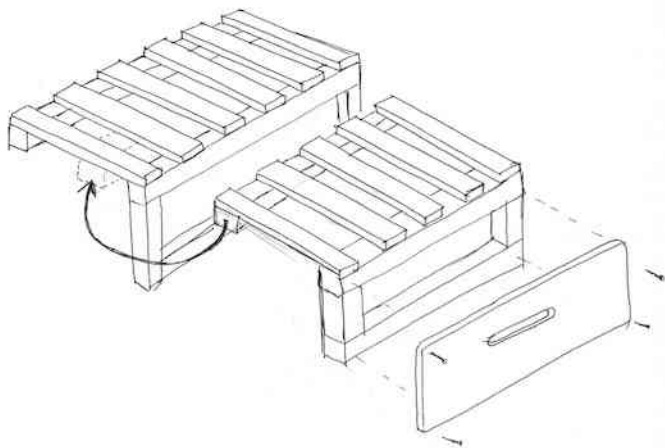
## Bed designs

Aside from a fixed bed which has the advantages of maximizing storage, reducing your daily admin but does reduce seating area options.

Here is a video with 10 different van conversion bed designs:

<https://youtu.be/1aXUzZCDhm0>

### Slide out bed

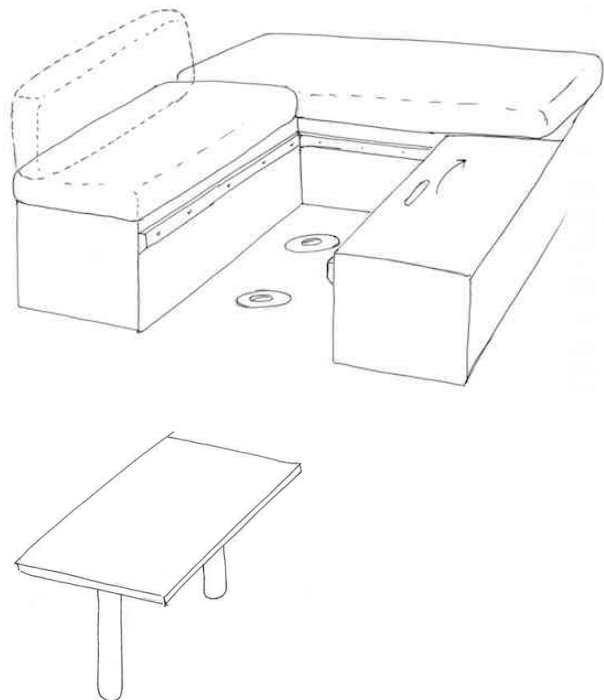


This popular and easy-to-build system uses two mattresses which serve as a back-of-seat as well as the other half of a mattress.

To construct put the parts together you need to insert 'slide part' in place before you screw down the slats on the static section!

You can see an interesting implementation of this system in a small space here; <https://www.youtube.com/watch?v=m0elTKz5qhU>

### Table and bed system



This is also a fairly standard design which gives you a table and a potentially very large bed. The table-top sits within the 'hole' and is supporting by a strip of wood that goes around it. Usually people use two cushions (that squeeze fit) to cover the table top and create backs to the chairs.

Under the seats is typically used for storage, accessed by lifting the cushion, or for battery and electronics storage. The legs detach totally and can be stashed somewhere over night.

Search for 'Island table leg sets' to find the kit for this kind of table legs.

### Bed plug to bench

This is the table and seating area in my second van – it can seat a snug six and the table is great for working on (where I am writing this right now).



### The Table Leg

The table leg has a simple construction for the folding mechanism. I added a slider bolt to prevent the whole table going down should someone accidentally kick the leg in. The pivot bar is 6mm threaded bar (the same I used to attach the stud-work to the ceiling structures).

The table is made from 9mm (3/8 inch) Hardwood Ply and is connected to a camper-van slider rail (a part I bought on ebay). The leg is hardwood and it's construction – specifically how to stop it collapsing on people is detailed below.

The bed-side seating area is created by removing the 'bed plug' which is part of the memory foam mattress that I cut off and turned into a removable cushion. The bed-plug itself can be used against the back of the van to make a comfortable lean-to back. (See 3rd image)







## Toilets

The age-old question; 'Where do you sh\*t?'

Here is my take on it. If you are in a city, there are bars, gyms, restaurants and cafés with toilets open from around 8am to 1am in most places. This covers you for the basic needs but if you get caught short, its really not ideal - therefore having some kind of toilet for emergencies is well worth it.

If you are in popular vanlife places - or plan to go to them - again, just for the sake of the local area (and the people who live there) get yourself some kind of toilet.

If you are in the wild – then you can nature poo anywhere. Just take a trowel and go for a 'Pike' (poo-hike). Dig a 6 inch hole and away you go. Best practices is to dispose of the toilet paper into a bin and don't go anywhere near a stream or river.

### Do you need a Toilet in your van?

A guide (clue, probably)

[https://youtu.be/xlDpZ91S\\_vY](https://youtu.be/xlDpZ91S_vY)

For those of who prefer their comforts or are perhaps a bit older and dashing to some woods is not ideal here are the main toilet options;

### No toilet (pee bottle)

A pee bottle is kind-of nice, saves going outside in cold or rainy weather.. or if you just don't feel like dressing yet. Nalgene wide mouth bottles can work for women if they work out their aim.

### Portable toilet – cassette toilet



There are a wide range of portable toilets which use chemicals to flush, clean and manage odours. You can make a space in your van where it can slide away when not in use. These are ideal especially for when you are caught without a non-van alternative.

They are not maintenance free and you can usually empty them at any normal fill point or other mains-connected toilet.



The main advantage is that they take little space. There is no additional build required and for a relatively small amount of money you have a toilet in your van.

### **Fixed-position - cassette toilet**



These toilets are the middle ground between a portable toilet and a fully plumbed in toilet that goes to a black water tank.

These cassette toilets are best when integrated into a shower unit. The seat/bowl typically swivels to give more room in the small shower space.

The cassette is removed from the back of the toilet and therefore it is usually placed with the back facing in-to the van so it can be accessed.

These fixed units (that can be plumbed in) cost more – around £500.

Again the cassette can be dumped into normal mains plumbed toilets or at waste dump sites in campsites etc..

### **Built-in toilet with black-water tank**

A built in toilet brings the requirement for a black-water tank. A 'black water' tank (toilet waste) needs a big hose to empty it – and a grey-water tank to empty after so the black water hose is cleaned up.

This is not really a suitable set-up for most van conversions, especially off-grid conversions as you need proper caravan waste dumping facilities fairly frequently to deal with the waste. I will not delve into these requirements in this book but if you search for adding black water tanks / plumbing in a flushing toilet for your van it should be fairly easy to work it out.

*Note; in the US black water holding tanks are pretty normal and there tends to be lots of dump sites. In Europe dump sites are much less prevalent therefore a cassette toilet is recommended*



## Sound system choices

I looked in to sound systems but it got fairly complicated - needing amplifiers, speakers, and Bluetooth modules, and it was looking quite expensive. On top of that there is a space aspect, where will the speakers go?

In the end I decided not to bother and went for the simple solution - a USB charged Bluetooth speaker.

I think this is best option for the following reasons;

- They can deliver great quality sound
- You can use them on your adventures outside the van
- They are powered by USB – simple is best!
- They can connect to your phone
- If it breaks – it does not affect the van build
- You can move it around the van as you wish
- Technology goes out of date? No problem.

For me it was a relief not to have to think about an inbuilt sound system and this solution is far better.

I am a fan of the JBL Flip series (waterproof) – good sound & portability. The total cost is less than just the amplifier component of an inbuilt sound system – and these are more than enough for the space of the van.

*See above, I use a couple of fold-away hooks (Ikea) to hold the speaker out the way.*

## Van Safety



I recommend having a gas leak detector, a carbon monoxide detector and a fire extinguisher at minimum.

Lots of people think you must put the detectors low down - but on all commercial builds you will see them placed higher-up. Although gas and carbon monoxide is heavier than air, the space is small and the nature of gas means that the detector will work anywhere.

I bought a fire extinguisher and put it in its own little alcove – it feels out the way (but easily in reach) and does not affect the over all look of the van very much.





# Van security

There are three types of security you can install into a van conversion:

1. Prevention of the theft of the van itself
2. Prevention of access to the van
3. Prevention of contents theft (if accessed)
4. Personal safety

## Prevention of the theft of the van itself

A big part of stopping someone stealing your van is making it appear to be more effort than it is worth (or at least less attractive than the next van).

### Steering wheel locks

These make it hard to use the van if you were able to start the engine. A skilled or tooled-up thief will probably be able to remove it but it does act as a deterrent.



### Pedal locks

A pedal lock is another way to prevent someone driving off with it. They are effective but are a bit more effort to fit on and off - and provide less of a visual deterrent.



### Kill switches

You can install a number of different switches to your van, including a switch that cuts off the fuel pump, the battery, ignition of fuse-box. These are typically hidden (or in some cases remote controlled) switches that make the van appear to have something wrong with it. The idea is that the thief tries to start the van, thinks that the battery is flat (or something) and gives up.

## GPS trackers

A GPS tracker does not prevent theft but it can enable law enforcement to find the vehicle. Sometimes thieves steal a van and drive it somewhere else so they have time to go through it and unload whatever they steal. They just leave the van wherever they parked it, meaning that your van could just be sitting a mile or two away and a tracker can enable you to find it.



Typically the better trackers require a monthly subscription to access the ongoing service they provide.

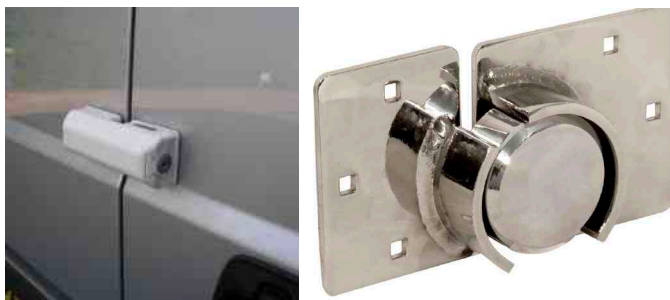
## Prevention of access to the van

In general, vans are not actually very hard to break into. Sliding doors can be jimmed and back doors can be popped open using a crowbar and enough force. Thieves know this and have learned how to break into the popular models.

### Additional deadlocks

The best way to protect your doors from forced entry is to install additional deadlocks. These heavy duty locks and plates are bolted into your van and make it substantially harder to access your van via the doors.





### Window security film

The windows are a significant weak-point in your van and if you can easily break a window and get into your van, then all the dead locks in the world are not doing you much good.

Window security film, primarily useful for large glass bonded windows means that if someone tries to break through the window the film sticks it all together - making it really hard to get in. This film is can be applied yourself, or by a company that specialises in it.

When smash-and-run theft tends to happen in a few minutes, this additional difficulty may well put off a would-be thief. You still have a broken window, but the stuff inside your van is safer.

### Prevention of theft of contents

Apart from the annoyance, and the cost of repair, if someone does break into your van, they are breaking in for a reason - and typically that reason is easily sold valuable items.

### Bulkhead

If you keep your bulkhead in place, it makes it much harder to access the body of the van through the cab (which, by nature of design, is vulnerable to break-in). This in itself can be quite a good deterrent. If you have a slider door, or hatch, you may consider making it the same colour as the rest of the bulkhead, or using a solid material to make it look (or be) impassible from the outside.

### Hidden compartments

If someone breaks into you van, you can use hidden compartments which are really hard to find. As a typical opportunistic break-in is happens quickly, thieves are focusing on quickly opening and emptying all the cupboards to find valuable items, therefore hidden compartments can be effective.

### Install a safe

Installing a safe can be a good idea, especially to protect important documents or electronics.

You can screw this into the floor of your van or build it into furniture. Of course, a well tooled up thief could probably break into it, or prise the safe out of the van - but it is unlikely that most thieves would bother.

### Personal safety

Last but not least, your safety is pretty important - and this section is especially important for women who travel alone. I have two key recommendations for this:

Have a way to access to the cab  
It is a really sad fact that women who travel alone are often harassed and this is no different for travelling in a van. Almost every woman I know who has spent considerable time living in a van has a story of some form of male harassment.

These may not be stories of someone aggressively trying to gain entry to their vehicle, but they were situations scary, or creepy, enough that they were very glad of being able to get into the cab and drive away without going outside of the vehicle.

The bottom line is, if there are concerning men, or concerning behaviour, outside of your van - by leaving the van you are placing yourself in more danger and at greater risk of direct contact with the people who worry you. Just staying inside the van is also an uncomfortable option - it is much better to be able to drive away and park-up elsewhere.

Therefore, I would recommend having a way to access the cab from inside the van, this does not have to be a full size door, but at least something you can get through if you want to in a hurry.

Internal locking of doors  
Old vans often do not have a way to lock the doors with the touch of a button. For the same reasons as above, and generally to sleep better at night in sketchier park-ups, it is much better to be able to lock your doors from the inside.

## Prevention!

The reality is, if thieves well tooled up, then nothing will stop them from getting into your van, so the main aim is to reduce the chances of being a target of opportunistic thieves.

Always, prevention is better than the cure. Much of this will be to do with where you leave your van unattended. Check for broken glass on the ground (a sign of previous break-ins). Consider paying for parking in more suspect places.

Check this video out - it has many ideas for different security systems.

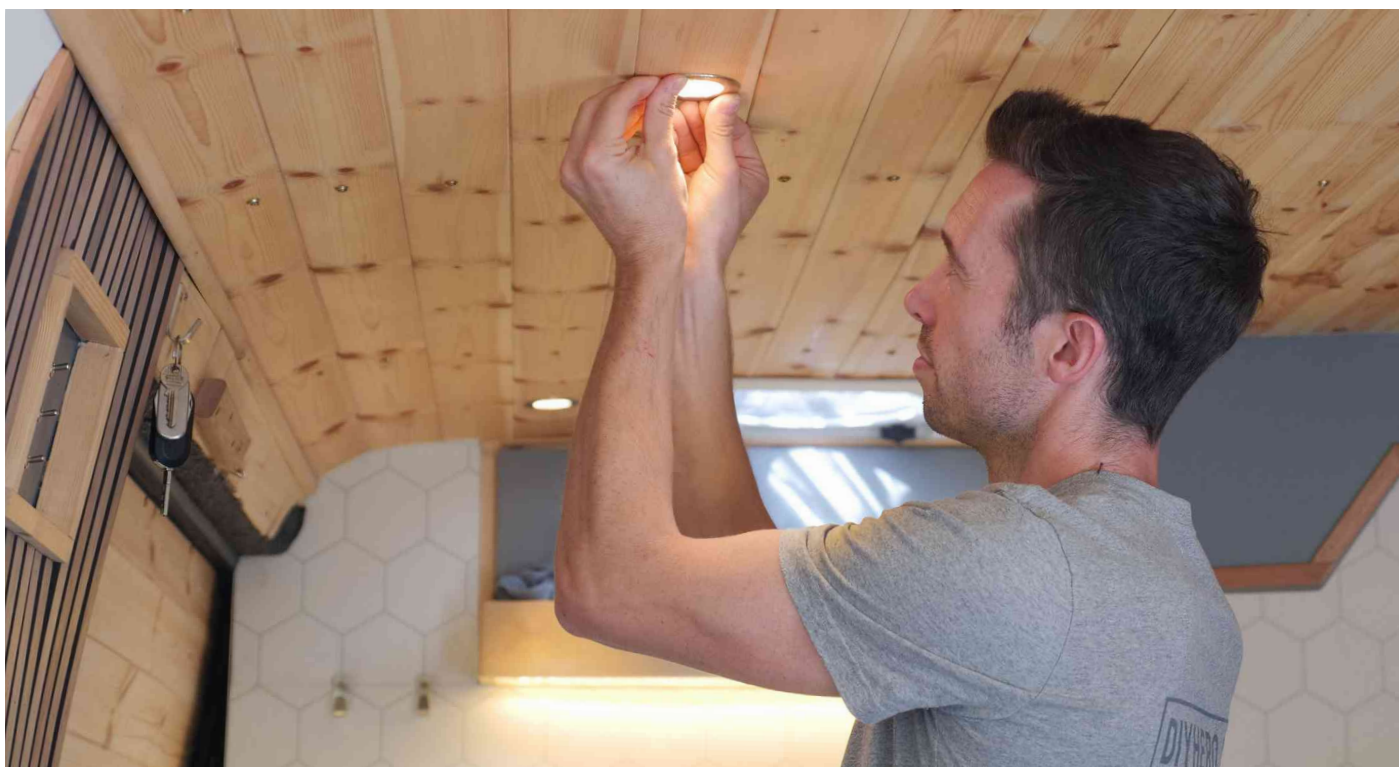


<https://youtu.be/OBjBYblrZnE>

Call me an optimist, or naive, but personally I am not too hot on security systems. For sure one day I might van might get broken into and lose my stuff, but somehow I prefer to not to live in fear and, if that happens, then I pay the price.

In reality they could steal my laptop and a camera – both well used and several years old – and some well used climbing gear. None of which would hurt too bad if I had to replace them. This way of thinking frees me a little and allows me to worry less.





## Lighting choices

Lighting can really 'make' a van. Poor lighting is either annoying, or feels bad when you are inside it. If there was any area to give a little bit of thought - it is lighting!

A lighting ring is when you have a few lights running off one switch. It can be useful to have different options for your day-to-day lighting.

I typically split this in two the three areas of my design:

- » **Kitchen** - where you want the option of bright lighting
- » **Dining area** - again, it is nice to be able to see what you are eating
- » **Bed area** - good to have both options for bright light and soft light

To manage this, I will usually have three options for bright ceiling spot lights (low profile 12V LED spotlights) and a couple of LED strip lights that give indirect / warm feeling lighting.

Therefore, my lighting switches are usually something like this:

- » Kitchen spots
- » Dining spots
- » Bed spots
- » Kitchen LED strips
- » Bed LED strips

## Types of light

The three main types of light used in a camper van conversion are spot lights (local switch), low profile spotlights and strip lights.



You should buy only LED lights (for energy efficiency and life-span) and they should all match your system voltage, so typically 12V (or 24V).

Spotlights with local switches make good reading lights, or to slight specific areas, but you probably do not want to use them for the whole van, else you need to go round turning them all on or off as required.

Low profile spotlights are great for fitting in to cladding or panelling. If you do not get low-profile spotlights you will need quite a bit of space behind them to hold the unit. Typically low profile LED spotlights are around 10mm / 3/8 inch deep.

12V LED strip lights tend to be the more power-hungry of the lighting options, but when used in recesses, they can really look fantastic. You can buy them with dimmers or even with multi-colour remote controls.

### Lighting temperature (Kelvin rating)

Lights typically come with a colour rating, and this will dictate how the lighting will feel inside your van.

The colour you use will partially depend on the colour of your van. If you have painted everything bright white you probably want to go for white lighting (else warm lights will make it look yellow), if your van has natural colours, pine cladding, or similar then you probably want to use warmer colours.

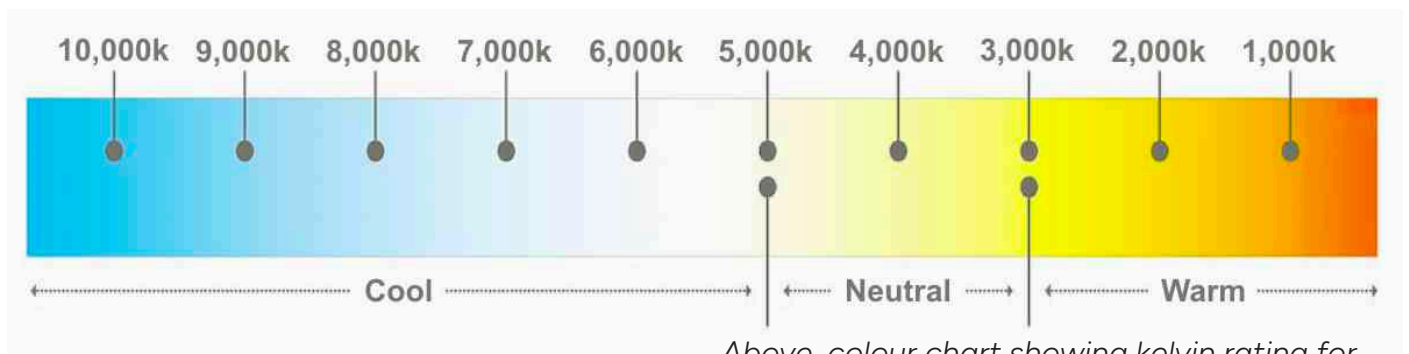


Personally I am not a fan of cold lighting, so I always go for warm-tone options.

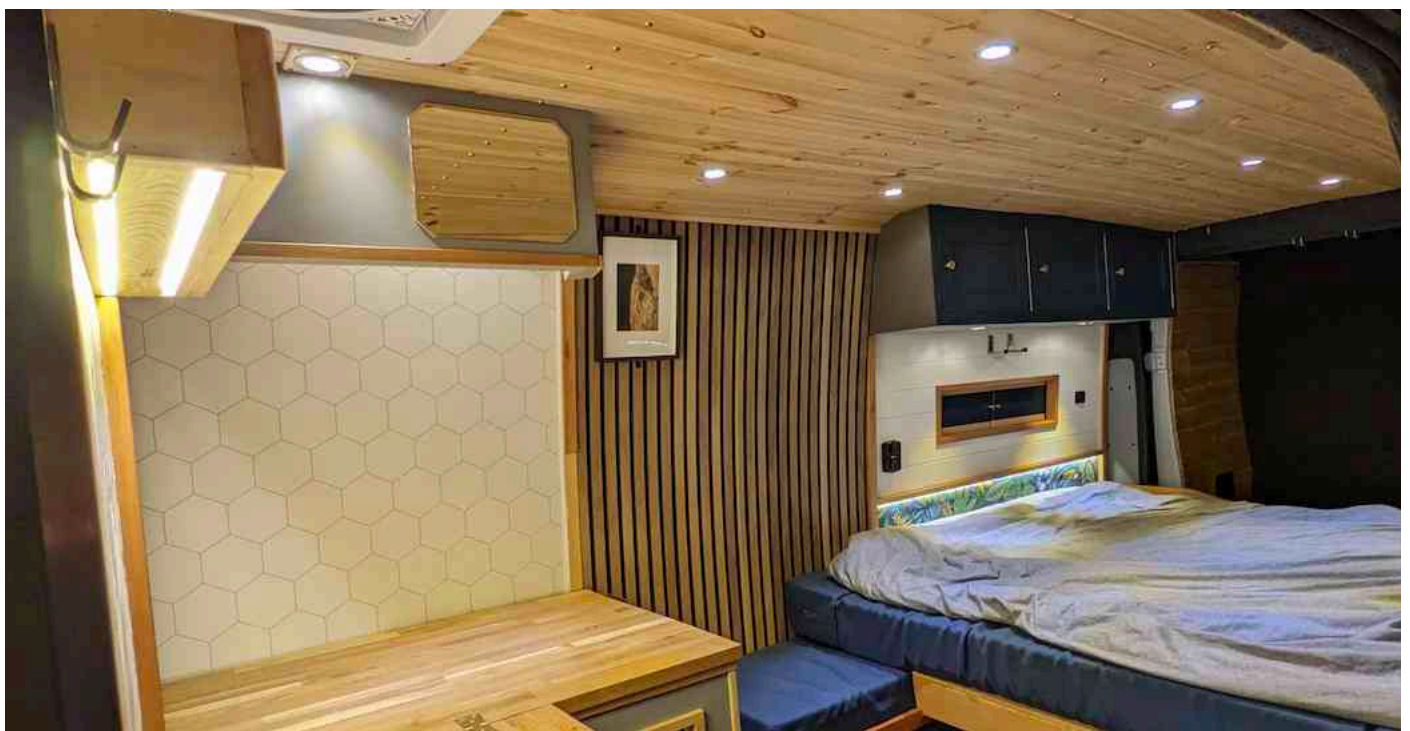
Warm tones can be further enhanced by having indirect light reflect off other warm tones, as with the LED strip light in the image below.



There is something very cosy about a van lit with indirect warm light.



Above, colour chart showing kelvin rating for lighting. Around 3000k is good if you want warm-white light.





A woman with brown hair and glasses is focused on working on a circuit board. She is using a red and yellow screwdriver to adjust a component. In the foreground, a multimeter is connected to the board with blue and red test leads. The background is a light-colored, textured wall, possibly made of wood or stone.

# System design

Electric | Water | Gas





## Electric basics

Electrics are intimidating and, for a novice, it looks wildly complicated! I want to reassure you that it is not that bad. I will walk you through the electrical basics, then move on to help you design your system.

*A quick safety note; when working with electrical systems there is a risk of electric shock. You should always be careful and use a professional to help you install it. I did not do this, but it has to be said.*

### System design

If this is your first time creating an electrical system I would advise you do either take two routes:

**Route 1:** Build a simple system and more-or-less follow a schematic from this book or someone else reputable. Be sure that if you change components that it will still function correctly together.

**Route 2:** Get an off-grid engineer to help you design a more advanced system, and install it based on the specifications provided. This means that for more advanced systems, you are installing the right kit that will work together correctly (and safely).

For this reason, you can order such a service through our website ([thevanconversionguide.com](http://thevanconversionguide.com)). Look for our 'electrical consultation' service. Also, if you are based in the US or the UK we can also ship you the entire kit down to wires and components.

### Electronics basics

There are a few simple principals that are useful to understand.

**Firstly, what is electricity?** When electrons move, they carry electrical energy from one place to another. This is called current electricity or an electric current. We measure electricity using Volts, Amps and Watts.

**Voltage** is a measurement of the electric potential or "pressure" at which electricity flows through a system.

**Amps** are rate that current flows through an electrical circuit. If voltage is like water pressure, amperage is like the rate of water flow. "Amps" is the common shorthand for this.

### Watts (= Volts x Amps)

Watts are units of electric power. Think of wattage as electricity at work when heating or illuminating a room in your home.

## Electrical circuits

For an electric current to happen, there must be a circuit. A circuit is a closed path or loop around which an electric current flows.

A circuit is usually made by linking electrical components together with pieces of wire cable. Thus, in a flashlight, there is a simple circuit with a switch, a lamp, and a battery linked together by a few short pieces of copper wire.

When you turn the switch on, electricity flows around the circuit. If there is a break anywhere in the circuit, electricity cannot flow. If one of the wires is broken, for example, the lamp will not light. Similarly, if the switch is turned off, no electricity can flow. This is why a switch is sometimes called a circuit breaker.

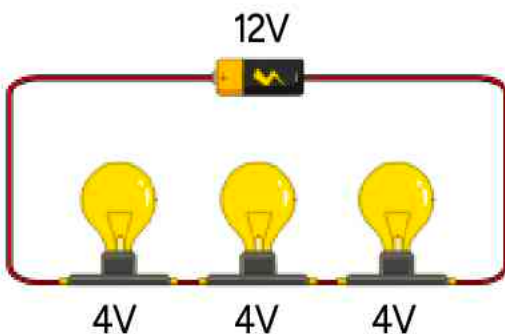
### Short circuit (bad news)

Short-circuiting is when an electric current flows down the wrong or unintended path with little to no electrical resistance. It can cause serious damage, fire, and even small-scale explosions. In fact, short circuits are one of the leading causes of structural fires around the world. If you've ever seen sparks in your electrical panel, it most likely was a short circuit causing them.

When it comes to your appliances or batteries there are two main types of circuit:

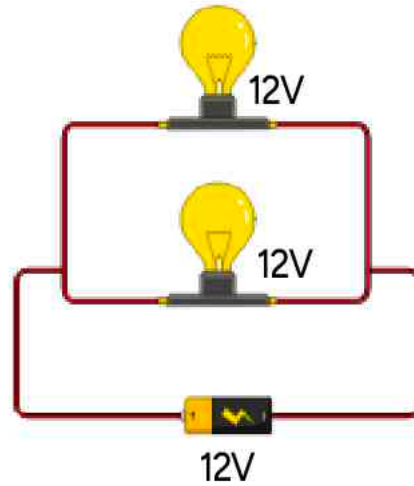
### Series

This is when your circuit items are placed all in a row, in this instance, three light-bulbs. This may appear to be the logical way to do things the voltage is ends up being spread-out throughout the loads. Here the battery provides 12V but each bulb only receives 4V because it is spread out over three bulbs. The result is that the bulbs are much dimmer than if they were wired in parallel.

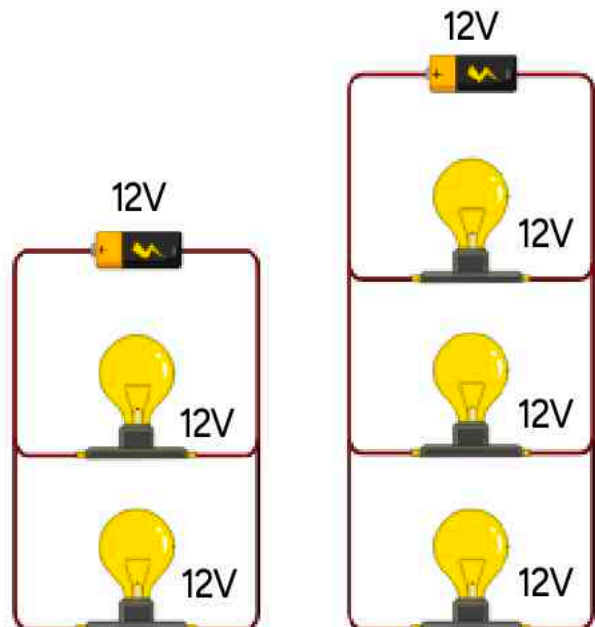


### Parallel

Parallel wiring is essentially how you will wire-up most of your electrical circuits. In this, because the electricity is not passing through two appliances they both can both receive the full 12volts and the lights are operating at their correct brightness.



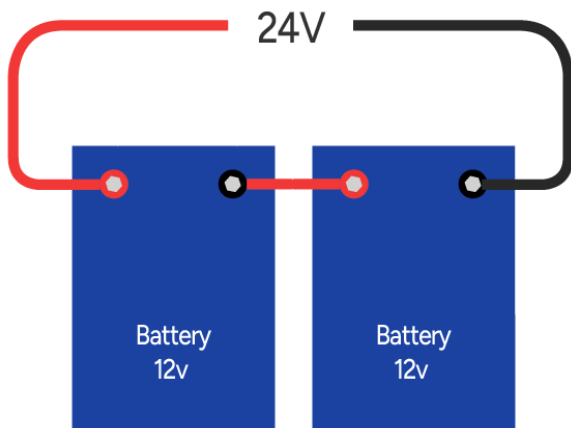
In parallel circuits it does not matter how many bulbs you put in place, the voltage will stay the same. For this reason, the majority of lights, USB points or other things that will come off one fused line (or switch) will be wired in parallel.



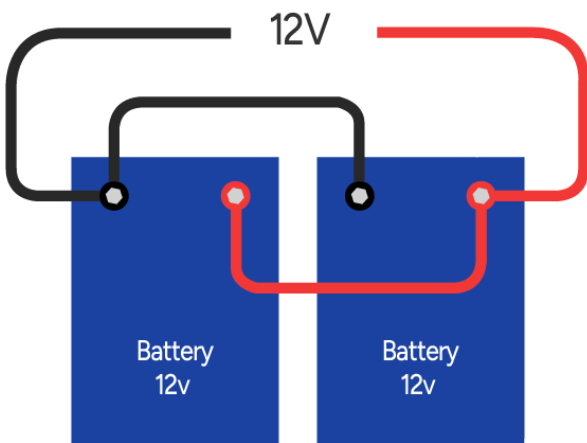
## Batteries series & parallel

When it comes to batteries we also need to think about how they should be wired. If you have two batteries and you connect them up in series then, just as the light bulbs in the previous example ended up dividing the voltage, batteries as the source of power multiply.

Below is two 12V batteries wired in series, the result is a 24V supply. You might want a 24V system, but if you don't this would be a bad way to wire your batteries.



Instead, if you want a 12V system and you are using two batteries, you would wire them up in parallel as shown below.







## Electrical system

### 1. The Parts

#### Van Conversion Electrical Kit

The following parts are the 'main' components of an electrical system.

#### Leisure battery

You already have a battery in your vehicle, this is the starter battery that is used to turn the engine over every time you start it (unless you have an electric car, then it is the power source of the vehicle).

Starter batteries are designed to give a big amount of current in a short period and are not suitable for running the low amperage appliances in your van conversion. Not only that, but if you run down your starter battery, you can no longer start your van.



So, instead of using the starter battery, we include a leisure battery. This is a battery that is designed to deliver lower amounts of power for longer periods of time.

Batteries are typically measured in AmpHours (the number of hours that it will provide 1 amp of power).

There are two types of battery you might want to use in you van conversion; lead acid (typically we would use AGM) and Lithium.

Lead acid batteries are cheaper but come with some disadvantages. Firstly you can only use 50% of the charge of the battery because running it down damages the battery - when it is flat a chemical reaction occurs that renders the battery useless - so, If you have a 200AmpHr battery, you only really have 100AmpHrs of usable charge. They are also heavy and will only last a few years of full time use. In my experience, if you are using your van full time, all seasons, you can expect a lead acid battery to last 3 years - 5 if you are lucky. This is because inevitably you will run it down too far and they just don't last that long in general.

Lithium batteries are more expensive, but come with some advantages. You can use 100% of the charge of a lithium battery, they are much lighter and take up less space. You can expect good quality Lithium batteries to give you 10 years of life.

Not so long ago it made sense to buy lead acid batteries just on the basis that you could buy three sets of batteries (therefore giving over 10 years) and still have money left over compared to buying Lithium, but times have changed. The push for greener technology has massively

reduced the price of Lithium batteries and today it generally makes sense to buy Lithium if you can afford to.

Of course, if you just want to get out on the road for a few years on a tight budget, lead acid batteries still have a place, but otherwise, Lithium is the way forward.

**Why not cheaper normal car batteries?** Leisure batteries have a longer discharge cycle to normal car batteries and are therefore much more suitable for charging appliances. Leisure batteries do tend to be a bit more expensive, but they are the right batteries for the job.

### Non-fully sealed batteries / vented batteries

Personally, I would not bother considering non-sealed batteries because they need external venting and periodic maintenance. See later in this guide for more info about venting.

### Batteries and Venting

I have split this up into another section just so it is clear – it has safety connotations, so it is worth making sure you get it right.

Lead acid batteries break down some of the electrolyte into hydrogen and oxygen during the final stages of charging. In general, if this gas escapes it's not a problem, but if not vented and in an enclosed space it can be a danger with a risk of explosion or fire. This is especially true of wet-cell batteries that you have to top-up from time to time.

I did not vent my batteries –this is because my batteries are Fully Sealed leisure batteries. In Fully Sealed batteries the gasses are contained within the battery.

Just cut out the faff and the danger by getting a fully sealed battery. These days it just makes sense... Just give your supplier a call and check if you are unsure of what you are doing or buying. If you are not happy or confident with their answer – use a different supplier that can provide better product advice.

### Non-sealed batteries

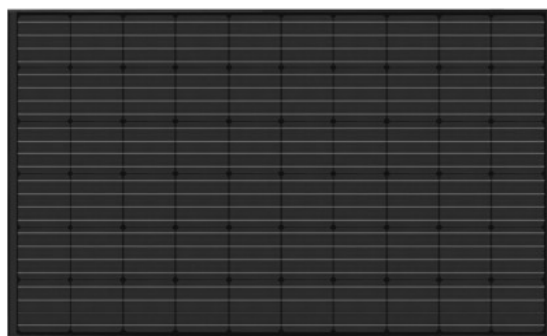
You will need to contain and vent these to a vent in the side of the van. But really, just getting fully sealed batteries will make life easier.

### A note about over-charging sealed batteries

As the gasses are contained within the battery, in certain circumstances (e.g. persistent overcharging) there can be a risk of pressure build up and gas leakage through the valves. If you want to be super safe, then you can vent the sealed batteries. but probably by having a way for any potential gas to get out and mix with air in the living space it will be enough.

*Note: a key reason for over-charging might be a too low rated Solar Charge controller – more about this later.*

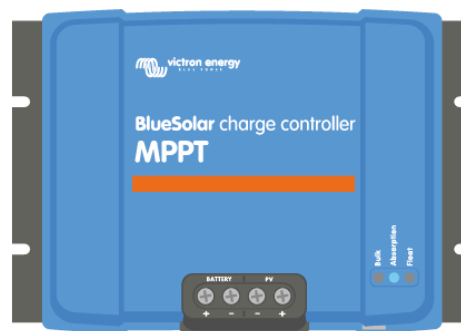
### Solar panels



Solar panels are either monocrystalline or polycrystalline. For the size of an array we can install on a camper van it probably does not make a lot of difference which you use - the main thing is to have enough!

Typically monocrystalline panels are black (as pictured above) and polycrystalline are blue with visible cells. I prefer the sleek look of the monocrystalline, but I am also aware that this is not necessarily what the more technically minded people care about.

### Solar Charge Controller



The solar charge controller is the 'brains' of your system. It tends to sit in the middle of everything, taking in solar energy, charging your battery and distributing power to your load.

There are two main types, PWM and MPPT. You are always better buying an MPPT solar charge controller because they are up to 30% more efficient and, typically, PWM units are cheap and often less reliable.

You need to make sure your solar charge controller is sized right!

### Battery to Battery charger (or split charger)



Most people install a way to charge their leisure battery from their engine as they drive, This is essentially powered by the alternator (a motor in reverse that charges the starter battery when you drive).

There are two main systems for this, using a **split charge relay** or a **battery-to-battery (DC-DC)** charging unit.

A split charge relay is a device that charges your battery only when your when your engine is running, and prevents it from happening when the engine is off (to avoid running down your starter battery). These simple device are cost effective but are generally not suitable for Lithium batteries or for use with newer vehicles that have smart alternators. If you go down this route, typically there are two types one that connects direct to your battery, and one that connects to your battery AND alternator, the former is typically a lot easier to install.

A battery to battery charger (pictured above) is a charging product that can safely and efficiently charge all types of batteries and typically, for most types of vehicle. This will need to be correctly sized for your system (and your alternator).

### Inverter



The power in you van will generally be 12 (or perhaps 24V) but you might have appliances that you want to use that run only on mains voltage (230V). To run these devices you can use an inverter.

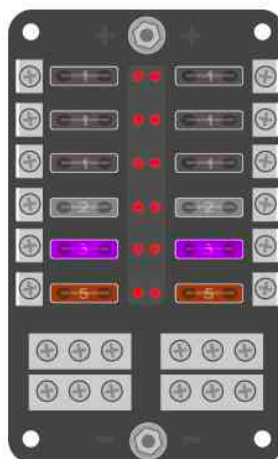
An inverter takes 12V DC and converts it in to mains voltage AC. This can enable you to power things like microwaves, blenders, laptop chargers or power tools. The inverter will need to be capable of delivering the power you require and to help you work this out, they are typically measured in Watts.

There are two types of inverter: PureSine and the other type you don't want to buy. It is worth noting that technically, to be 'by the book' in terms of regulations, an inverter should have a MCU and RCB (mains controller unit and residual circuit breaker).

I did not install this system as I only really use it for laptop chargers and other low power systems.

### Fuse box & fuses

It is important that appliances are fused, whether they be light rings of pumps and fridges. Fuses are thinner sections of wire that are designed to burn out and stop current flow when more current than expected flows.





This helps reduce the chances of electric shock and also fire. If an appliance malfunctions and creates an electrical short, without a fuse it may just keep heating up until it causes a fire. Electrical faults are the main cause of motor home fires so it is well worth getting this right.

### Battery monitoring system

You can monitor your battery using a volt meter but it only gives you useful information in certain circumstances.

#### When your voltage is accurate (not so often!)

A voltmeter tends to be inaccurate in the following circumstances:

- When your solar panel is charging it (it will sometimes show as high as 14V in this case)
- When you are drawing power to lights or other things – it will show lower
- When you have been doing either of the above in the last 20 minutes or so.

It basically takes a little while for the battery to 'settle' so you can get an accurate idea of the charge. This means that to know the level of your battery you need to check the charge later in the evening after you have been away from the van and everything has been off.

Much better is to install a **battery monitoring system** (for example the Victron Smart Shunt pictured below) that more accurately measures the charge of your battery.



These are not super cheap, so often people make do without - but if you want to know where you stand with your power, they are well worth installing.

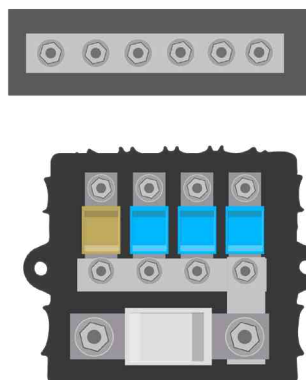
### DC distribution

When you come to install your battery it is easy to have a lot of wires going to it, this might end up being a bit of a nest of lugs going onto one battery terminal.

This is not ideal (from an installation point of view) and it is likely to not be compliant with

electrical regulations. To help with this you can install DC distribution, which is essentially a multi connection terminal that makes it all tidier. Some also have in-built fuses reducing the need for in-line fuses elsewhere.

Note that the cables that go from the battery to the DC distribution must be appropriately sized.



### Mains hook-up (MCU/RCD)

If you plan to spend time at camp-sites or wish to be able to charge your batteries via a camp site hook-up, you will need an external socket a (MCU) mains controller unit, a Residual Circuit Breaker (RCB).

To do this you need a Mains Controller Unit which is basically a box with a RCD and a circuit breaker within it.

Below is a 25 Amp Residual Circuit Breaker and has a 10 amp double pole MCB's (Miniature Circuit Breakers)



You can typically get these ready made in a plastic box – often made to about the right spec for bringing power into sheds.

- The RCD is essentially protection for the mains circuit and is designed primarily to prevent electrocution – but also other shorts or unintended current flow.

- The circuit breaker simply shuts down the electricity in the case of an overload or a short circuit.

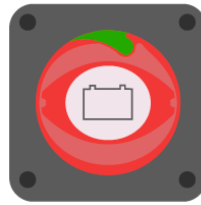
**Note:** In my latest van I did not install a MCU/ RCD or mains charger unit. The solar is simply enough for me and the Split Charge is enough of a back-up and I almost never pay for camping / mains hook-up.

### Battery charger

Many people install a battery charger, allowing you to charge your battery from the mains hook-up.



### Isolation switches



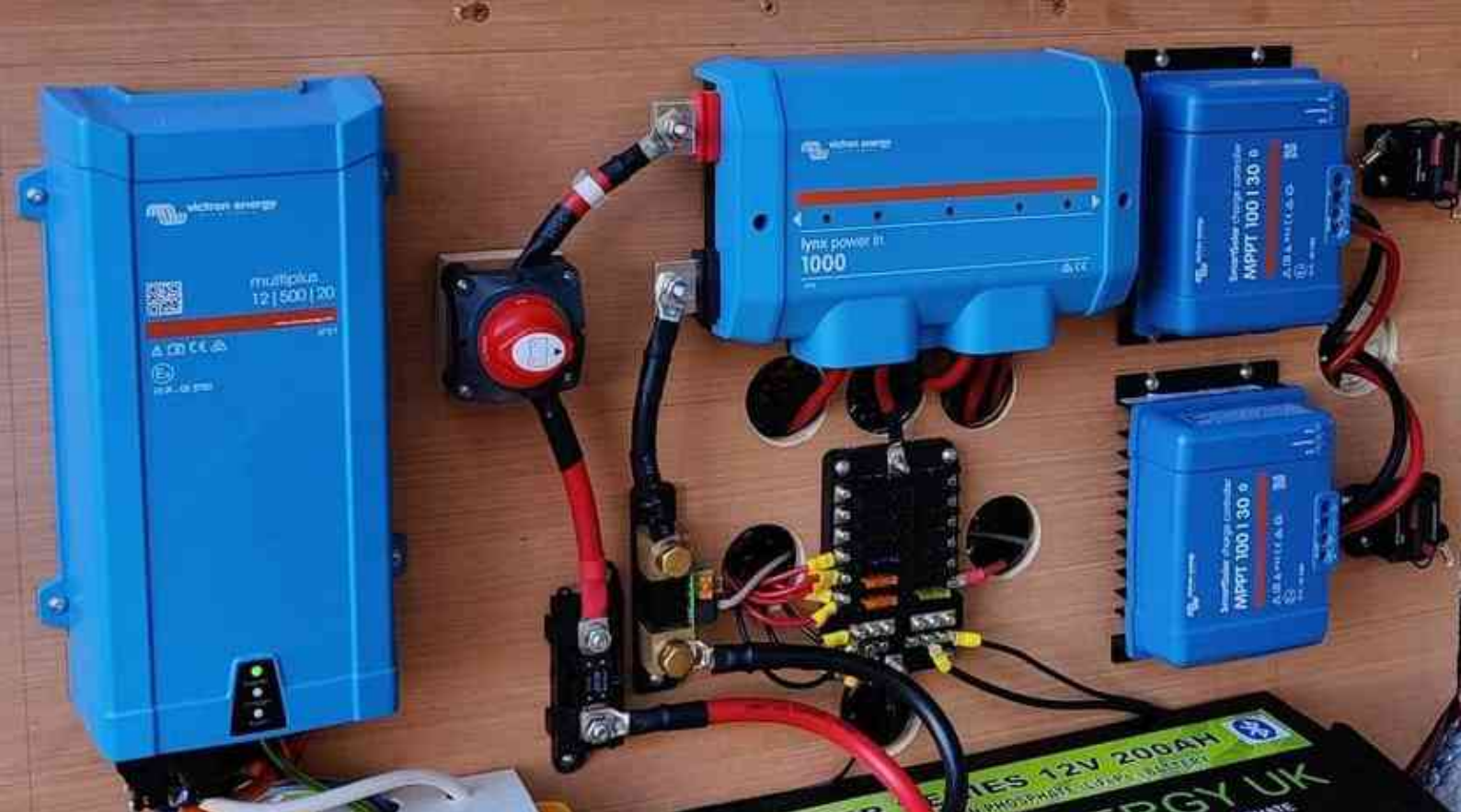
Isolation switches are basically beefy switches that enable you to turn off entire parts of your system. For example, an isolation switch on the positive cable before your main fuse box will enable you to turn off every single appliance in your van in one go.

This is useful for maintenance and, if there is a problem, a way to quickly turn everything off.

### In line fuse holder & fuses



These fuses are used for heavier gauge cable, fitted with lugs, and hold fuses (typically 30 to 100Amps).



## Electrical system

### 2. Sizing your system

The electrical system is the system people are typically most intimidated by but, honestly, it is not so bad. If you know how to install wiring correctly, you can carefully follow a schematic, and you can end up with a reliable and good system regardless of your experience.

This does however require you to firstly buy the right kit for your build, know how to install it correctly, and have a reliable schematic to follow.

#### What could go wrong?

If you install your kit incorrectly - quite a lot. Firstly incorrect wire sizes could result in an electrical fire, incorrect connections could damage expensive equipment, and incorrectly specified kit may not work as intended, or cause damage to system parts. Poorly installed electrics can cause electrocution.

In this section we will go through the electrical system parts, how to specify a system and how to wire it all up correctly.

#### Sizing your system

Before we go into detail about how to choose the various parts of your system, we first need to come back to what you need; what you will use the van for, what appliances you want to run, and where and when you are travelling.

#### Calculating your needs

To work out what we need (to help us know our system size - how big our solar panels and battery need to be) we first need to understand a few electric basics - starting with Volts, Amps and Watts.

**Voltage** is a measurement of the electric potential or "pressure" at which electricity flows through a system. Voltage is also described as the speed of individual electrons as they move through a circuit and is measured in units called volts.

**Amperage** is another way to measure the amount of electricity running through a circuit. Amperage is the "rate" that current is flowing through the circuit or the number of electrons moving through the wire. Amperage is listed in units called amps (or amperes).

Of all these different units of electricity, wattage is probably the most familiar. For years, you've been buying 40-watt light bulbs and 60-watt light bulbs with the general understanding



that a 60-watt bulb is going to be brighter than a 40-watt bulb. But why?

**Wattage**, it turns out, is the amount of power an electric device consumes. Another way to think about wattage is “electricity at work” — the power it takes to actually do something, whether it’s running a vacuum (400 to 900 watts), ringing the doorbell (2 to 4 watts) or illuminating a light bulb (40 to 75 watts).

To calculate wattage, you simply multiply voltage (pressure/speed) by amperage (volume), expressed as  $V \times A = W$ . The faster each electron moves through the circuit, and the greater the volume that the circuit can hold, the higher the wattage.

### AC & DC

AC stands for ‘alternating current’ and is used on the mains grid because it easier to generate and is better for transmitting over long distances, for that reason (and others) this is what is used for mains electrics.

DC stands for ‘direct current’ and is generally safer (our bodies can withstand electrocution of DC more easily). Batteries only store electricity in DC, therefore anything that comes from directly from your camper van battery is DC.

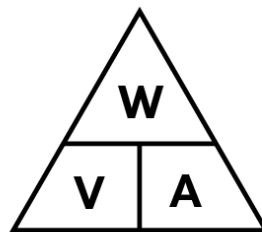
### How much solar/battery do I need?

Clearly the more appliances we use, the more electricity we need - and therefore the more energy we must generate. To generate electricity in a van conversion we typically get it from solar panels on the roof, or via the engine as we drive.

Therefore, if we want to operate off-grid (not plugged into the mains) we need to either have enough solar panels, or drive regularly.

To work this out, we need work out our power needs - based on the appliances we plan to use - and how much we would use them per day.

Many products will only have an Amp rating but the equations below will help. If your system is going to be 12V and you know the Amps you can calculate the Wattage of the product.



$$\text{Watts} = \text{Volts} \times \text{Amps}$$

$$\text{Amps} = \frac{\text{Watts}}{\text{Volts}} \quad \text{Volts} = \frac{\text{Watts}}{\text{Amps}}$$

Now, if you have a 5 watt LED light, you are not going to use it all the time, so how long you are likely to use it matters too. Some products cycle on and off – like heaters and fridges so you don’t assume they consume power all the time.

To account for this, we want to figure out the total Watt-Hours that our electrical system needs.

Imagine in your van on only have a LED lighting array.

The LED lighting totals = 5 Watts  
Hours used per day = 6 hours  
Therefore Watt hours =  $5 \times 6 = 30\text{Wh}$

Batteries are usually measured in AmpHours (how many hours it can provide 1 Amp of electricity, at 12V), so we want to take our 30 WattHours and convert into AmpHours. To do this we just divide it by the voltage of your system; which will probably be 12V

Therefore:  $30\text{Wh} / 12\text{V} = 2.5 \text{ Amp hours}$

This means that, if you had a 100 Amp Hour battery it would be able to run our LED array for 40 days.

$$100\text{AmpHr} / 2.5\text{AmpHr} = 40$$

If all you were running were a few LEDs you could go 40 days without charging the battery, but you will probably want to power more than a handful of lights.

Here are the calculations I used for my latest van:

<b>12V Appliances</b>	<b>Number of</b>	<b>Watts (each)</b>	<b>Hours Use</b>	<b>Total W Hrs</b>
LED Overhead Puck Lights	11	3	4	132
Meters of LED Striplights	4	5	4	80
Smartphone Charger	2	10	3	60
Compressor Fridge	1	47	10	470
Shurflo Water Pump	1	54	0.1	5.4
Fan (MaxxFan)	1	60	6	360
Gas Heater (Propex HS2000)	1	70	4	280
Gas Water Heater (Propex Malag)	1	70	0.5	35
			<b>Total W Hrs</b>	<b>1422.4</b>

<b>230V Appliances</b>	<b>Number of</b>	<b>Watts (Per Ur</b>	<b>Hours Use</b>	<b>Total W Hrs</b>
230V: Laptop Charger	1	87	3	261
<b>230V Totals</b>				<b>522</b>

The result of this is that I need approximately **2000 WattHours per day**. How much it takes to collect this power from solar depends largely on how much sun my array gets.

If I have **3.5 hours** of sun per day, quite likely if we are travelling outside of summer, then I would need  $2000/5 = 400W$  of solar panels. If I want to be able to last **2 days**, in very bad weather (with no solar gain) without driving and charging my battery via my alternator, I need a  $(2000/12) \times 2 = 333 \text{ AmpHr}$  battery.

With these two numbers, I can define the rest of my system!

### Choosing a Solar Charge Controller

Solar charge controllers are defined in Amps, typically 10, 20, 30, 50, 75Amps. It is important to choose the correct size Solar Charge Controller because if it is under rated you could either damage the unit, or cause over charging and damage to your battery.

Once you know the size of your solar array, if you are going to wire them in series, it is easy to specify your solar charge controller.

$$(\text{Solar Panel Watts} / \text{System Voltage}) \times 1.1$$

The 1.1, adds 10% to the calculation as a margin of safety.

For example:

$$(500W \text{ Solar Array} / 12V) \times 1.1 = 45.8Amps$$

In this circumstance, a 50Amp solar charge controller would do the job just fine.

If you are going to wire your solar panels in parallel, you will need to use the following equation, typically this results in a more expensive solar charge controller.

## Choosing my battery

Using my figure of 333AmpHrs, this is a pretty big battery, and realistically might be over specified.

I did however get a battery from AmpereTime for free, so got their 400AmpHr battery. This would have cost \$1800, and is relatively cheap for a Lithium battery, so far it has worked just fine. It is worth making sure that returns are possible if something does.

## Choosing a Battery to Battery charger

Because I have chosen a lithium battery ,and I have a newer vehicle, I will use a DC-DC charger - opposed to a split charge relay (voltage sensing relay).

### Why you need a DC-DC charger for newer vehicles

Newer vehicles typically have smart alternators (the part of the engine that produces electricity to charge your starter battery and other electrics). A smart alternator reduces the voltage it outputs when the starter battery is full – so DC-DC charger needs to make it appear as if the starter battery is never full. A DC-DC charger will also prevent the starter-battery from being drained by the leisure battery faster than it is being charged. It then regulates the voltage to meet the charging profile of your battery (you need to set this up).

### What size DC-DC charger do I Need?

The size of the charger you need depends both on your alternator and the size and type of your leisure battery. You should pay attention to the following:

Maximum Absorption Rate – this is the maximum rate that your battery can absorb power and should be listed in the battery specification. If your battery has a maximum absorption rate of 20Amps, and you buy a 40Amp DC-DC charger, then you have bought a charger that produces more than your battery can take – and therefore is money wasted. (Note, if you had two of the same battery, then the absorbion rate would be 40Amps, so it would make sense to have a bigger DC-DC charger).

- For most lead-acid batteries manufacturers suggest using a charge current equal to about

15% of the battery's capacity – so if you had a 200AmpHr lead-acid battery, you would look at putting in a 30Amp charge controller.

- Lithium batteries generally have larger charge currents, this can be as much as 50% of the battery capacity, so if you had 400AmpHrs of Lithium battery – you could use a 200Amp DC-DC charger (but this depends on the rating of your alternator)

**Voltage rating** – the DC-DC charger should have a voltage rating that matches the voltage of both your starter and your leisure battery. Typically, this is 12V or possibly 24V.

**Alternator rating** – the alternator will have a maximum current that it can output, this is usually within the range of 150-250Amps in vans. Not all of this can go to your leisure battery as your van will use some of this power for powering various electronics. Therefore, there is no point in using a very large DC-DC charger if your alternator cannot supply enough power for it. It is possible to change your alternator to something that has a higher output, but alternators are not cheap!

### Isolated and non-isolated DC-DC chargers

The difference is to do with the grounds that your leisure and starter battery use. If the grounds are the same (so in a van, if both ground to the chassis – as is typical) then the grounds are not-isolated, they share the same ground. In such a case a non-isolated charger is the right thing to buy – and this will be the case for most van conversions.

Some vans, or boats, may have fiber-glass or composite bodies which mean that batteries may not connect to a common ground (like a metal chassis) and in this case an isolated charger is the correct choice. For most people, who convert metal vans, a non-isolated charger is the right choice.

### Choosing an Inverter

This just comes down to what will you power simultaneously? What is the wattage of these appliances, and the result is the wattage you require.

It is always worth getting a pure-sine inverter, they are more expensive but will be better for any sensitive equipment (e.g. laptops).



For example, if you want to power a laptop charger (65W), a blender (650W) at the same time, you will need an inverter with a wattage which is higher than 715W. Probably 800 or 1000W will be appropriate.

### Choosing a Battery Monitoring System

You can use a cheap voltmeter to figure out the charge of your battery but they are not very accurate (most of the time) so if it is important to you to know the voltage of your battery then it is worth installing a battery monitoring system.

I did not install this as I mistakenly thought the battery had it's own system. I later bought a Victron Smartshunt and will install it later. There are a few on the market, and they typically cost around £120 / \$150.

### Choosing a Solar Charge Controller

Based on needing 500W of solar panel, I will install a 50Amp Solar Charge controller  $(500/12) * 1.1 = 45$ .

I chose Victron because they have a great reputation quality and reliability. As this is the brains of the system, I want it to be reliable.

### Wire Sizes and Type

Below is a useful table to give an idea for wiring sizes.

Basically, because I have no appliances over 18 Amps (4.5 Amps is the most I have seen go through the entire system – across lighting and appliances) so my cabling, at 1.5mm<sup>2</sup> is appropriate.

Note; you will need much thicker wires for your split charge systems and linking up the batteries (16mm<sup>2</sup> 100Amp wire typically). It is easiest to buy a Split Charge kit with all fuses, wires and attachment kit and fit it as instructed - installation requirements will depend on the type of split charge system you get.

### Solid or Multicore?

For a van conversion you want to use multicore/flex. It will be easier to work with, and it should be more reliable in the long run. You can do most of your system, with the exception of appliances that require an earth, using twin-core/flex cable.

### Wiring Colours

Typically, in a camper van we will use Red for + positive, Black for - negative (neutral) and green-yellow for earth.

However, you may purchase cabling from your local hardware store which has house colour conventions. Which colour is used depends on your region.

In the UK and Europe domestic cabling colours have converged on:

- Brown for + positive (Live)
- Blue for – negative (Neutral)
- Green-yellow for earth (Ground)

In the United States it is:

- Black for + positive (Live)
- White for – negative (Neutral)
- Green-yellow for earth (Ground)

mm <sup>2</sup>	AWG	Example use
1.5mm <sup>2</sup>	16	LED lights, USB points
2.5mm <sup>2</sup>	12	Inverter to mains plug socket
10mm <sup>2</sup>	8	Solar charge controller (or battery) to fuse box
16mm <sup>2</sup>	6	Battery to battery charger wiring
25mm <sup>2</sup>	4	Battery to chassis ground
35mm <sup>2</sup>	2	Battery to DC distribution

## Regulations

It is worth checking on the regulations in your country, and any specific standards that your conversion must meet to pass any local tests, be deemed insurable and safe.

It would be awful to have to rewire, or worse, re-do half a van conversion because of a simple mistake!

### Warning!

Electrics are especially important to get right. I recommend getting a qualified electrician to check your system.

# Electrical system

## 3. Solar system

The solar system is probably the coolest part of an off-grid van conversion. After living in an apartment, paying an electric bill every month it is quite amazing that it is possible to live in a van and get most of your power for free, from a couple of solar panels.

### Solar Basics

The solar system comprises of the following key components:

- Solar panel
- MC4 Cables
- Solar Charge Controller
- Batteries
- Remote monitor

The electricity generated by the solar panels goes to the solar charge controller – which intelligently distributes this power, either to the battery, or to the appliances that you are using.

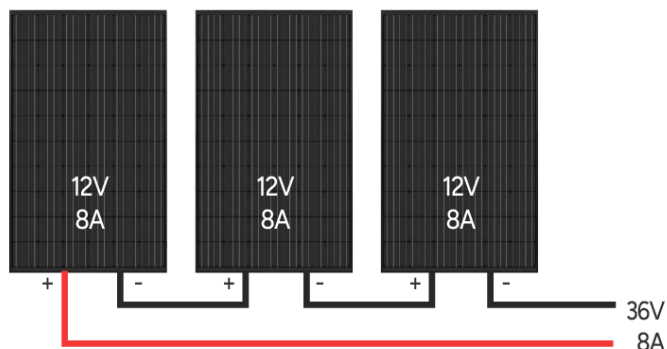
The Solar Charge Controller (if you get a good one) also does a few other clever things – like intelligent battery charging, preventing over voltage, and maximizing the usable energy from your panel.

### Parallel vs Series

How you wire your solar panels is important and impacts the design of your system. In short, if you wire your solar panels in parallel you will need a larger solar charge controller.

#### Series wiring

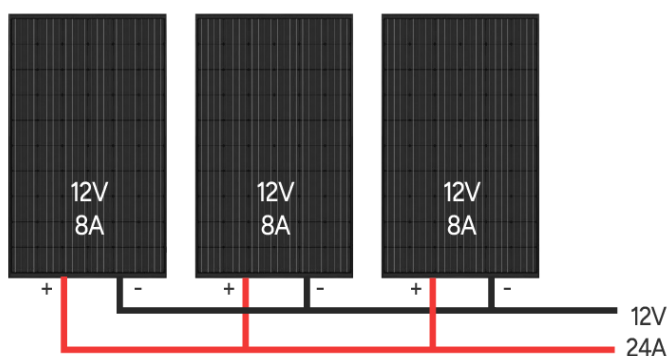
In series, the system's **voltage** is added up, while the **amps** are not. This means you can use a lower amp-rated solar charge controller.



#### Parallel wiring

In parallel, the **voltage** stays the same, but the **amps** are multiplied - requiring a larger (and more expensive) amp-rated solar charge controller.

As batteries often require a higher voltage in order to charge, panels in series mean that you are able to charge your system for longer periods of the day.



There are also advantages to parallel wiring - if one panel is covered by shade (say a close tree) - the others will continue to produce electricity. In a series system, the whole array is taken out.

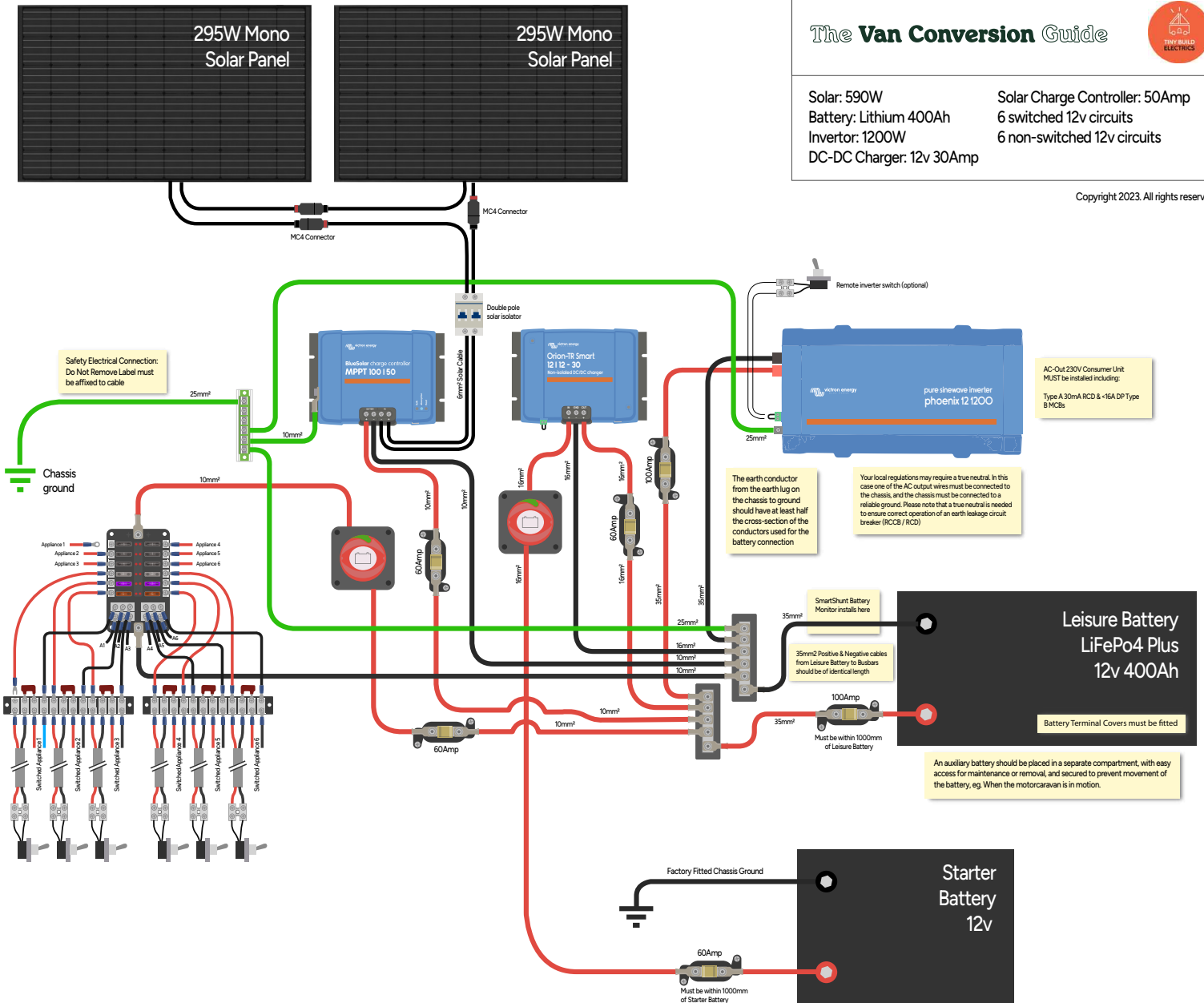
Personally, I would always wire a van conversion in series.



Solar: 590W  
 Battery: Lithium 400Ah  
 Inverter: 1200W  
 DC-DC Charger: 12v 30Amp

Solar Charge Controller: 50Amp  
 6 switched 12v circuits  
 6 non-switched 12v circuits

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This diagram is intended to assist with installation and illustrate the connections that are required for operation. Installations must always be completed by a skilled person in accordance with manufacturers specifications, BS 7671, BS EN 1648-2 and all on-site conditions. Grounding requirements vary according to your region. Victron advises making an earth connection to all metal enclosures as shown in this diagram.

All products should be mounted vertically on a non-flammable surface, with the power terminals facing downwards. Observe a minimum clearance of 10cm under and above the products for optimal cooling.

\*Cables shall be supported at maximum intervals of 400mm for vertical runs. Horizontal runs, unless run in conduits or ducts, shall be secured at maximum intervals of 250mm\*.

All Cable & Fuse Sizes Based On Manual Stated Manufacturers Recommendations

MUST Be Installed by a Skilled/Competent/Qualified Fitter

Every realization remains the responsibility of the fitter

ELECTRICAL INSTALLATION MUST HAVE AN ELECTRICAL INSTALLATION CERTIFICATE (EIC) ISSUED PRIOR TO FIRST USE

230 VOLT IS EXTREMELY HAZARDOUS DO NOT TOUCH ANY LIVE WIRED PARTS OF THE INSTALLATION! WHEN IN DOUBT, ALWAYS CONSULT A SKILLED ELECTRICIAN!

BOOK A CONSULTATION WITH TINY BUILD ELECTRICS TO ENSURE YOUR INSTALLATION IS COMPLIANT

## Electrical schematic

You can download the above schematic as a PDF using the mini-course portal.

### Schematic Download

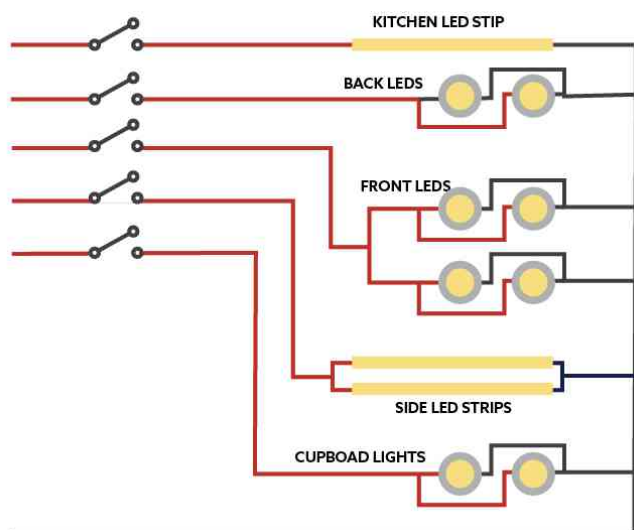
This is the electrical schematic for the system I installed in my latest van conversion. It has been signed off by an electrical engineer.

As the diagram is clear, always refer to the schematic (not images or videos) for the correct way to install a system.

# Electrical system

## 4. Lighting system

This is a diagram for a lighting set-up I have used in the past:



Essentially four lighting choices; front, back ceiling lights, side lights and a door light.



For me lighting is one of the most important parts of the conversion. Indirect strip lights to create a warm & relaxed environment and brighter spots when needed work well.



## Water system

### 1. System Options

Water management is a core aspect of vanlife, especially when living off-grid or away from easily accessible water supplies. Water-use anxiety is a real thing – when your uninitiated van-guest leaves the tap running like they are living in a house it's important to maintain your calm and be kind!

There are a two main ways of managing your water:

#### Jerry-can system

- One or more 20 to 25 litre water containers
- You can fill up a few at a time and swap them out as required
- Uses cheap and easy to install submerged pumps
- Good for places where it is hard to drive your van close to a water source
- Usually combined with solar shower-bags or similar
- Cheap and functional

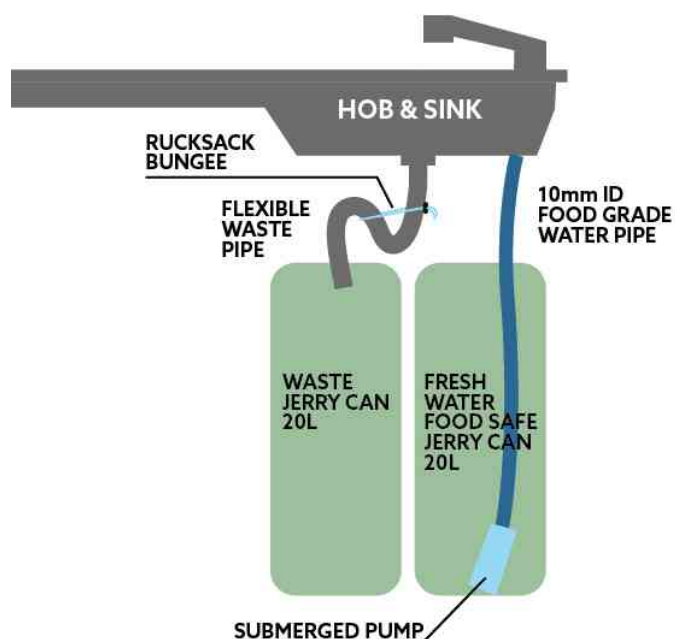
#### Large internal or under-slung water tank

- Generally, 70 to 150 Litres
- Internal if going to cold places
- External if very space sensitive
- Required if including shower system
- More expensive

Here are three different water systems:

#### System 1: Simple jerry-can system

Ideal for budget builds without a shower and for those with a desire to keep it as simple as possible – and make it easy to collect water from public taps.



As the waste tank is the same size as the freshwater tank so when you fill one, you empty the other, meaning that you should never have a waste-tank overflow problem. By having the waste tank also in a Jerry can it means you can easily carry it to a suitable drain or toilet to dispose of the wastewater. If you are using biodegradable soap – and it's just water from cooking and washing-up – then it increases the number of suitable places to dispose of your water.



The tap in this system is also a switch which, along with the pump, will need to be connected up to your 12v system.

The tap turns on the submerged pump and sends water to the tap.



The rucksack bungee is a little bit of a hack for flexible waste pipes (if it is long enough). You can use it to force a U bend into your waste pipe – stopping smells from your tank coming up into the van. To empty the 'U' – just pull it straight and its done.

Cost - approximately \$120/£105 with the following components.

- 2 Jerry cans (\$42/£35)
- Submerged pump (\$25/£20)
- Pipes (\$12/£10)
- Tap (with 12v switch) (\$55/£40)



You can get hand-pump taps, which do not require wiring in, but they are a little annoying for the times when you want to use both hands.

## System 2: Pressurised system with fixed tank and external shower

Installing a hot shower, using an instant gas water heater, meant installing a larger water tank and requiring a pump that can handle a bit of pressure.

Check out the video guide below with more information on installation.

### Mini-course Video

Main Components:

- Fammia 70L water tank. These popular tanks can be used in many directions to fit your space requirements.
- Shurflow 40PSI pump – this pump turns on when the pressure drops (for example when you turn on a tap). It is a little noisy but works well and the tap is not on an awful lot.
- Fammia A20 Accumulator – this is essentially a rubber balloon inside the plastic container which softens the kick from the pump and makes your water run more smoothly

### Shower Cut-off Valve

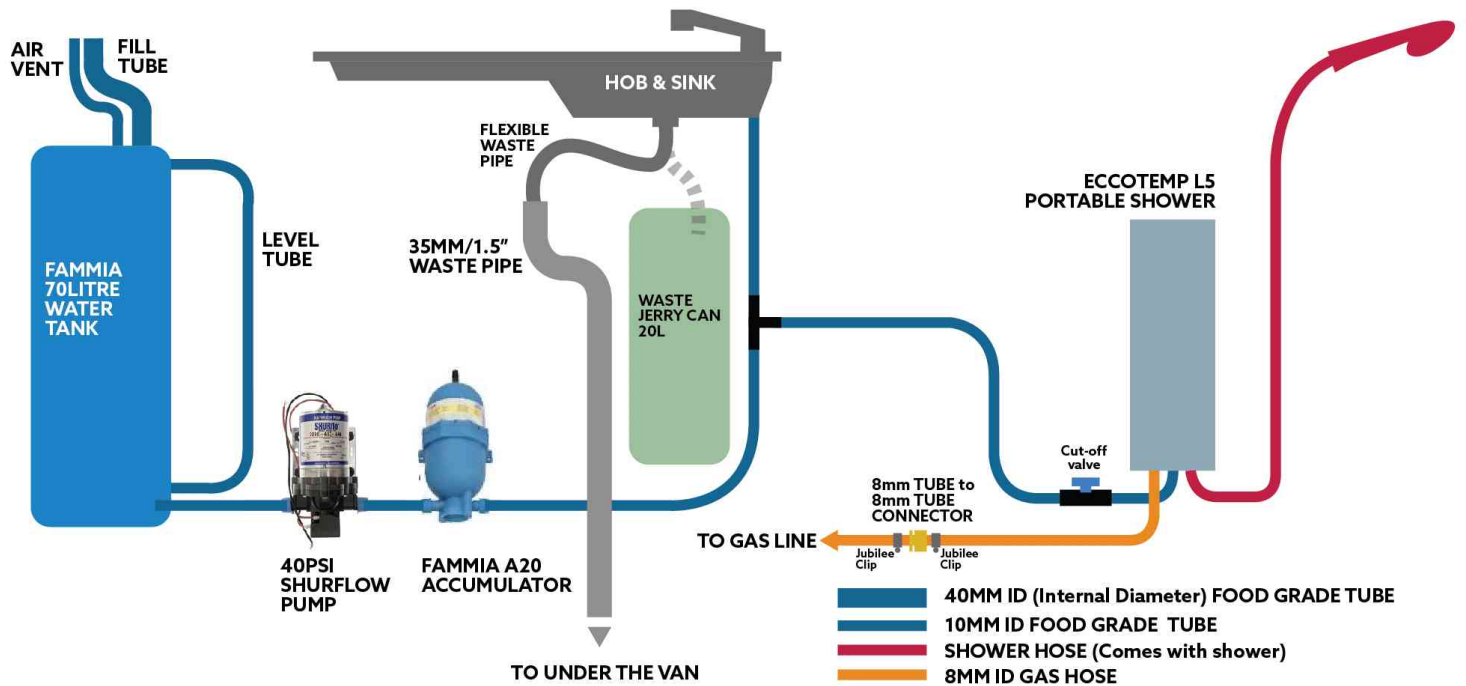
When I left the van unused in cold weather, I learned the hard way that you need to drain the shower to stop it freezing and destroying itself. I have now added a cut-off valve (before the shower) so that I can easily drain the shower if not using the van in winter.

The wastewater in this design has two options;

1. Through a waste pipe to under the van - often you are in nature and a bit of toothpaste and washing up water is OK to let run under the van (use biodegradable soap)
2. Into a 20-liter Jerry can - for when you are in places you cannot let your van leak water (you do have to keep an eye on it so it does not overflow)

**The shower** - I installed a hot shower out the back of the van (this I why I chose the 40PSI pump – the lower pressure pumps would not quite be enough).

**The level tube** – this essentially allows you to see your water level – I put a fishing float in mine to make it easier to see.



Above: system schematic

Left: installation

In the photo, you can see the waste pipe (black) which can be put into the green Jerry can – or into the waste pipe which simply empties below the van.

The vertical transparent pipe on the left is the water level measure.

The yellow tank is a 11kg Gaslow LPG tank (held solidly with a ratchet strap).

### Pump switch

With a pump that turns on when the pressure drops you need to have an accessible switch. Otherwise, if you run out of water it will keep pumping and compressing air (this is not ideal). Likewise, if you have a leak, it is useful to be able to turn the pump off quickly.

System cost:

Approximately \$340/£285 with the following components.

- Fammia tank & accessories (\$115/£85)
- Fammia accumulator (\$38/£30)
- Sureflo pump (\$80/£65)
- Pipes (\$50/£40)
- Tap (with 12v switch) (\$55/£40)
- Jerry can (\$30/£25)

**Note:** the gas parts of this system - using rubber hose & devoid of a properly sealed gas locker - is not regulation compliant. It is legal, but it would not be possible for me to rent this van out. See later for a compliant system.



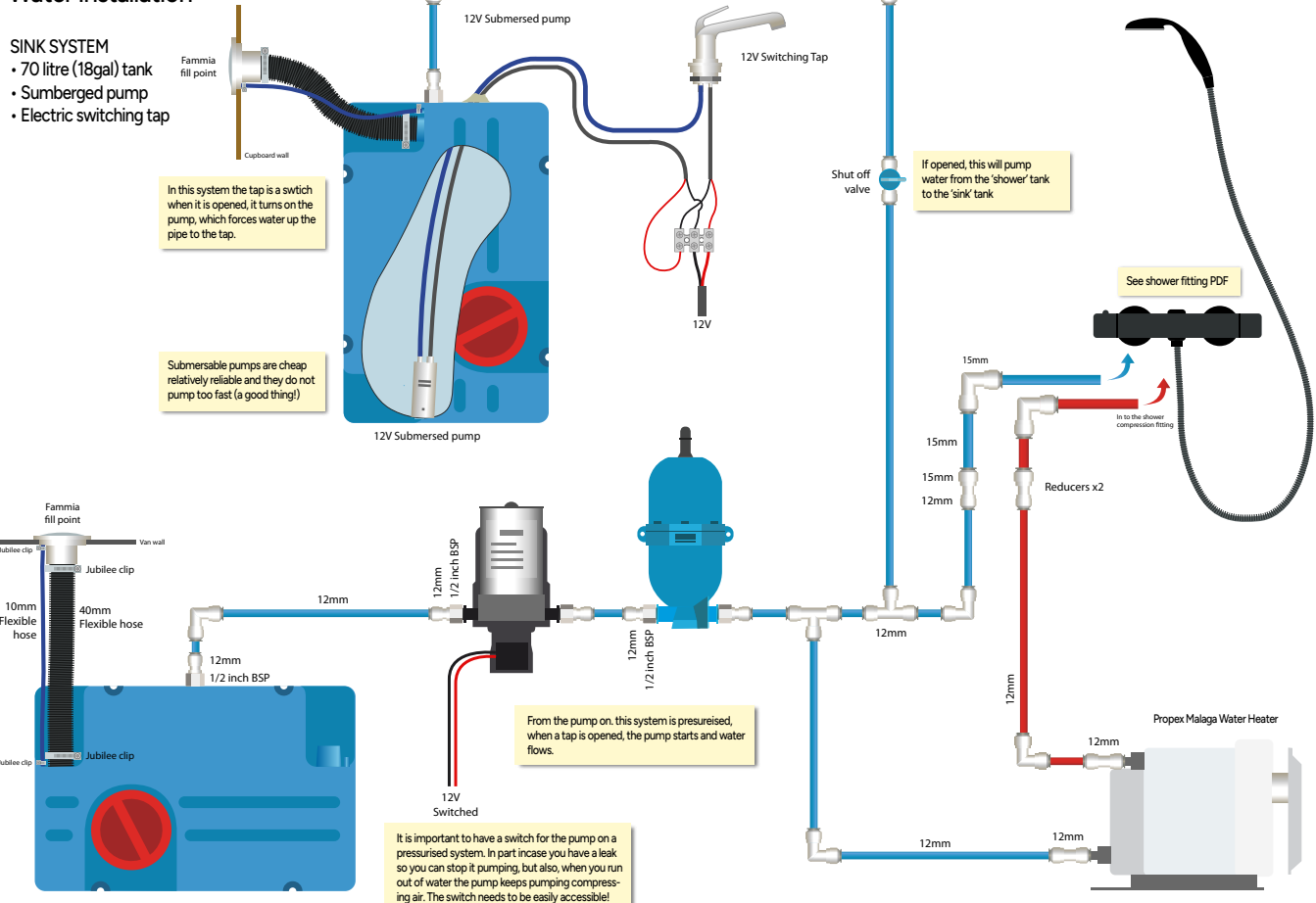
### Water Installation

#### SINK SYSTEM

- 70 litre (18gal) tank
- Submerged pump
- Electric switching tap

In this system the tap is a switch when it is opened, it turns on the pump, which forces water up the pipe to the tap.

Submersible pumps are cheap relatively reliable and they do not pump too fast (a good thing!)



From the pump on, this system is pressurised, when a tap is opened, the pump starts and water flows.

It is important to have a switch for the pump on a pressurised system. In part incase you have a leak so you can stop it pumping, but also, when you run out of water the pump keeps pumping compressing air. The switch needs to be easily accessible!

Different appliances will have different fittings, some might be 1/2" BSP (or occasionally other sizes). The Propex Malaga has points where you can simply push on 12mm pushfit parts and you are done! Very easy.

#### SHOWER SYSTEM

- 70 litre (18gal) tank
- Shurflo 30PSI pump
- Fammia Accumulator
- Propex Malaga Water Heater
- Shower mixer & head

### System 3: Pressurised system with internal shower, internal water heater, 140litre twin-tank system.

This system is similar to the above system but it uses push-fit fittings, has a tanked water heater (inside the van) to provide hot water to an internal shower.

The second water tank, that is used for the sink only means that you cannot run out of drinking water while having a shower (you can however pump water from the shower-tank to the drinking water tank if required).

Download the above schematic as a PDF from the eBook mini-course resource area.

 **Schematic Download**

System cost: \$1400 / £1100

- 2x Fammia tank & accessories (\$230/£170)
- 30PSI Sureflo pump (\$80/£65)
- Fammia accumulator (\$38/£30)
- Submerged pump (\$25/£20)
- Pipes (\$100/£80)
- Tap (with 12v switch) (\$55/£40)
- Jerry can (\$30/£25)
- Push-fit fittings (\$70/£55)
- Water heater (\$650/£500)
- Shower mixer/head (\$120/\$100)





## Refillable Gas System

A refillable gas system makes a lot of sense if you are travelling for longer periods of time, or through multiple countries where gas-tank exchange may not be possible,.

Refillable gas (usually coming under Autogas/ LPG/Propane) can typically be filled up in a minority of gas stations, There are several apps that allow you to find these gas stations and if you keep an eye on the level as you travel, it is usually not too much of a problem to fill up.

Refillable gas tanks typically have an over-fill prevention system (for safety reasons) and many gas stations will not allow the filling of tanks that do not.

You can usually buy a kit for refillable tanks that includes fill hose, high-pressure hose and a regulator.

In any gas system you have a high-pressure system & low-pressure system. The high pressure part is the tank (temporarily the fill hose) and the high-pressure hose (or fixings that come before the regulator).

The regulator reduces the high pressure of the tank to (usually) 30millibars. From your regulator onwards - to your appliances - is the low pressure system.

There are two main types of refillable gas system, internal and external (under-slung) tanks.

### Internal tank

An internal tank requires a gas-locker with a drop-vent (a hole out the bottom of the van). This is essentially a sealed box that contains the high-pressure system. This means if there was a rapid discharge of gas, your van would not rapidly fill up with gas - instead it would exit through the bottom of the van.

An internal tank is generally easier to fit, it is closer to your appliances and is typically a bit cheaper. Often they have a gauge on the top to indicate how much gas is in the tank, meaning you do not have to wire-up an external monitoring system.

The major downside is that it takes up a big chunk of space which could otherwise be used for storage.

### External tank

An under-slung tank means you keep the entire high-pressure system outside of the van in it's entirety. This is not just technically safer but it saves a whole load of space. It however does take up some of your 'under van' space which can impact where you can fit water tanks or other appliances.

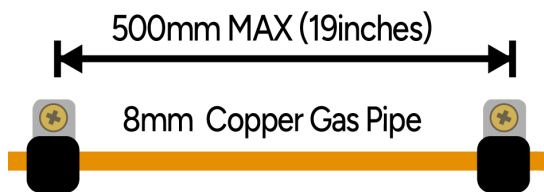
## Gas pipe

There are two types of gas pipe that you can use in a van - copper and rubber. However, regulations are fairly strict on what should be used where and how they should be fitted.

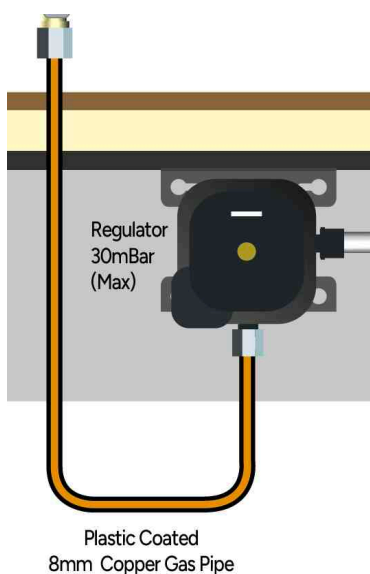
**Copper hose** (usually 8mm) is the gold standard, and from a regulation point of view, the only one you are really meant to use.

### A few installation notes:

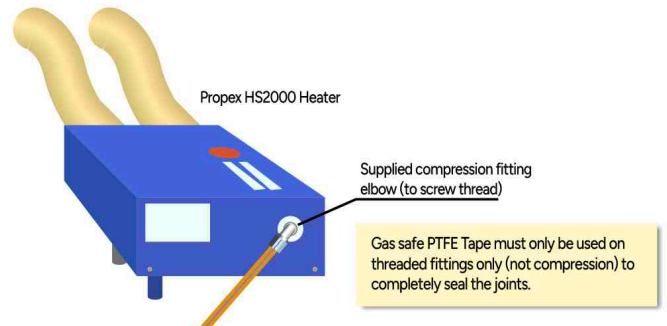
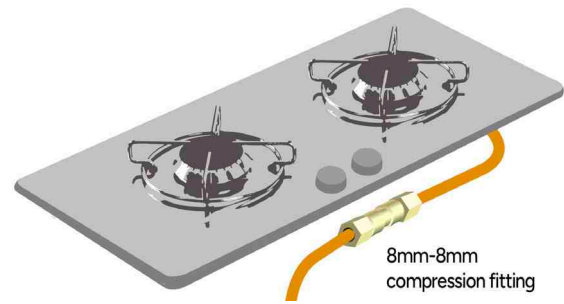
- See the 'Gas Regulation section, and the Gas System Schematic download for more details)
- Copper gas pipe should be fixed where it can be accessed (there should not be any joints behind the scenes which cannot be changed/checked or tested)
- The pipe should be proper gas pipe (and meet standards)
- The pipe should be fixed using a p-clips (ideally rubber coated to protect the pipe) at minimum every 50cm



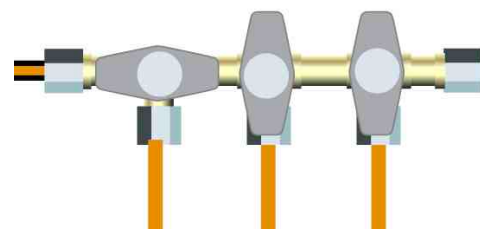
- Copper pipe underneath the van (therefore exposed to the elements) should be plastic coated to protect it against small stones the tyres may throw up



- Copper pipe should be fitted entirely with compression fittings (without adding gas PTFE tape - which should be used only on screwed threads)



- Each 'branch' of your system should come from a switched manifold (allowing you to turn each appliance supply on and off independently).



Although you may not have to abide by gas fitting regulations, it is worth adhering too because they have been created for a reason. It is worth noting that in many markets, if you want to rent out your camper van, it must have gas-safe certification.

**Rubber hose** is very easy to install, I am not entirely sure why you are not meant to use rubber hose in a van conversion, but that does not stop a lot of people using it (including me on two van conversions).

Rubber hose can be attached using hose junction fittings and jubilee clips. It should only be used where there are moving appliances (for example a stove that is stowed away in a draw) and should not be used outside of a single enclosed area in a van.

Also note, rubber hose should be changed every 8 years. If you use rubber hose, perhaps write down the date of the install somewhere so you, or future owners, when to change it.

## Regulators

Regulators that are fixed underneath the vehicle tend to have integrated brackets. Some, like the one pictured above, have crash-switches that automatically turn off in the case of an impact.

## Sensors / fill gauges

It is really useful to know your gas level. There are few things more annoying than getting half way through cooking a meal only to have your gas go out.

As mentioned above, internal tanks often have a gauge built-in to the manifold at the top of the unit. Underslung tanks, however, generally require some sensor that is wired to a display that is installed inside the van.

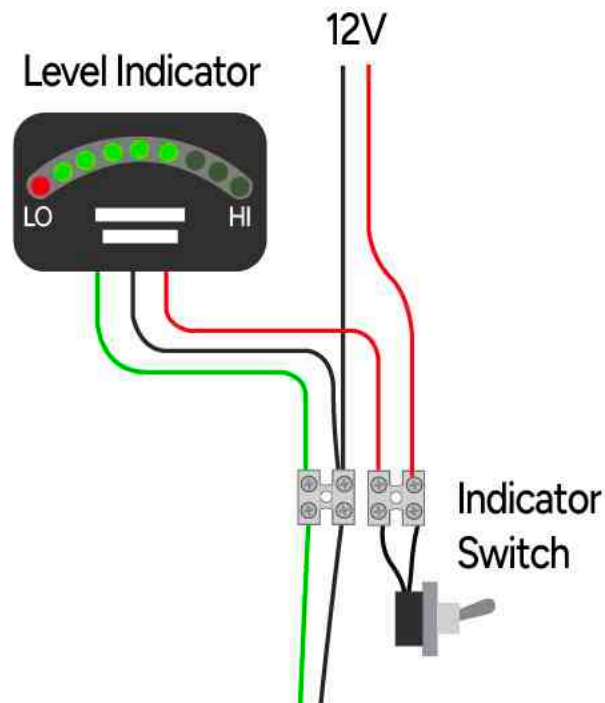
Below is the my gas sensor display, you flick the switch on & after a few seconds it displays how much gas is in the tank.



This is considerably better than crawling under the van to find out!

Below is the wiring diagram for the gas-sensor I installed - yours may be different but it will at least give you an idea of how they generally function.

To see the level, you turn on the switch, wait for the reading, and then turn it off again.



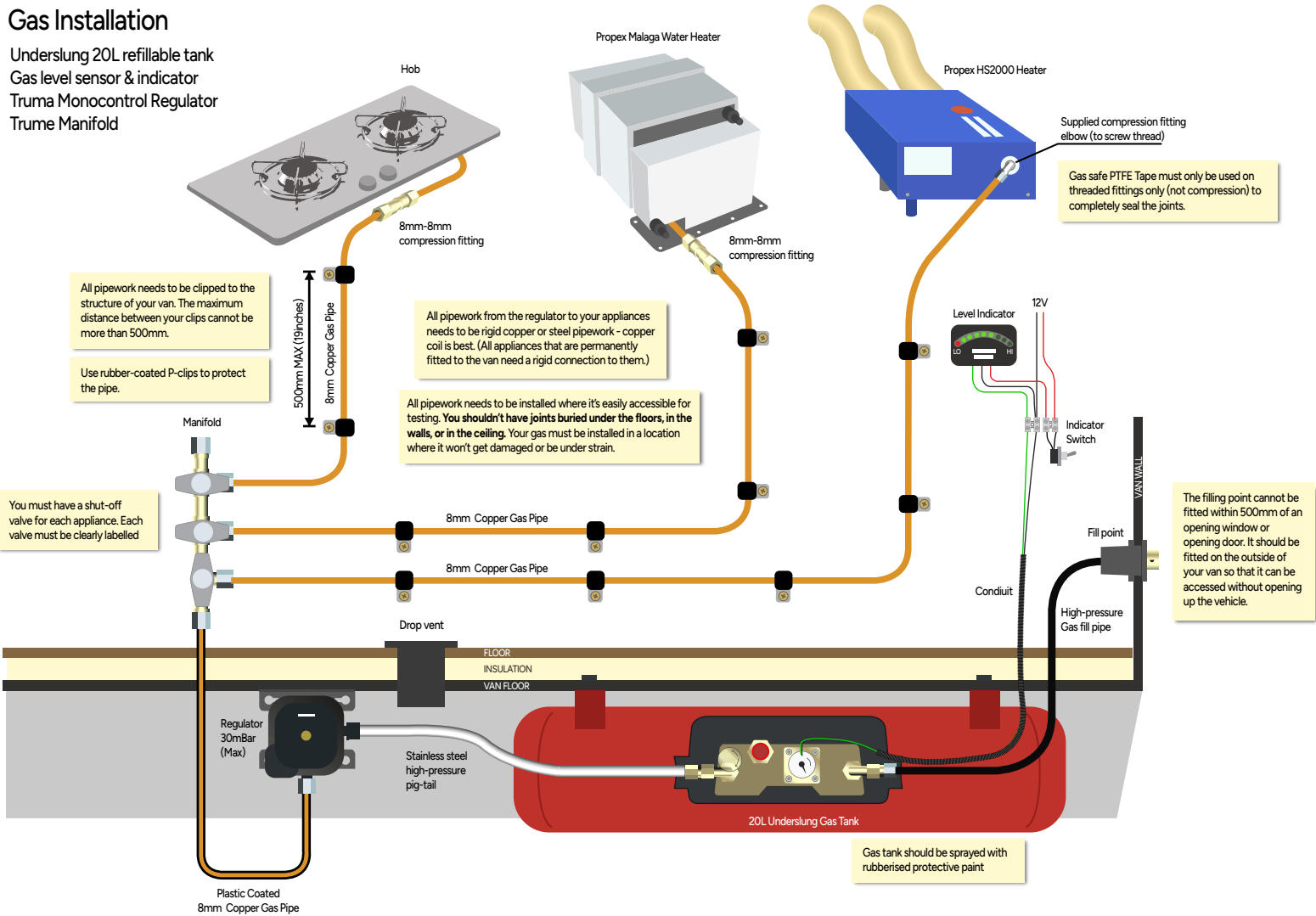
The green-black wires go to the sensor under the van.





## Gas Installation

Underslung 20L refillable tank  
Gas level sensor & indicator  
Truma Monocontrol Regulator  
Truma Manifold



This diagram is intended to assist with installation and illustrate the connections that are required for operation. Installations must always be completed by a skilled person in accordance with manufacturers specifications, BE EN 1949: 2011 + A1: 2013 and the Gas Safety (Installation & Use) Regulations 1998 (GSIUR) and all on-site conditions. Regulatory requirements vary according to your region.

**APPLIANCES & FLUES**  
All gas appliances installed in your van must be room-sealed appliances. Gas appliances such as fridges and heaters need to be ventilated with a flue to the outside.  
These are the regulations for installing a flue.  
- The location must be further than 500mm away from any refueling point.  
- It must not be fitted directly underneath an opening window.

Gas systems MUST Be Installed By a Skilled/Competent/Qualified Fitter. Every realization remains the responsibility of the fitter  
**GAS IS EXTREMELY HAZARDOUS. WHEN IN DOUBT, ALWAYS CONSULT A SKILLED GAS FITTER.**  
ALWAYS GET APPROPRIATE REGIONAL INSPECTION AND CERTIFICATION BEFORE FIRST USE.

## Gas schematic

The above schematic shows the gas system I installed on my latest van. It has various regulatory pointers (do check local rules!).

Download the above schematic as a PDF from the eBook mini-course resource area.

**Schematic Download**



# The build



# Work phases

By now you should have figured out the specification for all of the following:

- » Van layout & design
- » Window choices
- » Vent choice & position
- » Electrical system overview (lighting, USB, mains sockets, B2B charging, battery size and location, appliances)
- » Appliances and positioning - fridge, heater, water heater, sink unit (etc..)
- » Solar panels & where they fit
- » Gas system, type of tank and how it connects to appliances
- » Insulation choice

If so, you are probably ready to progress into the build! I see the build as comprising of three main phases:

## Phase 1: Holes in the van

## Phase 2: Preparation & Insulation

## Phase 3: The build

## Phase 4: Kit install & finishing touches

Thinking about the build in this way helped me work out my ordering process, for example my window, solar panel and fan had already arrived before I had received my van. This meant I could get to work immediately.

If you are trying to build intensely thinking ahead for any component dependencies is really important. I did my first conversion in 17 days and my second in 21 days. Both of these periods were intense - and a bit brutal – but it is very efficient to build a van over a short period of time.

At a guess, I spent 250 hours building my second van over 21 days – it obviously depends on the complexity of your build and the level of finish - but to think about the pockets of time you have spare – or the full days needed to build a similar van – this is probably a decent number to think about. If you are new to making things then it will take longer.

If you are building something quickly, it is generally good to be order everything for the next phase as you are start the one.

## Phase 1 – Holes in the van



Things that have to go into the van from the start (including anything that goes through the walls of the van) so insulation can be installed

- » Windows installation
- » Fixings – eye plates
- » Solar Panel installation
- » Vents installation
- » Under-slung gas tank
- » Key-safe lock boxes

## Phase 2 – Preparation & insulation



- » Floor insulation & ply
- » Accurate marking out/planning
- » Conduit (if required)
- » Pre-framing / stud work
- » Running wires (electrical first fix)
- » Waste pipes (depending on location)
- » Insulation
- » Vapour barrier



### Phase 3 – The Build



This is the main woodwork part

- » Stud work
- » Cupboards
- » Sockets / lights
- » Cladding
- » Panelling
- » Bed structure
- » Kitchen top (kitchen unit)
- » Water systems
- » Gas systems

### Phase 4 – Kit install & finishing touches



The rest – including all the finishing touches

- » Electronics wire-up
- » All electronic parts
- » Final gas system installation
- » Flooring
- » Panels
- » Drawers
- » Sockets
- » Auto-carpet, trim, fabrics
- » Everything else!

## Power tools

Good tools are not cheap, but they are better value for money than cheap tools. Every time I have bought cheap power tools (like when I was a student) I have regretted it. It is always a false economy because they do not last as long.

You are far better off buying professional tools. Typically most brands have a two or three tiered product range, the cheaper range is for DIY'ers who rarely use their tools, and the upper ranges are more robust and are aimed at the professional market.

### Why buy the pricier tools?

Firstly, if you plan to do more projects in the future, these things will last a really long time, Secondly, if you finish your van and decide 'never again' professional tools are better at retaining their value. Let's say you use them for a couple of years, you put them on eBay and you sell them for 25% less - then it will work out to be a fairly cheap rental.

Of course, if you are on a tight budget, then go cheap, but if not - its always better to buy good, buy once.

### Power tools

You can build a van with surprisingly few power tools but, if you want a high quality finish, precise craftsmanship, or to do your build efficiently, then you will need the right tools.

*This is my take on what you need:*

### Essential power tools

With these power tools you can build a van and they are likely to be the most used tools throughout your build.

- » Jig Saw - with wood and metal blades
- » Cordless drill - with metal drill bits; spade drill set, and hole cutter set
- » Circular saw to cut big sheets of plywood in straight lines or to cut wood that the jigsaw cannot handle

### Nice to have power tools

These tools will make your life a lot easier, I strongly recommend buying the tools with a star\*

- » Mitre saw - to cut wood batons quickly and accurately, useful for cutting joints too
- » Impact driver\* - basically a dedicated power screwdriver so you can drill and screw things

without changing bits every time

- » Belt sander - useful for cleaning up edges quickly and shaping wood (I lay mine on the side to use it as a table-top sander)

### Luxury power tools

- » Table saw - this is a dream machine, amazing for cutting accurately, making drawers, and any long cuts. I have one, I love it.

*It is worth noting, if you have one of these, you do not necessarily need mitre saw or a circular saw.*

- » Nail gun (Brad Nailer) - this can be used for fixing cladding, panelling, non-load bearing structures and is especially useful for trim. *Delwalt sell a 18v cordless nail gun, which is great because it does not require a compressor.*

### The tools I use

All the main, established, brands make pretty good tools. These are the ones I use, just to give you an example.

If you are buying cordless (battery powered) tools, **buy them from the same brand** so you can interchange the batteries.

### Cordless Drill

DeWalt DCD778D2T-SFGB 18V Li-Ion XR Brushless (2Ah Battery)

### Impact Driver

Dewalt DCF887D2-GB 18V XR Brushless Impact Driver (2Ah Battery)



### Jigsaw

Makita 4329 / 2 450W Electric Jigsaw



### **Belt Sander**

Makita M9400 4" Electric Belt Sander 240V



### **Circular Saw**

Bosch GKS 190 1400W 190MM Electric Professional Circular Saw 240V



### **Table Saw**

Bosch GTS 635-216 Professional Table Saw



### **Mitre Saw**

Titan TTB794MSW 210mm Electric Single-Bevel Sliding Sliding Mitre Saw 240V

This is not a 'big name' tool, but has done the job quite well.



### **Hand tools**

There are quite a few hand tools that can really make your life easier during a build, of course not all of them are essential. I have attempted to break these down below:

#### **Essentials**

- » Ear defenders, eye protection & dust mask – (not handy, essential)
- » Square - the main tool for building straight!
- » Tape measure (two, one is always lost)
- » Spanner set
- » Hammer
- » Metal file
- » Pliers
- » Wire Strippers
- » Wire Cutters
- » Lug crimp tool
- » Volt Meter
- » Paint brushes / roller
- » Masking tape
- » Carpenter pencils
- » Sharpie markers
- » Copper pipe cutter (if using copper gas pipe)

#### **Nice to have**

- » Rivnut set - to insert bolt fixings where you cannot access behind
- » Pocket screw set - to screw wood butt joints
- » Foam gun - makes all foam gun work easier (don't forget to buy foam gun cleaner)
- » Pipe cutter (esp if using push-fit pipe)
- » Wood or metal vice - you need a bench of this but just makes working easier. You can get away with using a Workmate (or similar).

#### **Luxury**

- » Wood plane
- » Wood chisel set & mallet





# Holes in the van

Windows | Vents | Fixings

# Installing bonded windows

In general, bonded windows are relatively inexpensive, can provide lots of light and look great inside and out. They are typically not insulated - so they do condensate more and are more prone to heat loss, but for me, these downsides are worth it.

## Mini-course Video

This is an overview of the window installation process.

*Note: Not all windows have the same installation process. Do check the suppliers recommended method.*

The process is fairly straight forward – but there is plenty that can go wrong!

1. First mark out the window placement on the outside of the van. Measure it about three to four times for your marking out. I used a marker pen to draw the hole to be cut out.

2. Put the window up against the van to check the lines you are drawing matches up with the actual window area!

3. Once you are 100% sure, drill a 10mm hole to put in your jigsaw blade, put on some ear defenders and eye protection (it is very loud) and cut your hole!



Cutting the window hole (notice the crossed out line – I changed the marking after I put the window up against the van to check)



Finish the cut at the top middle section. This means that, with a gentle push, the metal panel (with sharp edges) drops inside the van and not on your toes.

5. Take a file and run it around the edges to take off the sharp edges



6. Close up any panel work with pliers or mole-grips. Just be sure to protect the shape of the outer panel with some wood.

Using wood behind the metal panel I used some mole grips to close these sections that would stop me putting the window edging on neatly.

7. Apply the edging, tap it around so it is pressed fully into the corners, then when you are sure you have it right, cut the edging so the ends fit neatly together.

8. Paint on primer to frame. Clean the window adhesive area – this was in the form of some wipes – it removes grease and other dirt that could stop proper adhesion.





9. Apply the glue to window. It seems like you have to put on a lot of glue, and you do. It has to fill in the whole gap between the glass and the panel. There is a gap because of the thickness of the rubber edging.

If you do not put on enough, especially at the top, it will leak!

Tips:

Cut a good length off the nozzle on the glue to make squeezing the adhesive out easier

Don't squeeze too hard as it tends to buckle the handle of the gun (buying the better quality gun will also help with this)

10. As soon as you have applied the glue, place the window on to the van – get someone to help!

11. Hold it there for a while – I just held it for as long as it took that you could not feel any movement when pushing it up.. and then a bit longer to be sure. It probably takes 15 minutes – depending on temperature. Let it set for 24hrs before driving.

## Under slung gas-tank

If you are installing an under slung gas tank you will need to install this before you install your insulated floor. (They typically bolt into the floor of your van).

If your tank has a bracket that mounts on the structure of the van - then this might not be necessary but it is worth checking first.

See 'Gas compliant system' chapter for more information about this.



Above, making a cardboard jig in order to mark out holes under the van - ready to fit an under-slung tank.

## Installing a roof vent

I installed a Maxfan roof vent, although they are more expensive than some of the alternatives I do feel that they are good value for money. They have a good build and the remote control features (if you get it) are really nice.

### Mini-course video

To start with your fan installation you need to work out where it is placed. Some vans have slightly flatter areas on the roof (for air con units - or similar) and these are the easiest places to place a vent because the runnels are less - making sealing the vent easier.

The first task is to carefully measure out the fan location ready to cut with a jig saw. Make sure you are using a fine tooth metal blade and don't forget to use masking tape to protect your paint work.



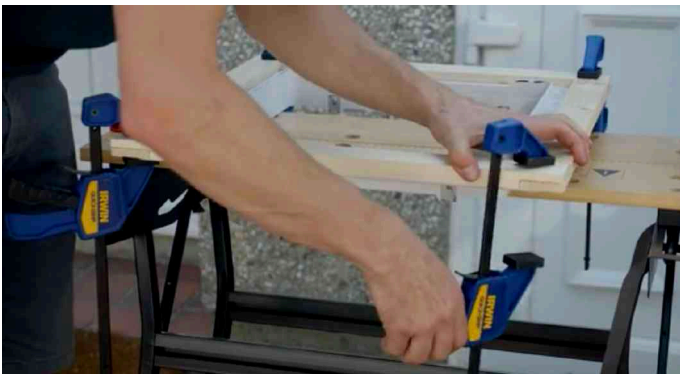


Drill a hole in each corner, then use the jig saw to 'join them up' and cut the hole.

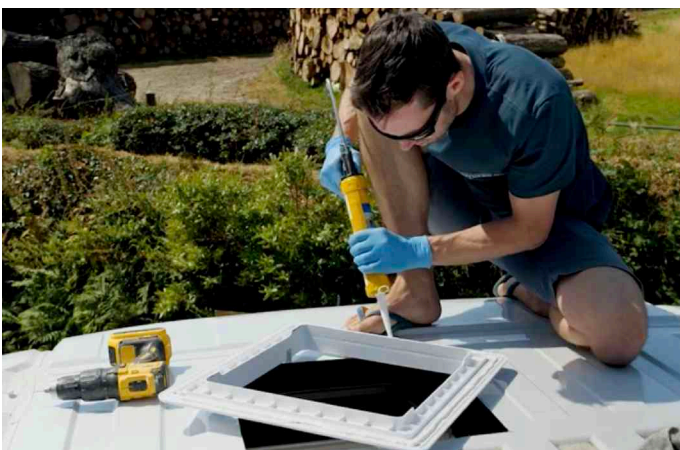
I then made a mounting frame to go underneath - this gives you something to screw the vent baffle into and gives the vent additional support within the metal roof. To do this I cut the wood to fit around the frame, cut some simple joints on the end of the wood - in preparation for glueing.



I glued the frame's joints with polyurethane wood glue and clamped them up. I did this around the actual vent part so that it definitely fits!



From there I used Sikaflex EBT+ a sealant and adhesive, and added a few thick beads in order to create a seal and bond the fan to the roof.



I then screwed the fan baffle into the metal and subframe. I put some sealant in each screw hole

to reduce the chance of a leak.

The last part was to fit the unit itself - this screwed into the baffle using four screws.



Later, once the insulation and even later, the cladding was finished inside the van I added the internal baffle - this needed to be cut down to match the thickness of my roof - and was screwed in to place.

## Lock box

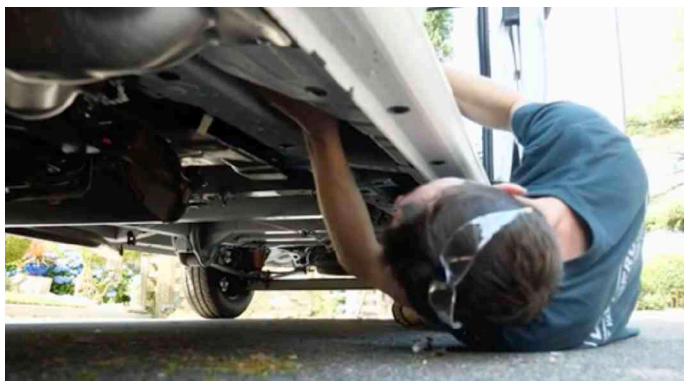
I installed a key-safe lock box under the van. this means that if I lose my keys, I can always get inside my home.

### Mini-course video

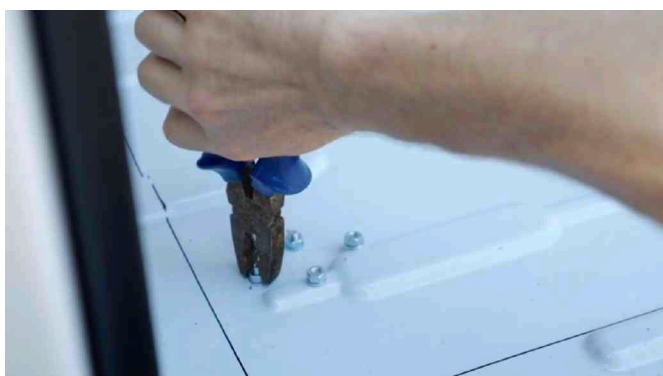
I chose a location which is hard to access - this makes it hard to attack with tools. There was a good space on my van just behind the sliding door mechanism.



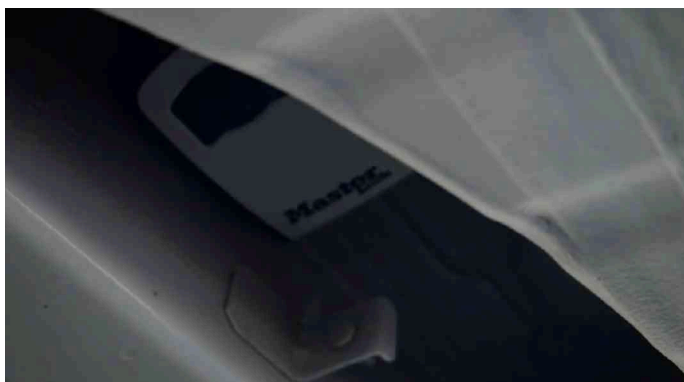
The first thing was to hold it in place and use a marker pen to mark out the hole locations for the bolts (the unit has four bolt holes in the back of the unit).



Then I place my bolts, nuts and washers and, holding the topside with some pliers, I used the impact driver to tighten them all up.



These lock boxes are easy to install, and an addition that can save some real headaches in the future.



## Hammock fixings

I like to put some strong ceiling attachments in the van.



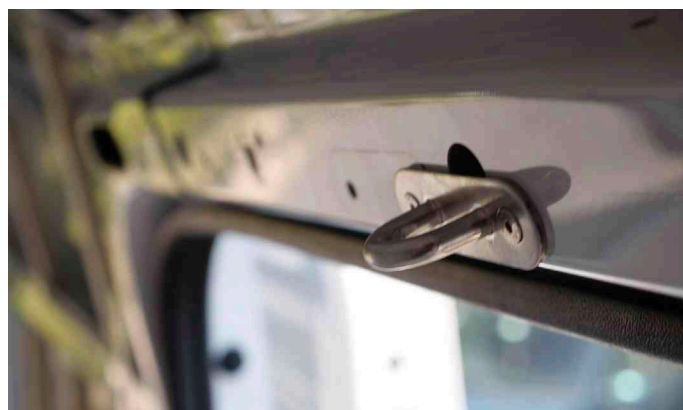
### Mini-course video

Partially for having a hammock from the van to outside trees but also to allow me to attach things to the roof in the future if I need to (e.g. surf boards).



On that basis I bolted six stainless-steel load bearing points to the roof; four over the bed and two at the front. I got mine from a yacht supplier – they only cost a few dollars each.

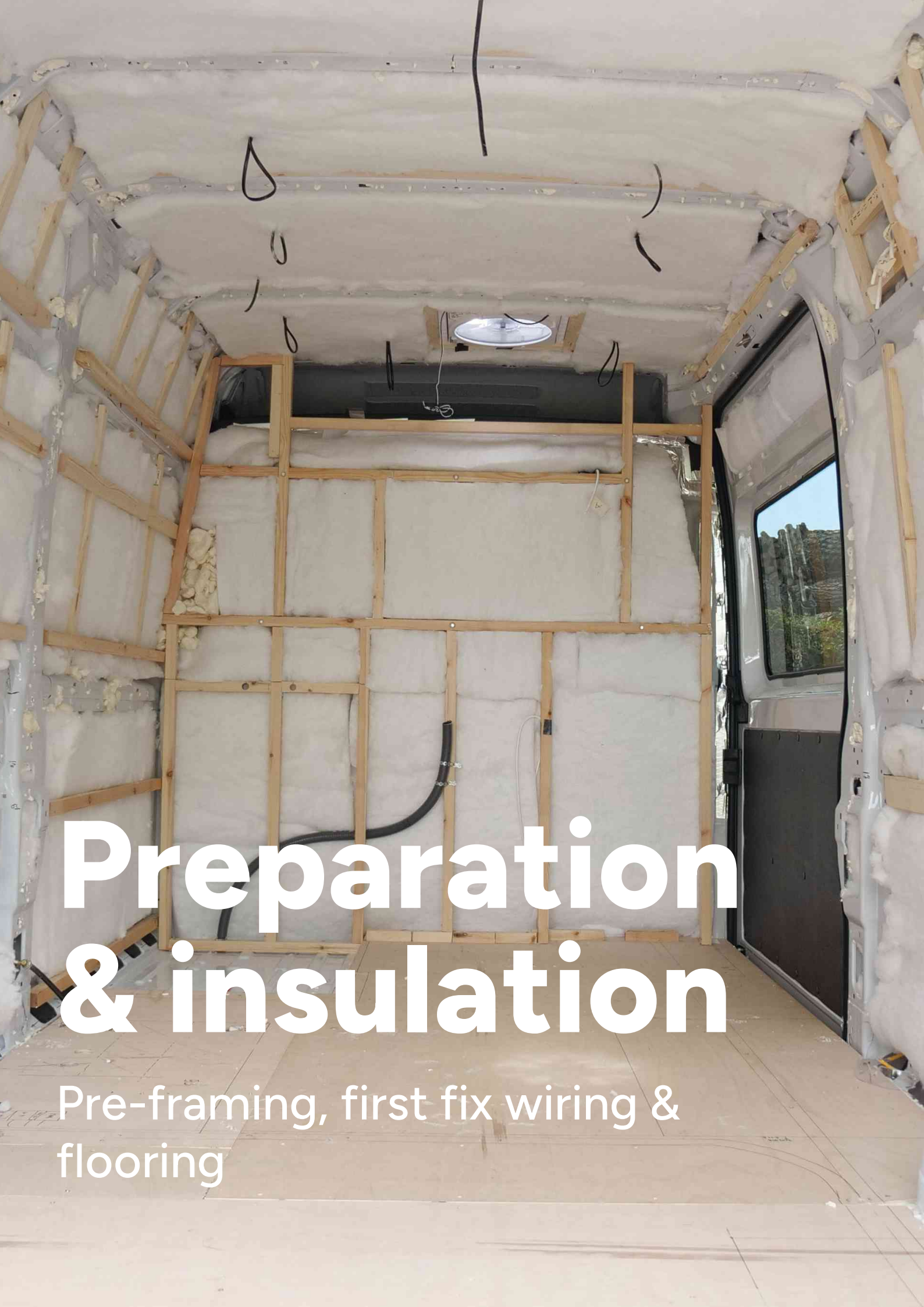
These were big enough to protrude through the wooden panelling and were rated for 300kg. I used stainless steel countersunk machine bolts. Using the powered screw driver I made them super tight to the metal work. This way they are unlikely to get loose.



**Tip:** You should find the thicker metal in the van for attaching these. On some vans (Citreon Relay/Dodge Promaster for example) the some of the metal box-work/framing is made with quite thin metal – which might buckle with too much weight.

Usually, the structural framing above and around the doors tend to be a thicker grade steel and are more suitable for attaching load-bearing points.

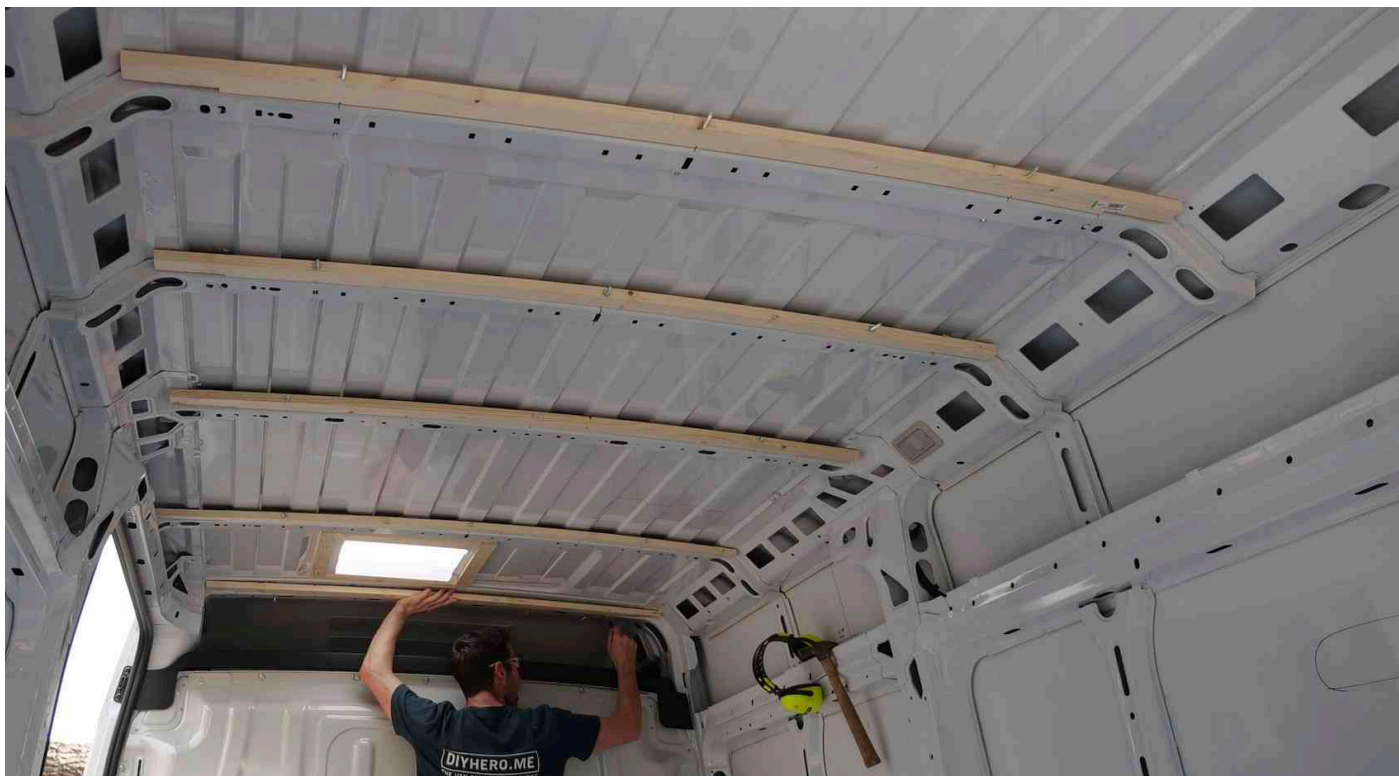




# Preparation & insulation

Pre-framing, first fix wiring & flooring



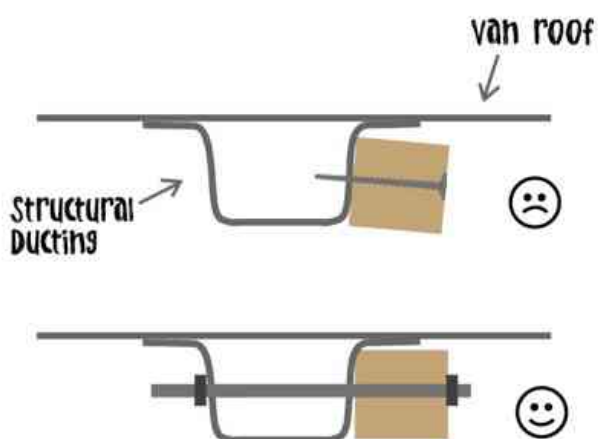


## Pre-frame stud work

If you are going to attach panelling or other things to the van you will need to have a way to attach it to the van. You can go directly into the metal work – but in some places there are holes or strange angles, and it is not really possible to screw it in anywhere – therefore it is useful to create a series of wooden structures which you can rely on and that will make your life easier later.



### Mini-course video



On some vans, these structural ribs are not very deep (see video above) and you need to use thinner wood. The ribs however are not square and have tapered sides. To manage this, I drilled

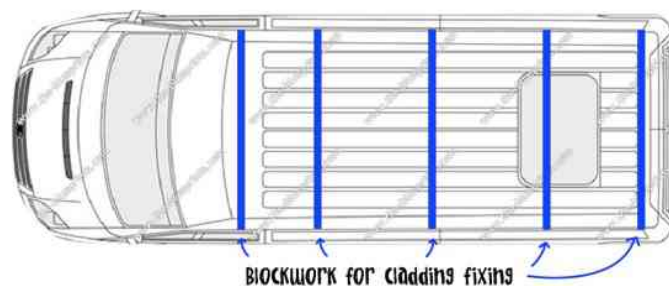
holes in each side of the rib, then bolted the stud work to that.

This made the stud-work square to the outside of the van and very well attached.

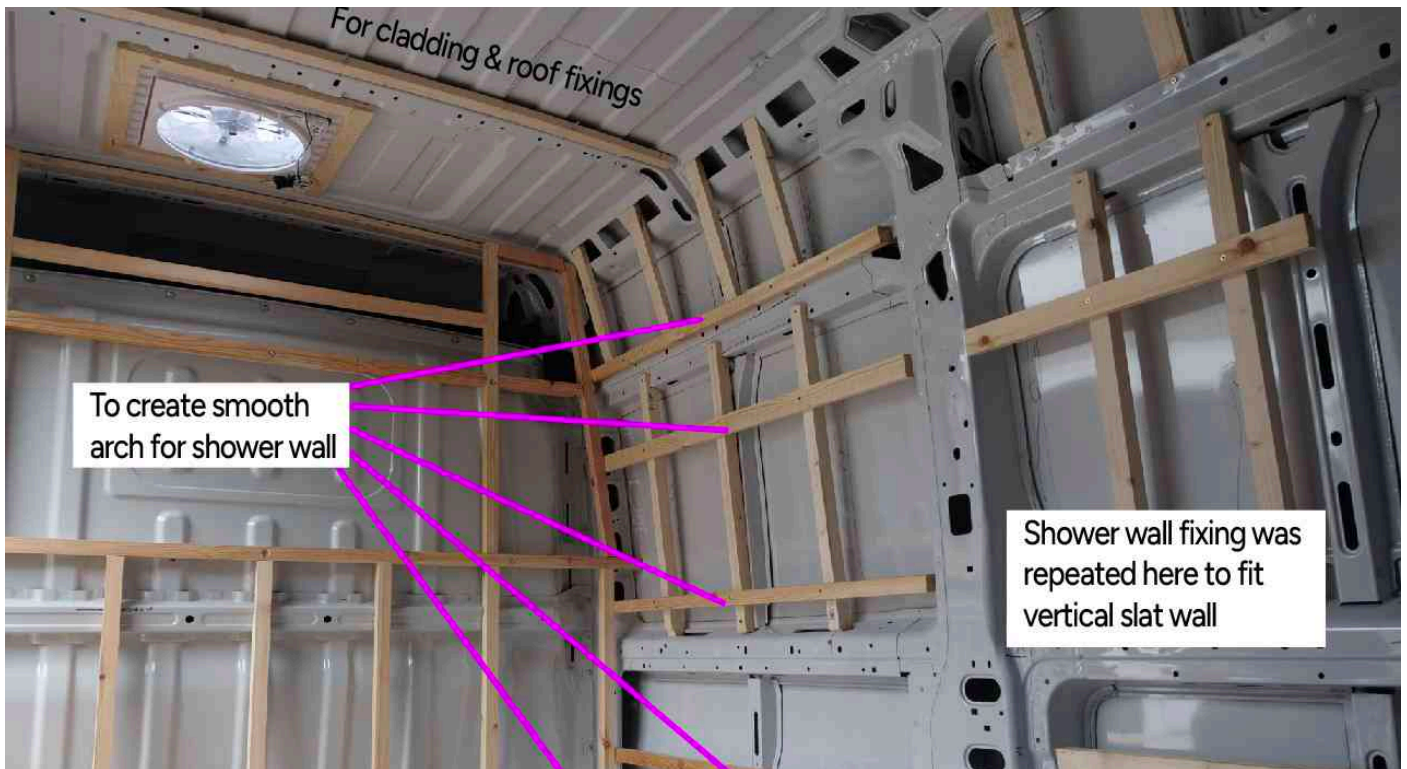
Side pieces of stud work – annoying to make as they are all different sizes.

*Note, I put stud work at each end of the van, and one each of the three structural ribs.*

To keep to the curve of the van's roof I cut some slots along the wood to allow it to flex a little.



Now this is complete, when it comes to attaching the cladding, we are prepared!



### Pre-framing

Good pre-framing requires a little forethought for what you will install and where in your van. By the time you are doing the finishing touches here you should have your insulated floor installed, upon which you can carefully mark out the layout of your van. This will help you understand what sort of pre-framing you need and where.

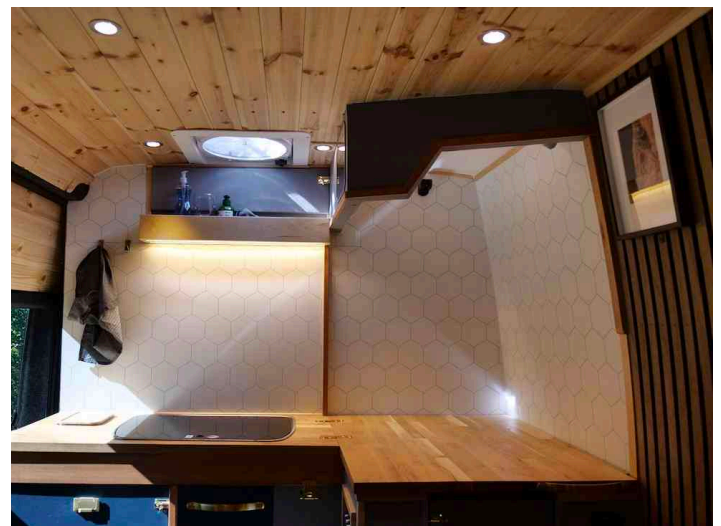
The above image shows how I pre-framed my shower area, to the right is the finished van.

As I required a smooth curve for my shower panel I spent some time putting in horizontal studs in order to support this. This was repeated to the right (not all shown above) to enable me to fix in my slat wall - which also required horizontal fixings to bend it into shape.

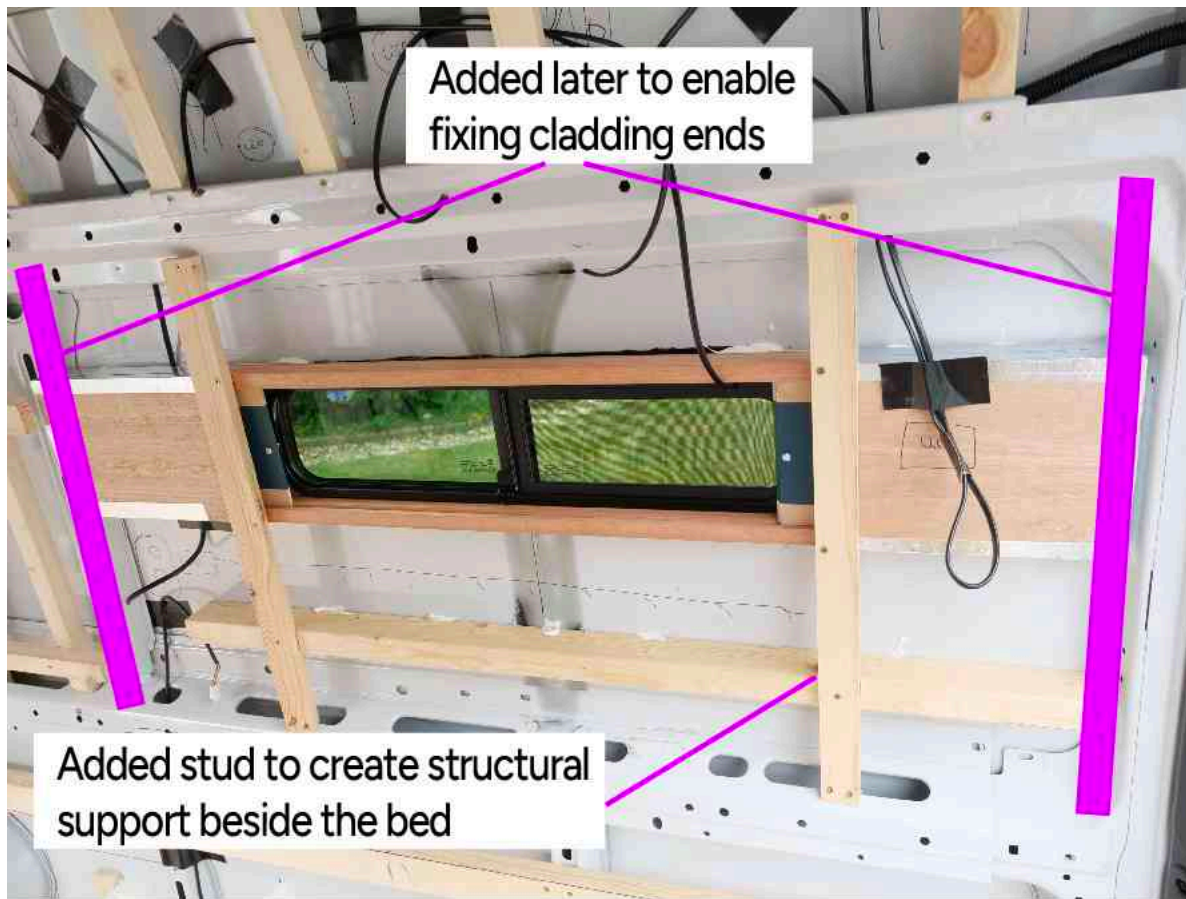
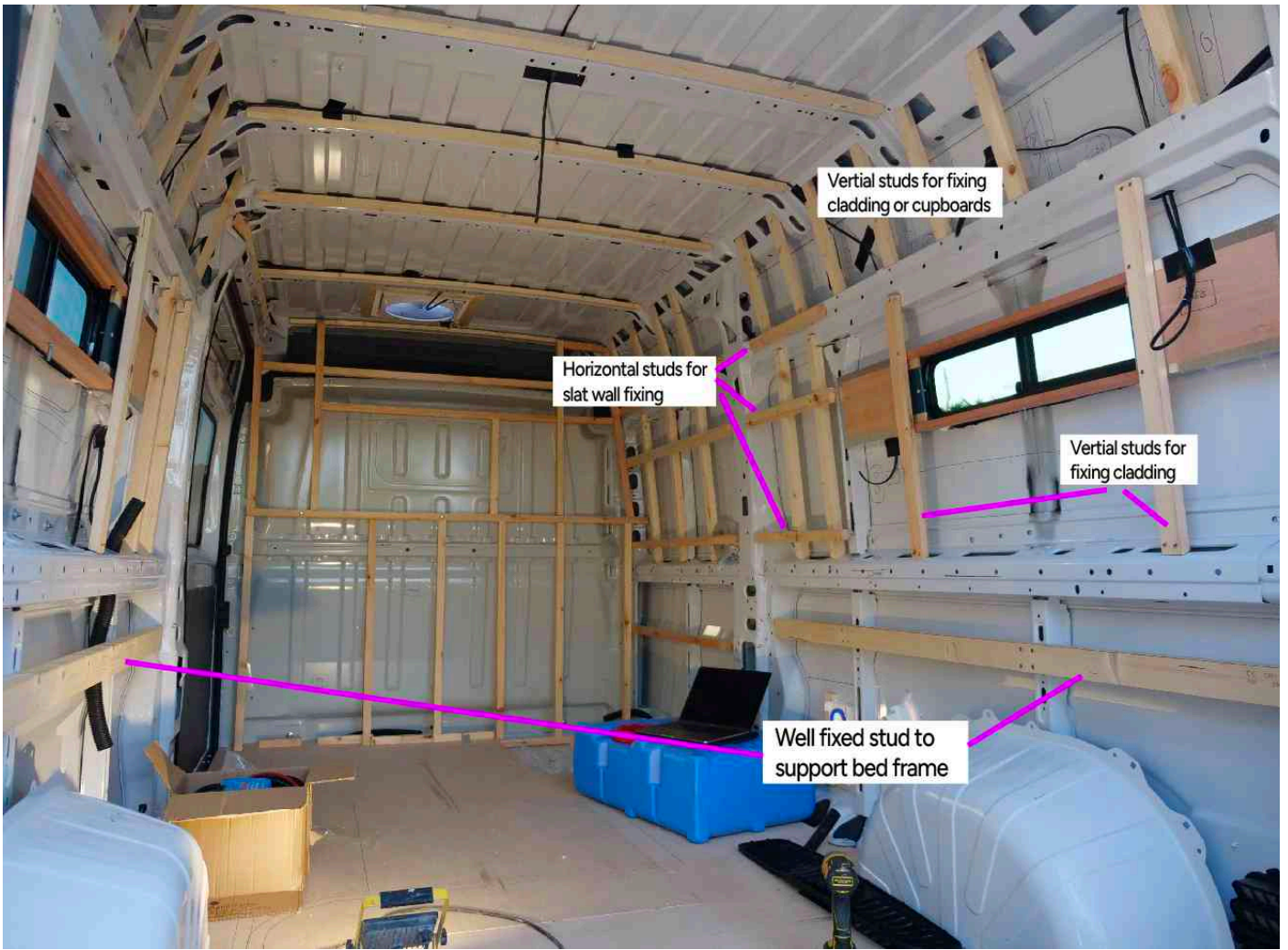
Behind the kitchen, I just needed enough uprights to give me options for fixing the kitchen and to provide adequate strength.

Above the kitchen I used the pre-frame to create the shape of the cup-board opening. All of these were really useful later in my build.

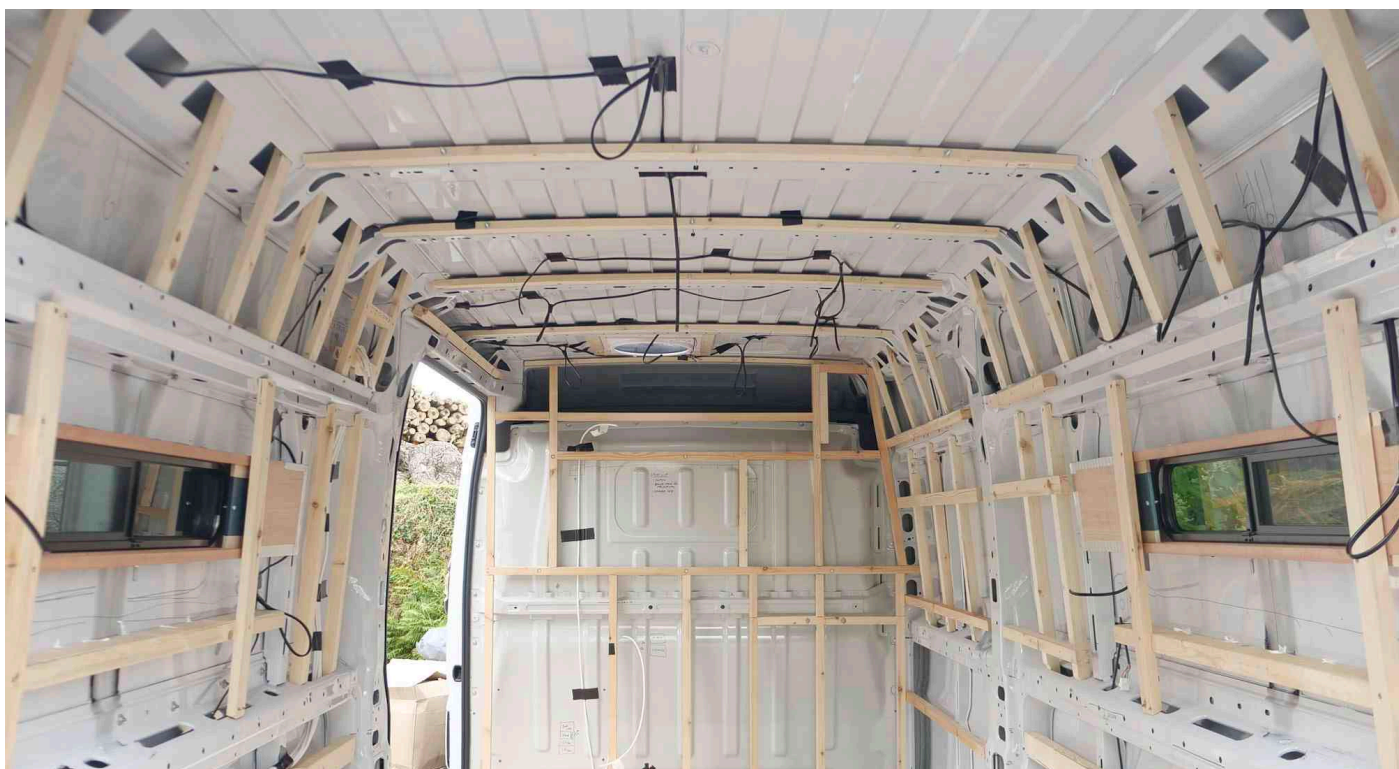
The following page shows other aspects of my pre-frame stud work which was put in place before first-fix wiring, insulation and vapour barrier.











## Electrical install (first fix)

Before installing the insulation and the vapour barrier it is best to run the appliance wiring in your van. This will be all the wires that go to lights, switches, USB points, electric vents - and anything else that will be fitted into the walls and roof.

This is my process:

### 1. Mark it out

I use a marker to draw out where everything will be (approximately). I will draw roughly the path of the wires so that I can visualise the lighting rings that I will install.

This stage helps me work out where I can bring all the wires - often we can drag them through some of the structural elements of the van.

### 2. Wire it up

Most of the wires go to lights, USBs, or my switch panel, so are essentially the same cable. In my last van I used about 120m/360ft of cable! It can be surprising how much cable goes into a van - especially if you have multiple lighting rings.

I attach them to the roof using Gorilla tape (or similar strong tape). If the weather is very hot, and you leave them for a while, cheaper gaffa tape tends to melt/peel off faster.

Where I am wiring a few items in parallel (LED lights, or a couple of USB points) I will put tape in a loop (see below). I leave enough to give me a bit of flexibility in positioning and to make working on the connectors easier.



I might run some cables under the floor using conduit, this is flexible tube for cable, but this will depend where my electrical storage compartment will be.



The above image shows the path of the conduit I ran. I used 35mm conduit because I wanted to pass large DC-DC charger cables through it.

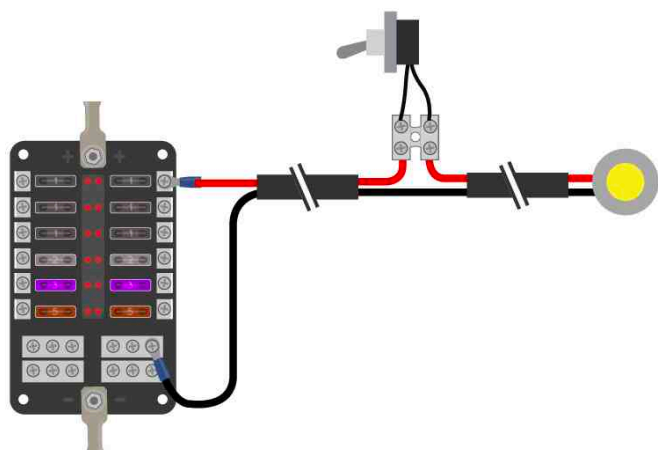
I used the conduit because I wanted to run the battery-to-battery (DC-DC) charger cables from where my battery was - at the back of the van - to the cab (where my starter battery is). If my battery was on the right hand side - or somewhere near the front - where I could run cables through furniture - I would not necessarily need to do this.

While I was installing conduit I also ran cables to the right hand side of the van where my heaters were to be placed.

### In-line switches

The most economical way of running cables to switches is to take a cable to a switch and then directly go to your appliance (say a light). This requires a little more thought but is a good way to do it.

Below shows the wiring for an in-line switch. If you wire up your switches in this way, you need to make sure you have a 'loop' in the right place for where you want to install your switch.



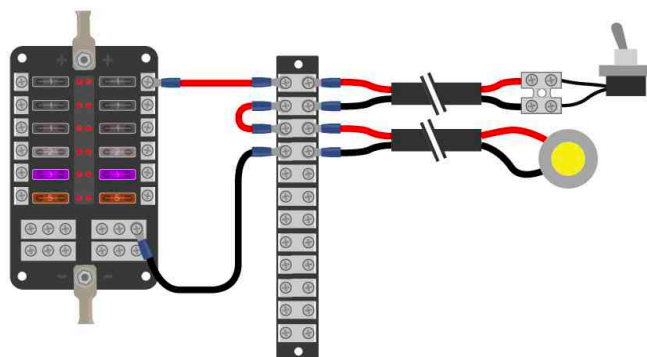
### Switch loom

I tend to run cables to switches separately and then connect them all up at my electrical board. This gives me a little more flexibility for what I use my switches for - reducing the pressure on the planning part - and makes wiring up the van bit easier.

By doing this, and having all your switches run from your fuse box separately can use a lot more cable if your switch panel is far from the electrical compartment. If you have 6 switches 5 meters away, it will add 30 meters of cable

to your conversion - ideally, if you use a switch loom it is fairly close.

Below shows the wiring I use to make a switch loom. The loom is all connected up on the electrical board using a bus terminal (lots of connectors in a line).



### Checking

I would take time to check your plans against what you have installed. Give some time to thinking about anything you might have forgotten, or anything you might like to add (or have the option of adding later). Make sure that the positioning of the lights and appliances work based on your latest thinking. Once you have added insulation, vapour barrier and cladding - it gets much harder to bring cables through the top of your van!



## Insulation options

Insulation is pretty important if you want to have a good living environment.

### You install insulation to:

- Protect against cold
- Protect against heat
- Reduce condensation

### Protecting against cold

The cold will sap the heat from your van with or without insulation but insulation will greatly reduce the speed that your van cools down. When combined with a heater, an insulated van will simply use less fuel to heat your van.

### Protecting against heat

Protecting your van from getting hot is probably the main benefit of insulation. We can install systems to heat the van quite easily but cooling a van is harder. It is not generally feasible to run an AC unit from solar – therefore if your van, and everything inside it gets hot, it can take a long time to cool down.

### Condensation

If you have ever unpacked a tent after a cold night you will find that the fly sheet is totally wet on the inside. This build-up of moisture in a van can cause all sorts of misery in cold weather.

I remember staying in a friend's uninsulated, non-heated van in winter in Chamonix, the outside temperatures crept down to  $-25^{\circ}\text{C}$  ( $-13^{\circ}\text{F}$ ) and the entire body work of the van built up a thick layer of frozen condensation. When the van warmed up in the morning, or when we drove somewhere the next day, the condensate melted and dripped over everything in the back of the van. Not only that but everything in the van froze – eggs, water, vegetables. This is not a good way to live.

### How to insulate a van

Some people go super nerdy about it, and there is so much technical information out there, but to a large extent it depends on your budget and what method suits you, and your needs, best.

In this guide I will go through two simple insulation methods, which anyone can do without specialist equipment.



## Installing an insulated floor

This is a system I always use for my vans. I glue studs down, fill the gaps between them with PIR board and seal any gaps with spray foam.



### Mini-course Video



On top of this I put down ply (sometimes you can re-use the ply that was already in the van). But otherwise it just needs to be cut to fit the shape of the floor.

Be sure to finish joints of plywood on studs so that it is strong throughout.

## Insulation System 1



Celotex / Polyisocyanurate / PIR board

- Walls & doors: 50mm Celotex foam board + Insulation foil + Cladding/Panels
- Roof: 30mm Celotex + Insulation foil + Cladding
- Floor: 30mm Celotex foam + 9mm (3/8 inch) ply/flooring

Ducting: Filled with spray foam

Remaining metal work: Auto carpet

In general, I do not want to lose too much height so there is a bit less on the ceiling and floor. As it is, if I stand straight my hair just

brushes the roof – It would not have been good to lose another inch.

For the floor I put in wooded stud and glued it down, with the shape of the base of the van it left just the right space to put in insulation board. I screwed the plywood down on top of it (a new ply base came with the van).

For the walls and the roof, the shapes tend to be a bit awkward, but my general process was as follows:

1. Measure and cut the shape out using a jigsaw
2. Place it in, ideally it is just a little too big, so it wedges in
3. Use spray foam as 'cement' and fill in any gaps (using the gun grade foam)

This also worked on the ceiling, which saved having to prop the insulation panels against the roof for ages while glue dried. Wedging it in and using the spray foam was really quick.

Using the expanding foam as a fixant worked really well and was quick to do. The box work (at the top of the photo) needed various pieces to be cut, slid in and tessellated until it was full. I then used foam gun to fill in any gaps.



Gluing in the foam board insulation with the spray gun

### Important!

There are some areas of ducting, especially around the doors, which have functional mechanisms in (locks/access to lighting etc.) – just check you are not filling something that one day you will need to access. or you will have to spend half a day trying to dig-out because the door no longer locks!

On my first van I sprayed a bit too much spray foam around my light unit, when I needed to change the bulb it was a nuisance to get the light unit out.

This is the van 70% insulated. At this point I have half applied the foil to the van.

Notice the slots in the foam around the electrical conduit. These spaces could have been smaller, but I eventually just filled it with foam gun in the end anyway.



The van is looking a bit of a mess at this time but don't be disheartened – this is a major preparation stage and, once finished, everything you do starts to make it prettier!

An easy way to put up the foil insulation layer..

I used some old screws, pushing them through the foil and into the foam insulation behind it – simply to tack it up in its place. A whole load of these and the insulation is quite effectively attached. I then used foil tape (or gorilla tape) to seal up the edges.

### **Extreme cold insulation**

If you want get nerdy about it - Celotex (or similar polyiso insulating board) is not ideal for vans where the average temperature will be lower than around 5°C (41°F).

However, because the main benefit of insulation is to prevent the van getting very hot and that if you are operating in cold temperatures for long periods then a heater is essential for your comfort – then the polyiso board is probably still a reasonable choice.

### **Better cold-weather insulation**

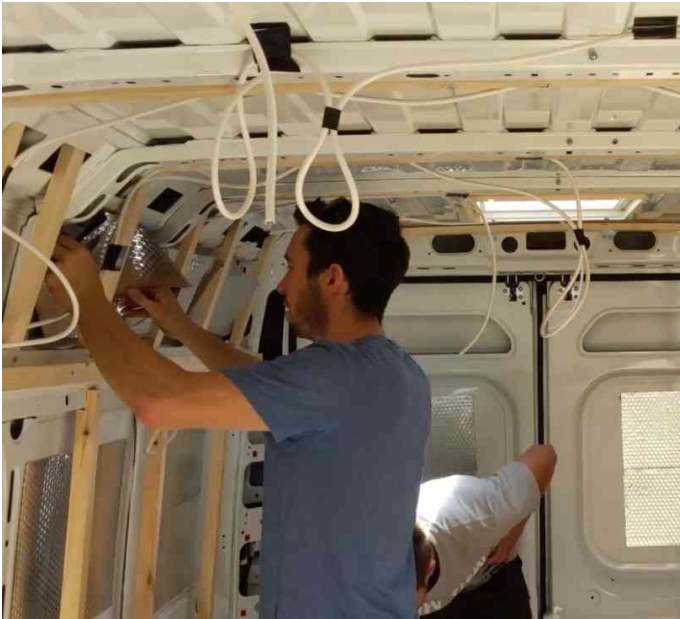
XPS (extruded polystyrene) is a better performer (as are some others – see link below) when it come to cold weather performance. XPS is not the most environmentally friendly product to produce – however in a life-cycle analysis it may be beneficial.

## Insulation System 2

Polythene Fleece (typically recycle bottles)



### Mini-course Video



If you are going to go down this route – I would give them a call/drop then an email and tell them what van you are looking to insulate and they will put an order together. You can see the quantities I used at the end of this book.

- Walls & Ceiling and doors: Sound deadening & fleece
- Floor: 30mm Celotex foam + 9mm (3/8 inch) ply/flooring
- Ducting: Filled with spray foam
- Remaining metal work: Auto carpet

**Step 1:** Do the floors the same as the system described above – the video guide below explains why I used the same flooring insulation for my second van.

Watch the video below to learn how to install the rest of the Dodo wrap system. It is fast to do and I have found it to be really effective.

**Step 2.** Add sound deadening. These heavy sheets are easy to stick on and the whole process takes just a few minutes.

**Step 3.** Fleece installation



If you get van-specific fleece, it is usually fairly soft, relatively easy to tear, cut, and stuff in holes and apply.

Use spray glue to spray on the van, and onto the fleece and simply stick it to the wall.

This is a much faster process than the PIR board/Celetec which needs each section crafting to fit your van's spaces.

**Step 4.** Dodo Thermo Van Liner (or foil-based liner)



The van liner can be used direct to the metal as a first layer or – as I use it doubled up as a vapor barrier.

Tips for installing the van liner;

- Have someone help you when it comes to wrapping it around the van – the rolls are big and it is tricky alone
- Make sure the corners are pushed in as much as you can. If you do not then you get a bowing effect and it is hard to fit wood up-to the corners
- If this does happen (it probably will some-



where) then use some thick tape (like Gorilla tape) and cut the liner, allow it to open a bit and tape it up to re-create the moisture barrier.



### Insulation Method 3

#### Professionally Sprayed Foam Insulation

Another method for insulation is to have the whole inside of your van sprayed professionally with foam.

The process for this is as follows:

- Attach wood stud-work (so you can still attach things to the van walls afterwards)
- Mask out all areas which are not to be spray foamed. It is very important that you do this carefully and thoroughly – including all rubber seals, windows, locks, mechanisms, light panels etc..
- Take it to a company who sprays the foam



Typically the foam is 30-45mm thick and it also provides a moisture barrier. This is a very effective

way of doing your insulation but does require professional spray foam kit and therefore it is unlikely that you will be doing it yourself.

The cost is for a long-wheel base/high top van should be around £450 so it is not vastly different compared to other insulation methods especially considering someone else does the insulation work.



Before & after spray foam images thanks to Mateusz Pakulski



## Cladding & finishes

I used 8mm interior cladding. This is thinner than external cladding and easier to flex around the van shape and it has a better finish than external cladding.



### Mini-course video

Typically, the cladding has a smooth side and a slightly rougher side. Just make sure you are putting it on the right way!

Applying the cladding to the window side. I first screwed plywood strips to each end (see where the cladding is screwed) and also in the middle. The cladding is fixed at both ends with screws, and in the middle using cladding clips.

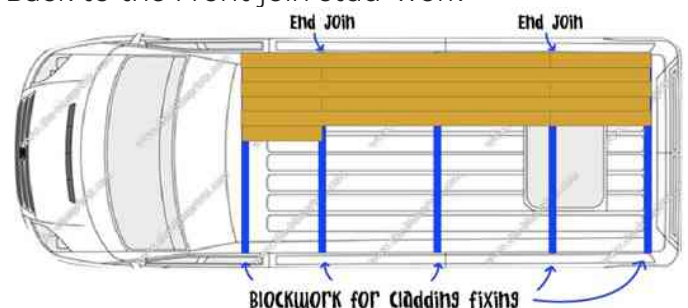
Cladding clips. They usually come in packs of 50 and include little nails. The spiky projecting section shares the slot in the cladding's groove and the nail goes in the hole behind it as the fixing.



For the top of the van, as we have fixed points to fix the cladding to, (the stud work across the ceiling) you need to ensure the joins are on one of these bits of stud work.

The cladding I had was 3 long, about 40cm too short to go the full length of the roof. For that reason, I cut the cladding down to two lengths.

- One length from the Front to the Second-to-last stud-work
- The other half the length from the Back to the Front join stud-work



I started on one side of the van and worked my way over to the other. The way cladding clips work mean you can only work one way! Along the tongue of each piece of cladding I put a thin line of sealant glue. The idea was to reduce any creaking and make it more solid.

As I went I measured and cut holes for the roof eye-plates, lights and for the extraction fan. This was done BEFORE I fixed the cladding up.



Where your cladding needs more support (especially on the doors) using screw cups is a nice touch & it protects the wood from splitting.



Once done, I sanded the cladding down. P150 sandpaper is about right.

## Danish Oil

To finish the cladding I used Danish Oil. It is pretty good stuff.

Danish Oil protects the wood without making it too glossy. It makes it slightly darker – but on the pine, not much. I bought two 500ml cans. These two cans were enough for my whole build.

To apply it, once you have given the cladding a rub down with sandpaper, you just use an old rag and wipe it on. Leave it 6 hours and repeat this until it has three coatings. You can buy fast drying Danish oil but I find using this stuff gives me headaches as it off-gasses.





# Gas Installation

Regulations, internal & external  
tank, drop vents, pipes & hosing

# Gas installation

## Gas inside your van – safety notes

A tank inside your van is basically a bomb of deadly gas inside your bedroom. Start with that mind-set and rationalize from there.

Check you are doing or thinking about the following:

- You have a vent in the floor for any leaked gas to escape. More than one if necessary.
- Ideally store the gas system in a sealed cupboard – so if the gas leaks it has nowhere to go but out of the vent (and not into the living space)
- Test all your gas pipe joints (you can use 50/50 washing-up liquid and water dabbed on the joints) if there is a leak it will bubble and you can do something about it
- Make sure the gas cylinder, pipes and appliances are well fixed down, so there is no possible movement from vibration of the van. I fixed my internal cylinder in with a ratchet strap which I fixed permanently to the framework.
- On threaded joints use gas grade PTFE tape and make sure everything is appropriately tight
- If using copper tubing, use appropriate gas compression fittings (do not use PTFE tape)
- If using rubber tubing, make sure you push the tubing all the way down the nozzle adaptors – its hard to do - and use the right size jubilee clips on all joints and tighten appropriately

**GET IT CHECKED BY A PROFESSIONAL** – it is your life (or those you love). It is not expensive to get it checked.

- See this advice as a rough guide - I am not a gas professional, I cannot really advise you – other than telling you how I have done my conversions and try and persuade you to take safety seriously
- Also, I recommend that you install a gas leak detector, a Carbon Monoxide detector, and a fire extinguisher!

# Gas compliance

What are the regulations for installing gas in my campervan? Do I need a gas safety locker? How will I know that it's safe? There are a lot of things to be uncertain about when installing LPG in your self build camper van - and it's hard to find the right information online.

Greg Virgoe (of YouTube) helpfully bought a copy of the standards and we have worked with him to create this concise guide to help self-builders understand the regulations for installing and testing your LPG.

Before we get stuck in, a word of warning from Greg;

“Hey guys! Installing LPG in your campervan is by far the most dangerous part of a self build. In the UK (and in many US states) there is no governing body for gas installations in vehicles, so there is nothing to stop a DIY van builder from doing a home installation. If you plan to install your gas yourself, you need to make sure it's done safely and tested thoroughly. Remember, gas can be fatal and should be treated with respect!”

This lack of regulatory oversight is not the same in all countries or states. In the US - as far as I understand - you can do almost anything you like, but in Spain, Germany and many other countries the regulations are far stricter. Always check the rules that apply to your vehicle!

## Gas regulations for van conversions

The regulations for installing LPG into caravans and motor homes are detailed in the BS EN 1949:2011+A1:2013 document. It does provide all the information you need, but it's very long to read and also expensive to buy.

## How to test your LPG installation

A gas leak in a small space could be catastrophic. Before you use any appliances with your DIY gas installation, it should be tested for leaks to make sure it's completely safe.

If you aren't comfortable testing the system yourself, get a qualified gas engineer to carry out the test for you. Speak to a local caravan accessories supplier to find an engineer.

Before we learn how to test the system, it's

essential to understand that there are two sides to a gas installation: The high pressure side and the low pressure side. Each side needs to be tested differently.

LPG (Propane) Cylinder Pressure Chart

Temp	Temp	Pressure	Pressure	Pressure
°C	°F	kPa	PSIG	Bar
70	158	2482	360	24.8
60	140	2013	292	20.1
54	130	1794	257	17.9
43	110	1358	197	13.6
38	100	1186	172	11.9
32	90	1027	149	10.3
27	80	883	128	8.8
16	60	637	92	6.4
-1	30	356	51	3.6
-18	0	152	24	1.5
-29	-20	74	11	0.7
-43	-45	0	0	0

### The high pressure side

The high pressure side of your LPG system runs from the gas cylinder up to the regulator. In this area, the pressure changes with the temperature - from 1.5bar at 0°C up to 25bar at 70°C. This chart shows the pressure depending on where your cylinder is stored

### The low pressure side

Low pressure side of your system runs from the regulator to your appliances. The regulator reduces the pressure down to a very low pressure of 30mBar / 0.435.

### Testing the low pressure side

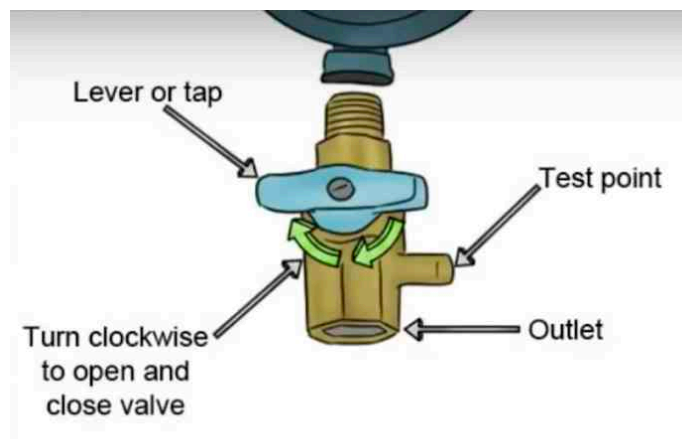
Once you have completed the installation in your van, you need to test it up to five times the pressure. You will need a manometer and an LPG hose for the test.

Follow these steps to test all of your pipework, right up to the appliances.

1. Turn all the taps off on your appliances.
2. Open the local isolating valves - this allows you to test right through to the appliances.
3. Connect the LPG hose onto the plus side of a manometer.
4. Connect the other end of the hose to the

system side of the regulator (there will be a test point on the regulator).

5. Pump the system up to 150mBar.
6. Leave it for 5 minutes and allow the temperature to even out.
7. Then take a first reading of the pressure.
8. Wait another 5 minutes.
9. Then take the final reading.



In the time between the two readings, the pressure should not have dropped any more than 10mBar. Ideally, it would not have dropped at all! A pressure drop would indicate a leak in the system.

### Testing the high-pressure side

It's sufficient to test the high-pressure side of your system with a leak detection spray. Because the pressure is much higher there, it's okay to test with working pressure. Spray all the joints with leak detection fluid (similar to fairy liquid). If there is a leak, the fluid will bubble up. There should be no leaks within a 30 second period of applying the leak detection spray.

### Gas locker regulations

In caravans, access to the gas compartments is usually on the outside of the vehicle. However, in self builds, it's difficult to make an opening in the side of your van - and so you can have a sealed compartment which is accessible from the inside. (Another option is to install an under-slung LPG tank, which is fixed to the underside of your van.)

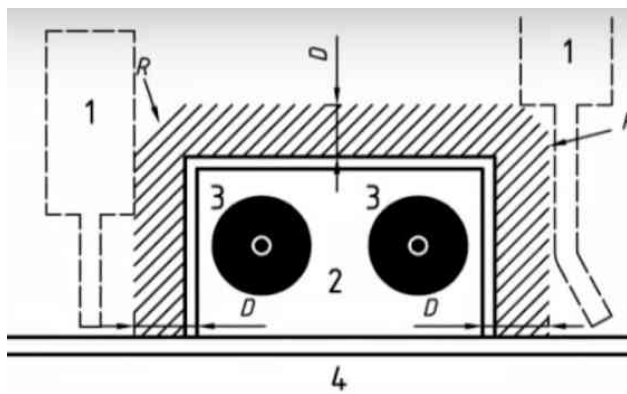




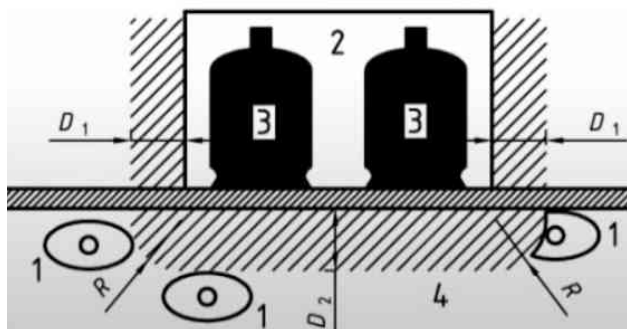
If you choose to install a gas cylinder inside your van, the following restrictions apply.

You can carry a maximum of two cylinders with a maximum capacity of 16kg each.

- The cylinders must be stored in a compartment sealed from the living space.
- The sealed door must not go right to the floor, there must be a 50mm up stand.
- The cylinder must not be positioned directly above your van's exhaust pipe. It must be at least 250mm outside of a zone around your exhaust.



a) Top view



- The cylinder needs to be securely fixed at both high and low levels.

- You must be able to undo all straps and methods of securing without the use of tools.
- The compartment must not hinder access to the regulator, isolator, or any other gas components.
- The gas compartment must be ventilated - the ventilation area must equal 2% of the floor area.
- The drop-out vent in the bottom of the cylinder must not be obscured.

## Ventilation

It's essential to add a drop-out vent to your gas compartment. LPG is heavier than air, so if you do get a leak, the gas will fall out of the bottom of the compartment and escape through the vent.

Drill a hole through the bottom of the gas compartment and the floor of the van to install the vent. A 50mm vent offers 800mm<sup>2</sup> of ventilation. If you have a small cylinder (below 7kg), you can get away with one 20mm drop out vent.

## Electrical cable

If you need to run electrical cables through your gas compartment, it is safe as long as

- There are no joints or connections inside the compartment.
- All of your cables are protected by conduit or trunking.
- The openings in and out of the compartment are sealed.

Pressure regulation and working pressure

It's important to regulate the pressure in your LPG system. A regulator turns the high pressure gas from your cylinder into low pressure gas (max. 30mBar) that is used to run your appliances.

## Rules for the regulator

The regulator can be fitted on top of the cylinder.

- It can also be bolted to the wall and attached to the cylinder with a short, high pressure hose. The hose must not be longer than 400mm and there must be no stress on the joints.
- The cylinder must be positioned so that you are not obscuring the regulator or any shut-off valves.

- There should be a maximum flow rate of 1.5kg/hr.
- Each system should be clearly marked with the pressure in the system.
- All hoses should be clearly marked with a pressure rating, colour coded, and tested for resistance to LPG.

Components and materials for installation

## Pipes

- All pipework from the regulator to your appliances needs to be rigid copper or steel pipe-work (copper coil is best).
- All appliances that are permanently fitted to the van need a rigid connection to them.

No flexible hose to permanently fitted appliances!

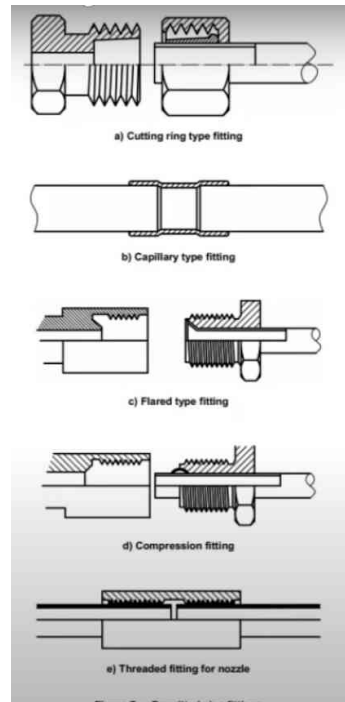
- Flexible hose
- Flexible hose can be used for moveable appliances (e.g. portable stoves).
- It must not be more than 750mm long.
- There must be a shut-off valve on the bottle before the hose.
- The hose must be to LPG standards.

It must be visible and not hidden under floors or behind walls.

## Fittings

There are a few kinds of fittings that you can use in your LPG installation.

- Compression / Ring cutting (olive and nut)
- Soldered
- Flared



Gas safe PTFE Tape must only be used on threaded fittings only (not compression) to completely seal the joints.

In compression fittings, the seal is formed by the olive, not the threaded nut, so PTFE tape could actually cause a leak instead of preventing one. You can use a small amount of gas-safe jointing compound to seal compression fittings.

## Shut-off valves

You must have a shut-off valve for each appliance. Each valve must be clearly labelled with 'Gas' and with the direction for turning it on and off.

## Installation design

When you first start designing your van, you should consider where your gas service pipes will be installed. Planning ahead is key to make sure that everything is safe and easily accessible!

There are a few rules to remember for the layout of your LPG installation.

- All pipework needs to be installed where it's easily accessible for testing. You shouldn't have joints buried under the floors, in the walls, or in the ceiling.
- Your gas must be installed in a location where it won't get damaged or be under strain.
- All pipework needs to be clipped to the structure of your van. The maximum distance be-

tween your clips cannot be more than 500mm.

### Connecting appliances

All gas appliances installed in your van must be room-sealed appliances.

They must all be connected with rigid pipework (apart from portable appliances), installed free of stress, and have a local means of isolation.

### Warning: other appliances are unsafe.

- They use up all the oxygen in your van.
- They give off fatal gases.
- They give off water, which leads to condensation.

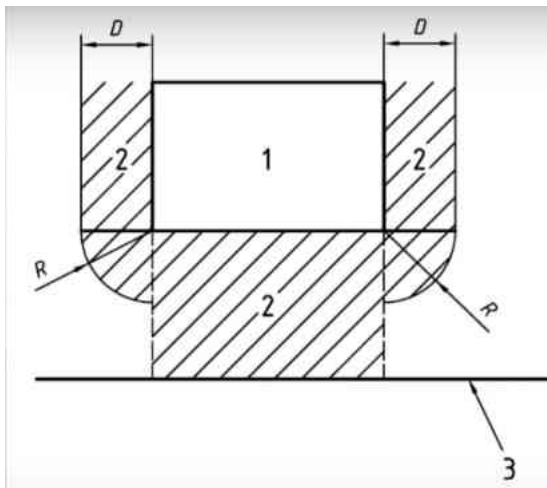
### Flue Terminals and Locations

Gas appliances such as fridges and heaters need to be ventilated with a flue to the outside.

These are the regulations for installing a flue.

- The location must be further than 500mm away from any refueling point.
- It must not be fitted directly underneath an opening window.
- It must be more than 300mm to one side of an opening window or an opening door.

### Filling point



Similarly, the filling point cannot be fitted within 500mm of an opening window or opening door. It should be fitted on the outside of your van so that it can be accessed without opening up the vehicle.

### Installation of LPG tanks

- The LPG tanks that you install must meet the following safety standards.
- There must be an automatic cut-off system

on the tank when being filled.

- The cylinder must not be filled to more than 80%.
- There must be a level indicator on the cylinder.
- There must be a manual shut-off valve.
- There must be a pressure relief valve.
- There must be an overflow regulator.
- The regulator must be fitted at the top of the cylinder.
- The cylinder must be stored upright.
- A warning label must be fitted to state that all appliances should be manually isolated before refilling.

You must shut the manual valve on top of the cylinder when you are refuelling.

Don't take any chances with your DIY gas installation.

It's vital that your system is safe and does not leak - otherwise, it could be life threatening. We can't stress enough that if you are unsure, you should always get a professional gas safe engineer to carry out the installation for you, or check what you have done.

It's not a requirement to get a gas safety certificate for self build vans, but if you plan to hire out your van, it will need to be signed off by a professional first. Getting a gas safety check is a quick and low-cost process that will give you peace of mind about your installation.



## Compliant system

This is an install of an under-slung gas tank that aimed to be compliant with gas regulations. This install includes a manifold, copper tubing, external regulator, and is connected to an air heater, a water heater and a gas hob.



**Mini-course video**



**Schematic Download**

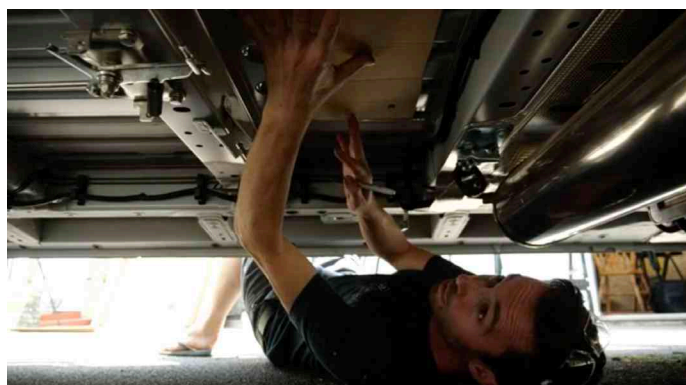
### Under slung tank

This is bolted to the bottom of the van, the tank was installed before the insulated floor.

To install my tank I first made a cardboard jig with holes that corresponded to the bolt holes on the tank.



I took this under the van and marked the holes using a marker pen.



I drilled the holes to-size and as I held the tank up and put bolts through the holes a friend put

on the nuts and washers. Afterward I tightened these up with a spanner.



### Connecting gas fittings

When connecting any gas fittings you need to be careful that you do not damage whatever it is already connected to.

To do this you must always support the opposing joint with a spanner. In this circumstance you are tightening against your own strength - otherwise you are risking breaking a fitting or twisting your pipework on the other side.

This is the same for all connections, you may be tempted to tighten against an appliance, or gas tank fitting, but this is always bad idea. It is easy to break your appliance with the torque a spanner - and it might be very expensive to repair.



*Above, using opposing spanners to connect up a compression fitting. Notice the point in the middle of the fitting for this very purpose! (Note - this is the same for many water fittings).*

### Fill pipe

The fill pipe (in this case a rubber tube) connected to the fill point using an elbow

compression fitting.

### High-pressure hose

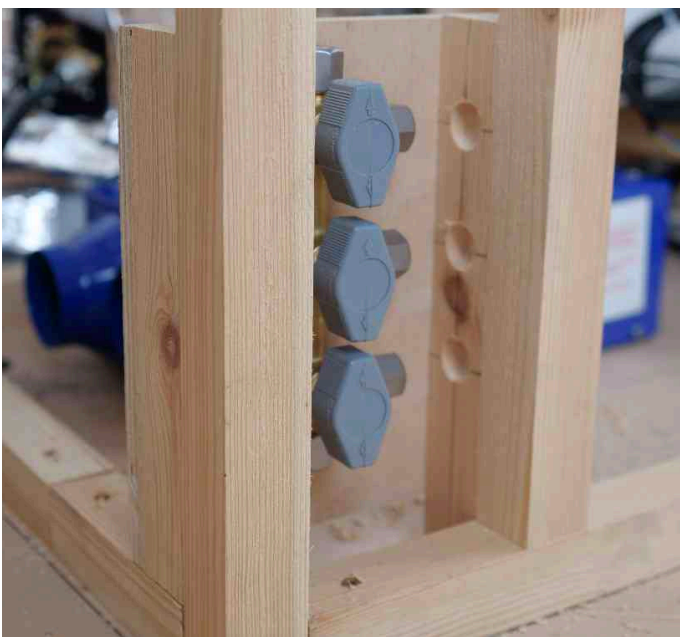
The high pressure hose was fitted to the tank using gas PTFE tape.

### Regulator

The regulator was fitted under the van. The high-pressure hose was fitted to the regulator. The copper tubing (that goes into the van) was fitted with a compression fitting.

### Manifold

I made a section of my cupboard to hold the manifold, in the end I put a small cupboard door over it - meaning that it is easily accessible.



### Copper tubing

To fit the copper tubing (usually 8mm) you ideally have a tool to bend the pipe - either a spring (cheap) or a pipe bender (better).



You also need a pipe cutter, this will give a clean cut and will not deform the pipe. You can buy an adjustable pipe cutter - these seem to be better than fixed-size cutters that can deform the pipe in the process of cutting it.

To cut a pipe, put on the pipe cutter (notice

the direction of turn - usually labelled on the tool), lightly tighten the cutting wheel, rotate the tool and repeat. This will quickly cut your pipe cleanly.



*Note, if you over tighten the tool, you will deform the tube and will mess up your cut - patience is best!*

### Air & Water heater connection

This is the housing for my water heater and air heater. I put both appliances in one unit (with manifold and fill hose connector. This means that the holes in the floor (for connecting the manifold and the fill tube) act as a drop-vent.

A drop-vent means that if there is a leak, the gas has somewhere to go (it is heavier than air) and should always be installed where you have gas appliances. You can purchase parts that have a little grill on them, shown below, that fit through the floor of your van.



The Propex Malaga water heater was mounted onto two rails that put it at the right height for the vent that I installed in the side of the van.



The water heater has a section of 8mm gas pipe sticking out the back of it (see above, it has a yellow cap on it (bottom rear of unit).

To connect this to the gas tube you just need to use a straight compression fitting (shown above in 'connecting gas fittings' section.)

### **Connecting up the air heater**

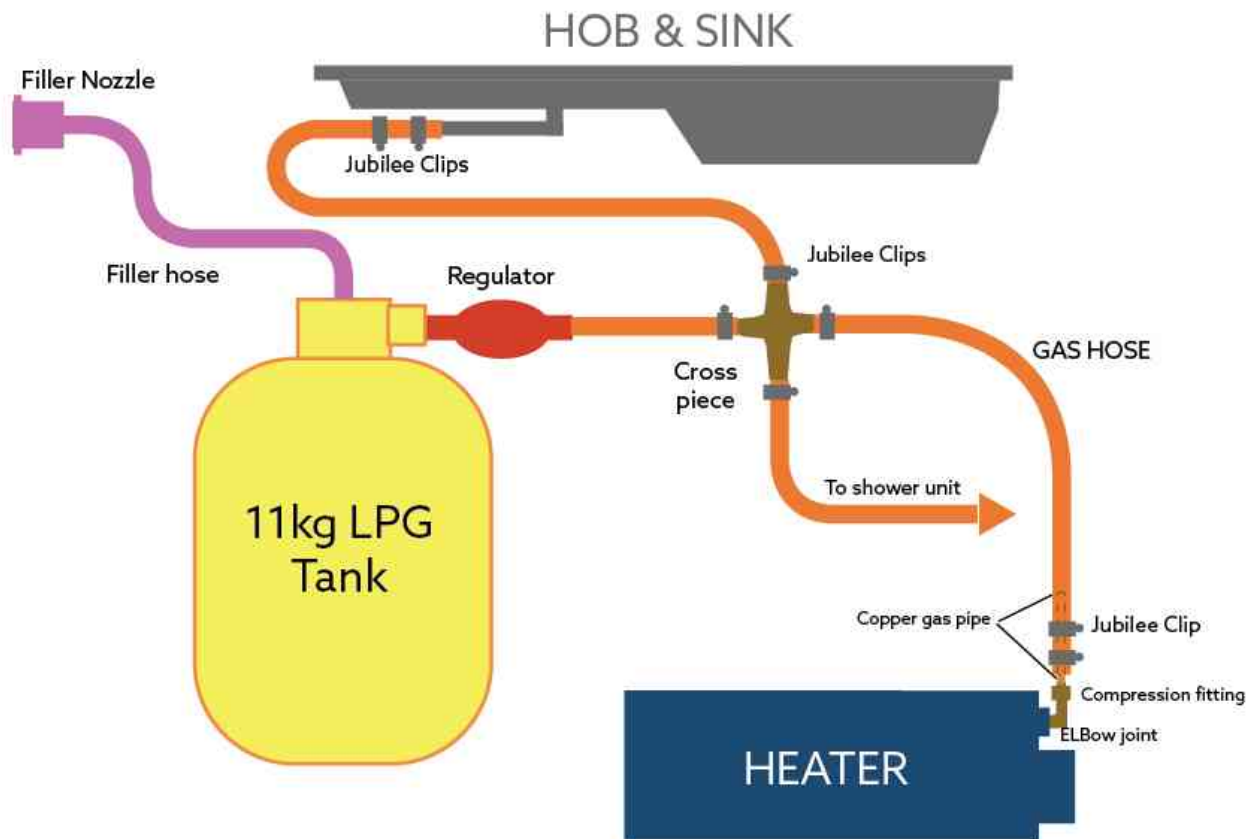
The Propex HS2000 heater has an elbow compression to screw thread fitting for connecting up the gas.



To fit this I added a decent amount of gas PTFE tape and screwed it in - once this is in place - and pointing roughly the right direction - you can connect the gas pipe to the compression fitting.

When applying gas PTFE tape you want to apply in the direction of the turn so that, when you screw it in to the fitting, it does not have a tendency to unravel or snag up.





## Non-compliant system

### Regulator

These 37mbar are pretty standard bits of kit. Check the thread you need to attach to your gas tank.



I used Gas PTFE Tape on all my screwed joints.

### Filler hose

I bought the official filler hose from the supplier of the LPG tank. It is expensive but you know it is going to do the job!



This is the position of the LPG filling point on my Transit van. In my latest van it is on the outside – this is because the kitchen was on that side.

Shown is the UK LPG filler type, you can buy adaptors for other locations fairly cheaply online.



## Floor vent

You need a hole in the floor under your gas tank/system to allow any leaking gas a chance to escape. If you want to be safety-conscious make the whole gas-area sealed/air tight so that any leaking gas has only the drop-vent as a place to escape.



I drilled a hole through the van and used one of these vents, they are fairly widely available if you search online for 'campervan gas drop out vents' or similar.



# Heater installation

This is the heater I used in both my van conversions;



It is a Heatsource HS2000, 12V, Single Outlet 2KW Gas Heater.

## Mini-course Video

I got it as part of a full installation kit - this was handy as it came with all the fixings necessary, and I did not have to think too much when it came to installation!

### Why this heater?

I wanted a heater that ran off the LPG gas and had an external flue. This Heatsource 2000 comes with a thermostat so it will cycle on and off overnight.

### Installing the heater

The heater is located under the plywood beside the LPG tank. You can just see the ducting for the hot air.

The heater firstly needs to be connected to the 12V – so that goes through my fuse box using the supplied fuse.

The heater needs two holes going through the bottom of the van.

You cannot put it anywhere – under the van there are structural and functional elements that mean you have to measure in from the edge of the van to work out where it can be placed.

I first drilled a pilot hole to check I was in the right place. I wasn't, so based on that hole drilled another, marked out the final two holes for the heater inlet and exhaust.



These are the pipes (black inlet, chrome; exhaust) coming from the heater. As you can see you cannot just put it anywhere!

After connecting the inlet and exhaust pipes (as per the heater's manual) attached them under the van – making sure the inlet and outlet were, as instructed, not inside a cavity under the van. I zip tied them in to place – drilling holes where necessary to do so.



The ends are screwed in using clips that came as part of the fixing kit.



# External shower installation

## External gas powered shower installation

This is what I installed in my second van. It is actually pretty good (but be sure to drain the system if you are not using the van in freezing weather) – I do not need to have a separate room to shower in but can have a hot shower whenever I want.

This system requires a 70l (or similar) water tank, a 30psi or higher pump, and an accumulator.

I used the 'Eccotemp L5' Portable Outdoor Tankless Water Heater - but there are other similar products out there. I chose this unit because it was vertically small (so it would fit under the bed) and would do the job.



I removed the grey handle and made a frame to mount the shower.

It is important to note that this cannot be installed inside your van. I did this nevertheless because I can only use it when the back-doors are wide open. Therefore, when the gas burns the poisonous gasses come out the vent, they also go outside.

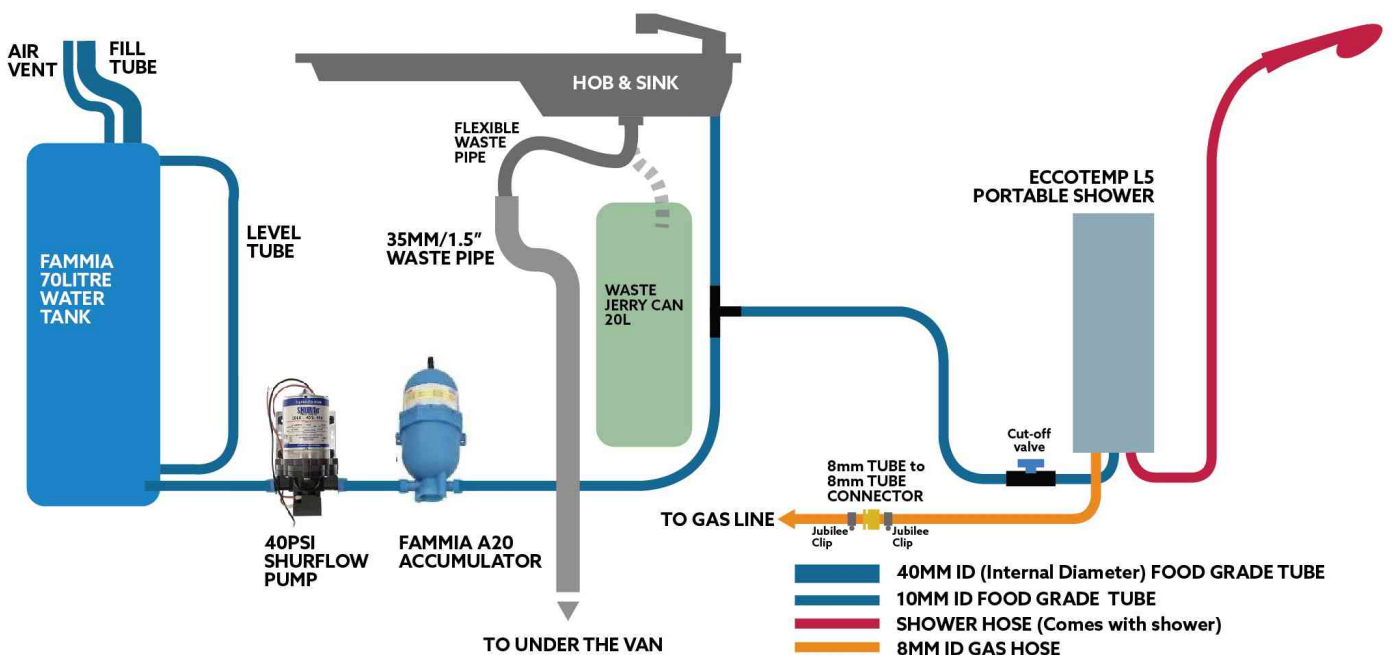


I created a heat shield to stop the heat and moisture from burned gas from going into the bed for obvious reasons.

I used 1.5mm aluminium sheet and bent it to fit – however it would also be possible to mount it in such a way that it did not vent into the bed if your metal working skills are not up to scratch.

The gas shower is simply attached to the LPG gas line and the waterline coming from the pump. When you turn on the shower, the pump fires up, and the two DD batteries in the shower ignite the gas and you have hot water.

The shower came with a gas hose attached to a regulator. I already has a regulator, so I simply cut the hose (to keep the fittings that went directly onto the shower unit) and got a 8mm-



8mm hose adaptor and connected it into my gas system.

I could not find a one-piece male-male 8mm adaptor in my local hardware shop, so I screwed these two parts together using Gas PTFE tape.



After years of looking at vans, and living in them, I think this is the best middle ground solution. It is relatively cheap to install, it takes up hardly any space inside the van and the shower is hot.

*Note, this shower installation (due to the use of rubber hose that connects to the shower unit) did not meet gas-safe standards. It did however, work very well!*



The shower screen was made using PVC backed fabric. This was given structure by thin wood batons which had screw-hooks on each end. These hooked into small eye-plates which were fixed into the cladding on the doors.

This design is fast to put-up and take down, the PVC dries quickly and the wooden structure means that it does not blow around if it is windy.

## Tanked water heaters

The following is the Propex Malaga water heater, it has an integral water tank which takes 15 minutes or so to heat up from cold.



The unit requires a vent that goes out the side of the van. It is a pretty compact unit and fairly easy to install.

Because it is mounted on the side of the van it can be put inside cupboards or other places away from the shower. This makes it a bit more flexible in terms of installation.





# Water Installation

Pipes & Fittings | Tanks | Showers



## Water tank installation

The Fammia 75 litre / 20 gallon water tank is a commonly used water tank. It has a large opening (big red cap) which enables you to clean the tank. It has two placement options, on the flat (red opening facing up), or upright (as shown below).

It cannot sit in a 'landscape' position (on its long side) because when the water filled to the height of the breathing hose, the air would not be able to escape and it would become impossible to fill any more.



There are several parts to install with this tank, these are:

**Water inlet/fill point** - this is typically a locking fill point which fits into the wall of your van. You just need to use a hole cutter to cut a hole the right size.

***TIP: when using large hole cutters, drill the centre hole first (without the hole cutter part), otherwise when it pops through, the hole cutter part is prone to dig-in, bounce, and make a mess of your paint work.***

**The filler hose** - on the Fammia tank this is 40mm ID hose. You fit it with a pipe-clip/jubilee clip with a little bit of sealant to ensure it is water tight.

**Breathing pipe** - this is a tube that goes from the tank to the fill-point and gives a way for air to escape as you fill it - this makes filling smoother.

**Water outlet** - the tank comes with a fitting that can be attached to any of the 'square' areas with a center point for drilling. This needs to be sealed in and tightened and attaches to 1/2inch

BSP fitting, or to 10mm Internal Diameter pipe-clip adaptor (shown in following image).



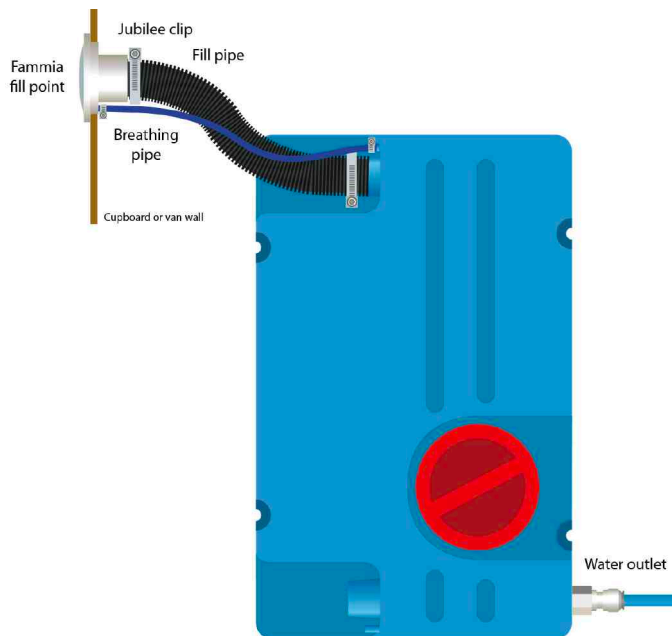
The fill point (above) has a rubber washer, this goes on the inside of the tank (with sealant). It comes with a plastic nut which you use to tighten the joint up. Once sealed, leave for 24 hours to cure.

You can either use fittings to connect to the 1/2 inch screw-thread, or you can use the 10mm pipe-adaptor (pictured in-place above).

**Brackets** - the water tank comes with threaded bar with washers and nuts to allow you to bolt the tank to an internal structure of your van.



I attached one water tank to the bulkhead - I installed riv-nuts to enable me to do this.



## Flat installation

If you are laying the tank flat on the ground, you may not need to use the threaded bar. I just put some stud-work around it to stop it sliding around and used a length of building strapping to fix it in place.

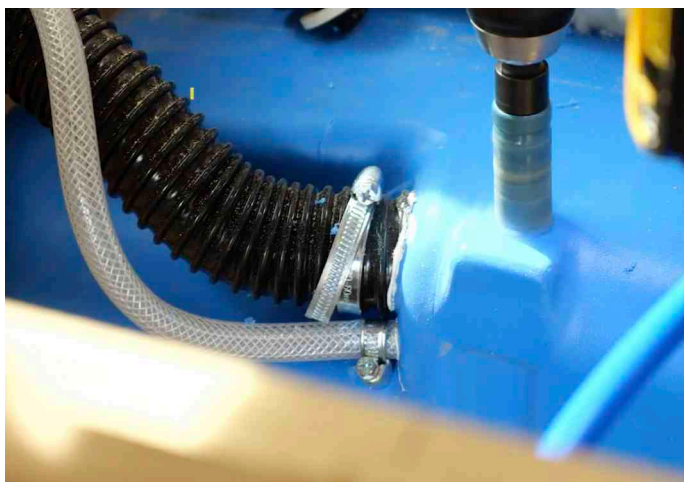


TIP: with building strapping, by screwing in using a hole which does not quite reach the wood, you can use the power of the screw to cinch it down tight.

## Preparing the tank for connection

The tank has two options for where to place your fill & breathing pipe and, whichever ones you choose, need to be drilled out in order to make a hole. (This leaves debris inside your tank, make sure you clean this out before you fill it with water as it could cause problems with your pump)

The blocky-square features on the corners and middle-of-edges are for fitting your water outlet - they have a centre hole to help get your placement right (see image below). These have slightly thicker plastic and will make a more stable connection point.

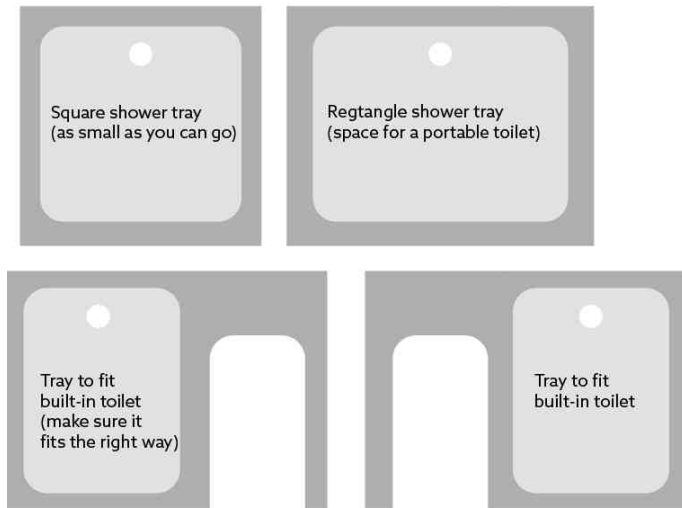


If you have a water outlet which is not at the bottom of the tank you will need to attach a hose to it to reach the bottom of the water tank.

# Internal shower installation

This is a fairly generic overview for a shower installation. Later I will show in more detail a system I have installed.

## Buy a tray!



You have two options – a base that fits a cassette toilet or standard base (you can also make the base large enough to store a portable toilet in there too).

If I wanted a shower and a toilet I would choose a larger shower tray & use it to store a portable cassette toilet.

## Build the frame



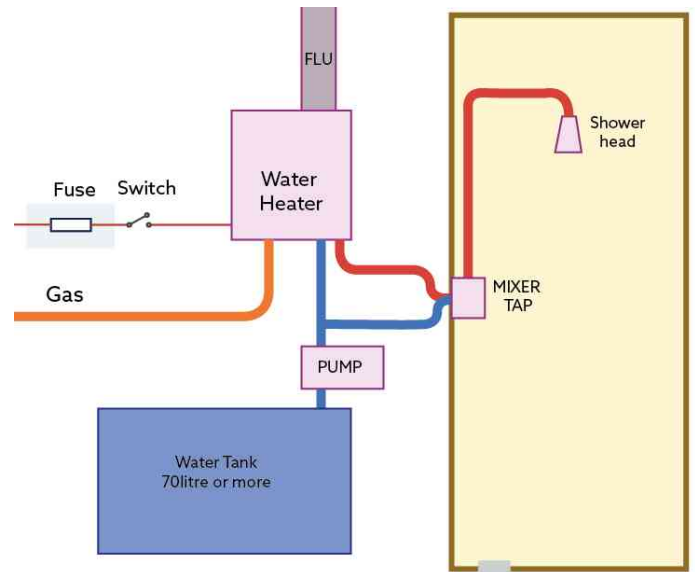
Your frame is entirely built around the size of the shower tray and the orientation of your shower within the van.

Simply build it using stud-work like you have

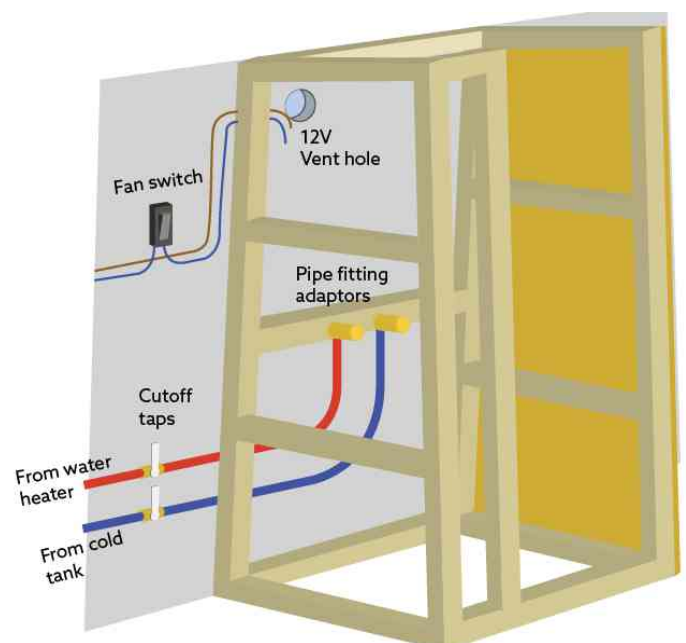
many other parts of your van.

## The water heating system

There are a lot of options but here is a pretty simple route to go down.



1. Cut holes in the right places for your vent (you could also use a roof vent)
2. Lighting (not shown here) will need to be added
3. Wire up the switch for the van
4. Fix pipes into the frame (from the outside or through the timber)



Fix your pipes to adapters (the exact type will depend on the plumbing standards for your region) any good hardware store will be able to advise.





Otherwise, here is a simple method using a slightly extended wall panel

This could also go straight into a mixer tap-unit.

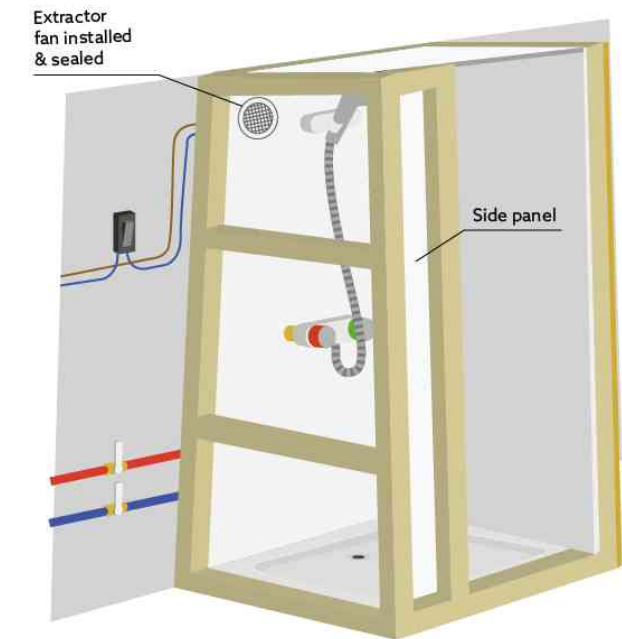
5. Glue in shower tray, you may need to add some wood below it to support it. Be sure that it is well supported and sits well when placed.

- Glue it in with sikaflex or similar sealing adhesive. I would be quite generous with the adhesive.

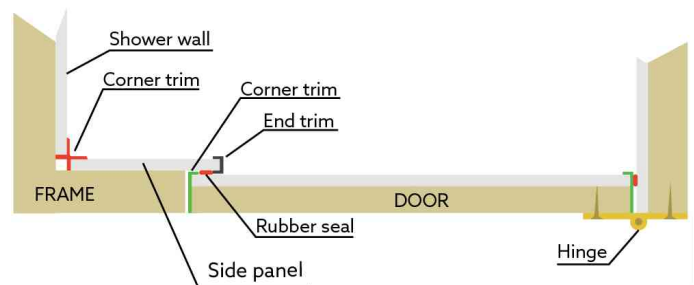
6. Add Shower Wall – I would recommend using plastic shower wall as it is easy to cut and can give a durable and nice finish.

- If you are adding a curved top – the plastic board can be scored (outer layer cut) from behind to allow it to bed.

7. Plastic shower walls come with a range of corner options which should be used to create a nice effect and a better seal

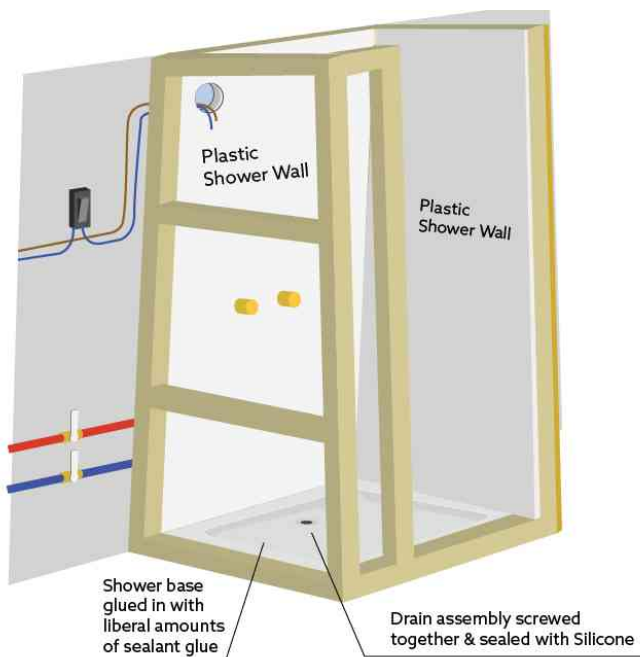


The door is made with a simple frame – the front and back (perhaps thin ply on outer side & shower wall on the inside). By including trims and some rubber seal you can probably make the door waterproof quite easily. Magnetic shower seals are also available.



It is helpful to have some kind of catch or lock to hold your door shut while you are inside it!

At the floor level built in a step and again look at rubber sealing options – this will depend on the configuration of your door. But you want to make sure that the water will not run down the door and out the bottom of it into your van!



8. Door & sealing – there are probably a hundred ways to seal your door. I would recommend looking at the plastic panel manufacturer's options for seals and edgings as there may be some good options.

## In-built shower heater

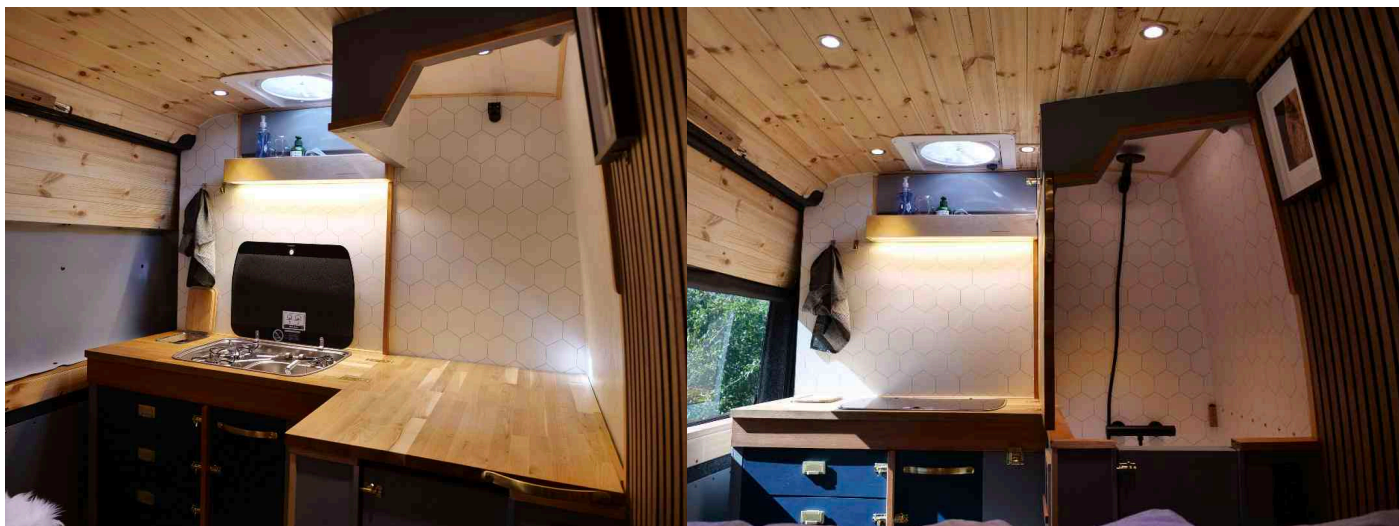
**GAS WARNING!** Again, get it done by an expert if you do not know what you are doing. At absolute minimum get it checked. Gas & faulty heater flue systems can kill you!

You must have your heater adequately and safely vented – if you do not the heater will burn up all the oxygen in the van and give you carbon monoxide poisoning which can be fatal.

### Wall mounted, instant heaters.

These typically require a flue coming vertically out of the unit and through the roof, or potentially a side-wall.





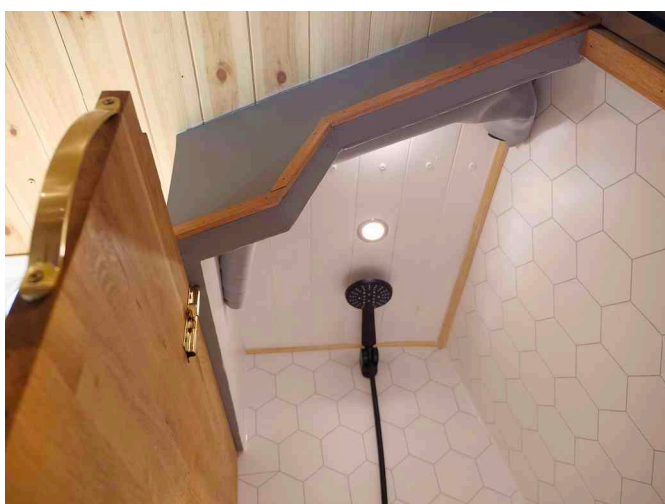
## Internal shower installation (hidden shower)

This shower design aims to mitigate the major downside of having an internal shower; a huge wooden box that takes up space, makes a van feel more cramped and is only used for a few minutes a day.

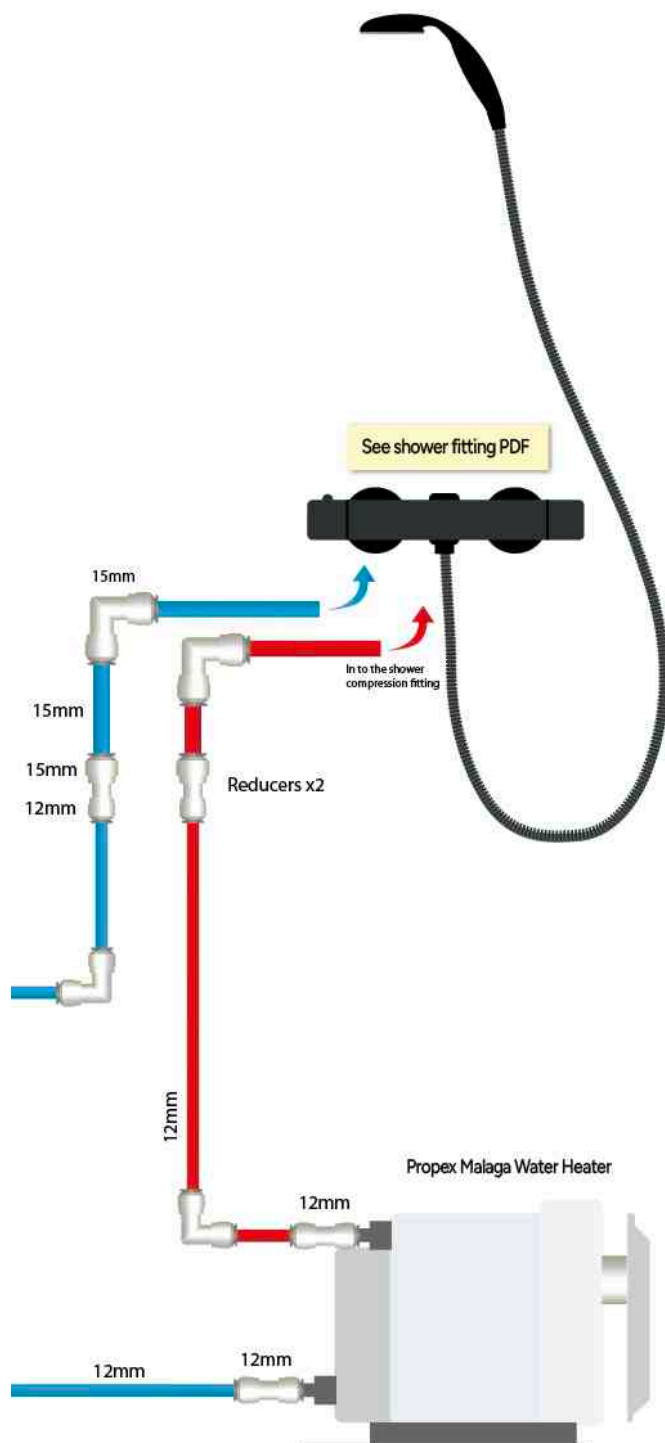
### Schematic Download

The design essentially hides the shower under the kitchen counter top, and uses part of it to create the side of the shower wall (see above).

It has a half height shower curtain (rolls down from the top) which is hidden behind the 'top wall' which is required to meet the counter top.



The shower wall is the same as the shower wall throughout the kitchen, so that when the shower is in 'kitchen mode' it looks like it is always a kitchen.





## System design

The system itself is quite simple. The water flows from the pump, it splits with one line going to the Propex Malaga water heater, and from there the hot water goes to the mixer valve. The other line goes to the cold on the mixer valve.

The mixer valve is a standard one you would install into a house and the shower head is an 'eco' one (generally uses less water).

## Push-fit fittings

I used push-fit pipe and fittings throughout this water system. The following illustrations show the main details

## Using push-fit pipe

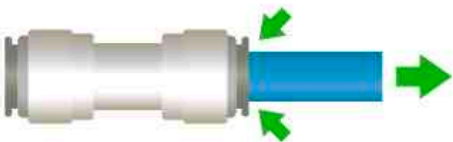
### 1. Push to stop




### 2. Pull to test




### 3. Push collet to remove




## Pushfit parts used

 12mm  
Equal Straight Connector

 15mm to 12mm  
Reducer Connector


 12mm  
Equal Elbow


 12mm  
Equal Tee

 12mm to 1/2" BSP  
Tap adaptor

 12mm  
Shutoff Valve

## Pipes used

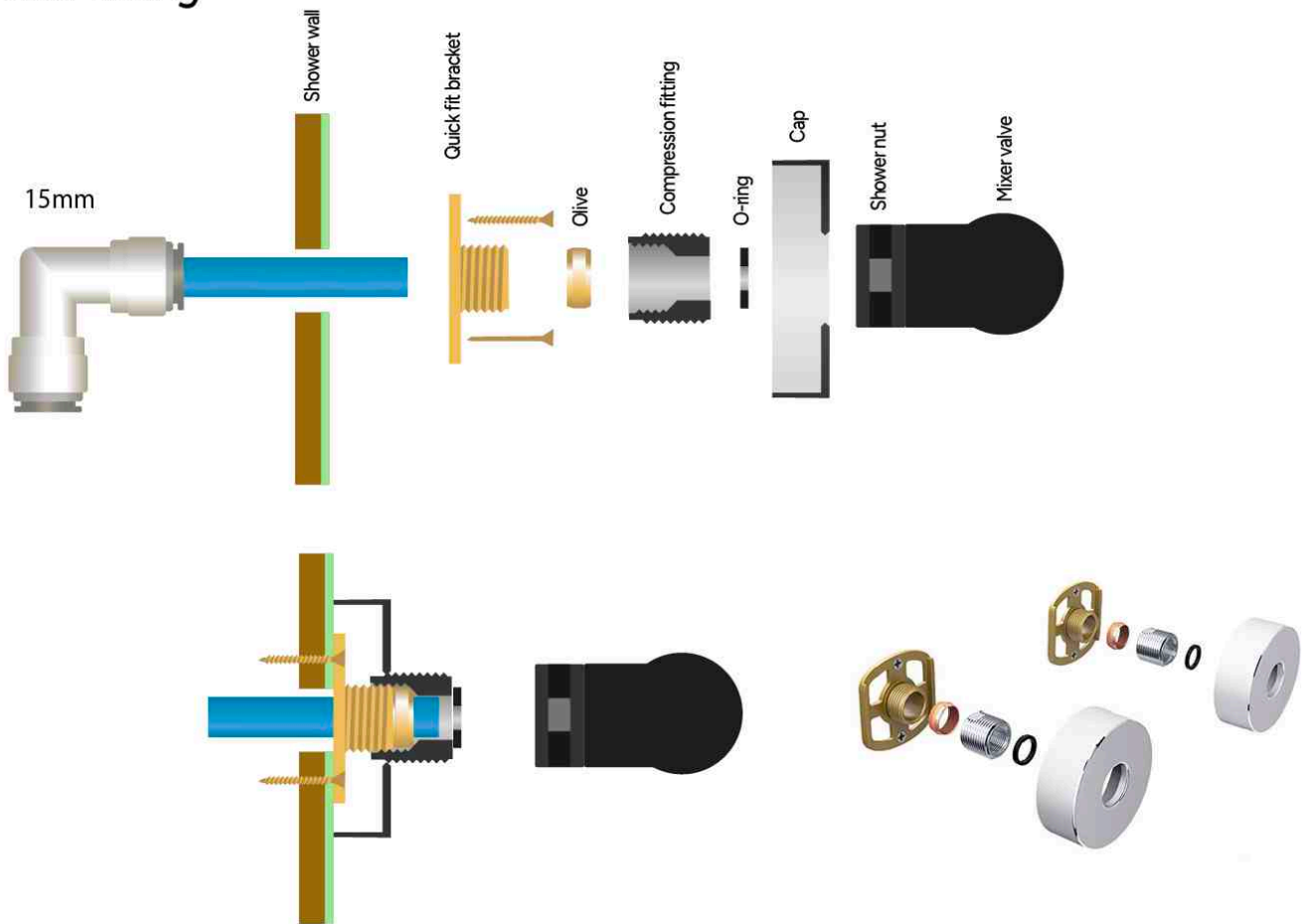
 12mm  
Pushfit plastic pipe

 15mm  
Pushfit plastic pipe

 40mm (ID)  
Flexible Hose

 10mm (ID)  
Flexible Hose

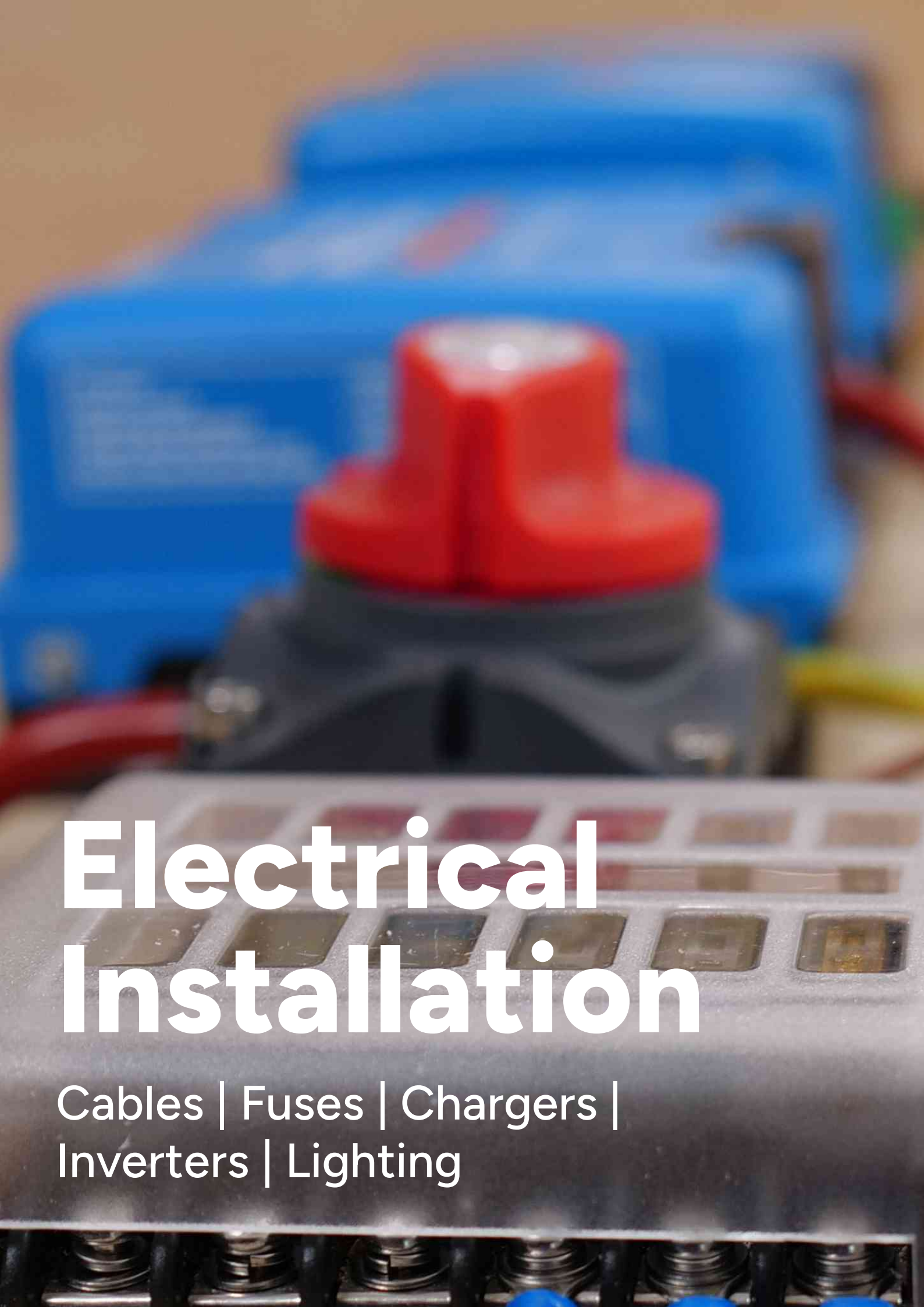
# Shower fitting



## Shower fittings

I used quick-fit shower fittings. These do make life easier and result in a strong and secure shower fitting.

The diagram above should help you understand how to fit the shower mixer valve to the pipe and the wall.



# Electrical Installation

Cables | Fuses | Chargers |  
Inverters | Lighting



# Electrical installation

## Schematic Download

### Stripping wires

You can use a wire stripping tool, or you can use a pair of wire cutters, to strip the end of the wire. Once stripped, to maintain order, you can gently twist the wires.

### Lugs & crimp tool

A crimp tool is useful for crimping a lot of lugs - and is pretty essential for heavier-duty lugs.



### Main electrical board

To make your electrical board, the first thing is to sit in the van and work out where you want the different items to sit. This will depend on where your cables are, where your battery is, and where your cables are coming from.



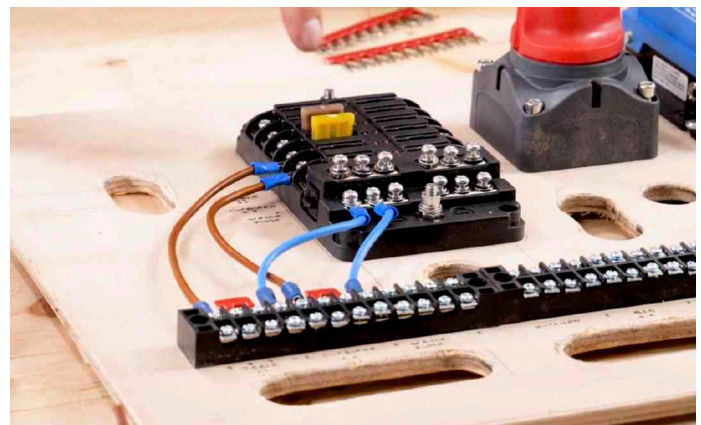
After that, you can mark out the location of items on the board, and cut slots, which will allow your cables to come through to your electrical appliances.



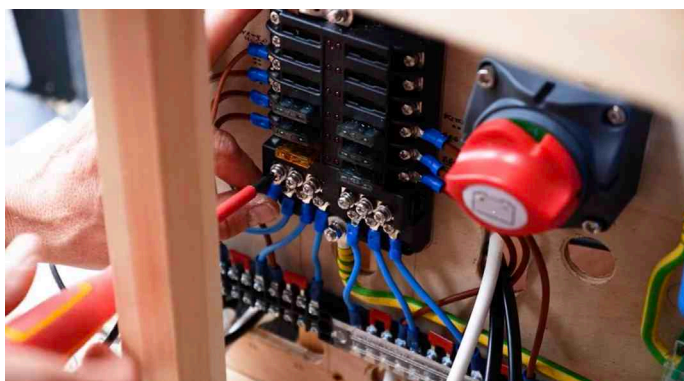
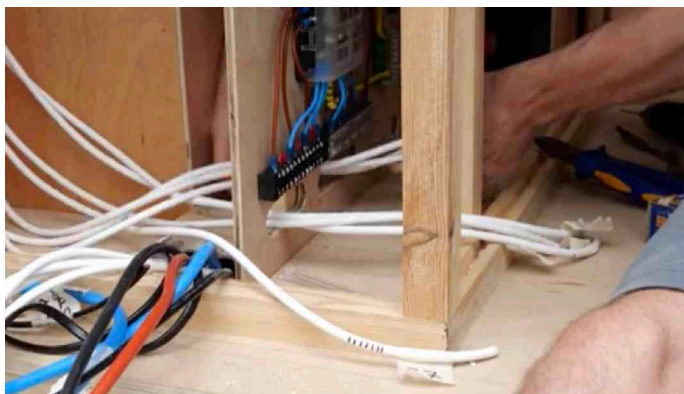
To make the slots, first use a hole saw to cut two holes. Then use the jig saw to join them up. Sand the edges of the holes down to make it smooth.



Then you can screw on your appliances and wire up your board (see wiring diagram as a reference).

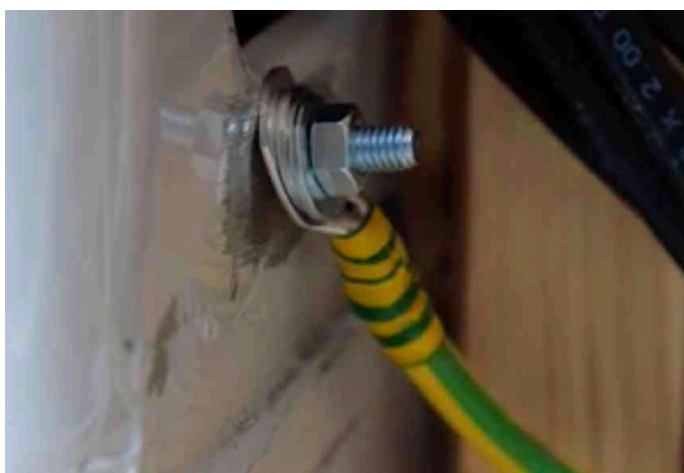


After that, you can put your board in-place, draw through the cables into the right positions and fix them to the board.



## Ground / Earth

I drilled a hole in a bit of the metal work in the base of the van, sanded down around it and bolted my earth wire to it.



My earth cable & connection point – I had some spare 16mm<sup>2</sup> wire so I used it to connect my earth to the van body. (See image above - this photo was taken before it was tightened up).

# Electrical Installation (second fit)

This is the lighting set-up I have used;

Essentially four lighting choices; front, back ceiling lights, side lights and a door light.

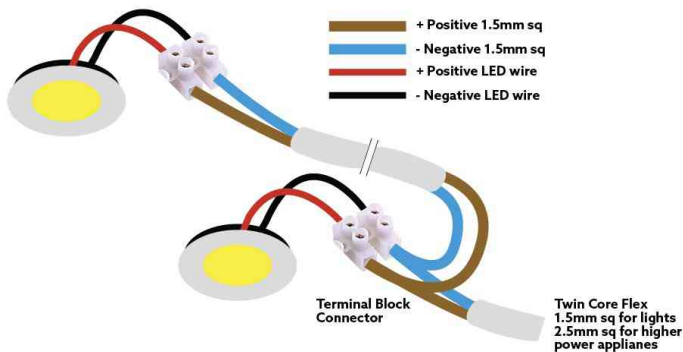
For me lighting is one of the most important parts of the conversion. Indirect strip lights to create a warm & relaxed environment and brighter spots when needed work well.

## How to wire up lights in parallel

For many appliances, for example pump, heater, fridge etc.. you will just run a cable from your fuse box and connect up the positive and negative – easy!

For lighting you will want to wire them in parallel. Taking it from a schematic to real-life can be tricky – but here is a pictorial diagram for how to wire-up parallel items.

Terminal block connectors are cheap and you just cut off the number you need. You can use them for almost all your wire-to-wire connections in the van.



## Tips:

- Don't strip the end of your wires too long else they will make the other side hard to insert and screw up
- Make sure your wires are properly 'in' the unit so there is not wire showing outside of the plastic part of the terminal block connector



The reel of LEDs comes with a connector – but only one. I found I was able to connect my strip LED to a terminal connector by splitting the contact and screwing a terminal connector on to it.

This is a bit fiddly, but it works.



# Fitting solar panel

## Options

### Metal brackets

The simplest connections are metal L brackets that connect the solar panel to the roof, these are cheap and can be bolted on both the panel and the roof. Typically you will bolt them to the panel first, then fit them to the roof.

### Plastic corner mounts

You can also purchase plastic mounts which are screwed to the roof (first applying sealant under the bracket).



### How I did it

The simplest system is to simply use pre-made brackets as above however, I prefer to use a slightly hybrid system which enables me to lift the bracket up. This allows both cleaning underneath - and if you are in winter conditions - the fixing of the panel at an angle that better suits the position of the sun. This can practically triple the solar gain in the middle of winter.

How useful is this? Honestly, I have only used

it once for a period of a week. But actually I like the fact that I can lift the panels up for cleaning or maintenance.



To do this, I use a couple of stainless steel door hinges and a couple of angle brackets to attach my solar panel to the van.

This video tutorial inside the mini-course will give you the detail you need to do the same should you wish..



## Mini-course Video

### Bringing the cables inside

The cables need to be taken through the roof in a waterproof way. To do this you can use an electrical (external/weatherproof) junction box with a hole cut in the bottom to take the cables from the solar panel into the van. You can also buy products that are made for the job.

Depending on your van (and your solar panel) it may be possible to sit this underneath the solar panel. It should be screwed and glued with ample amounts of sealant.

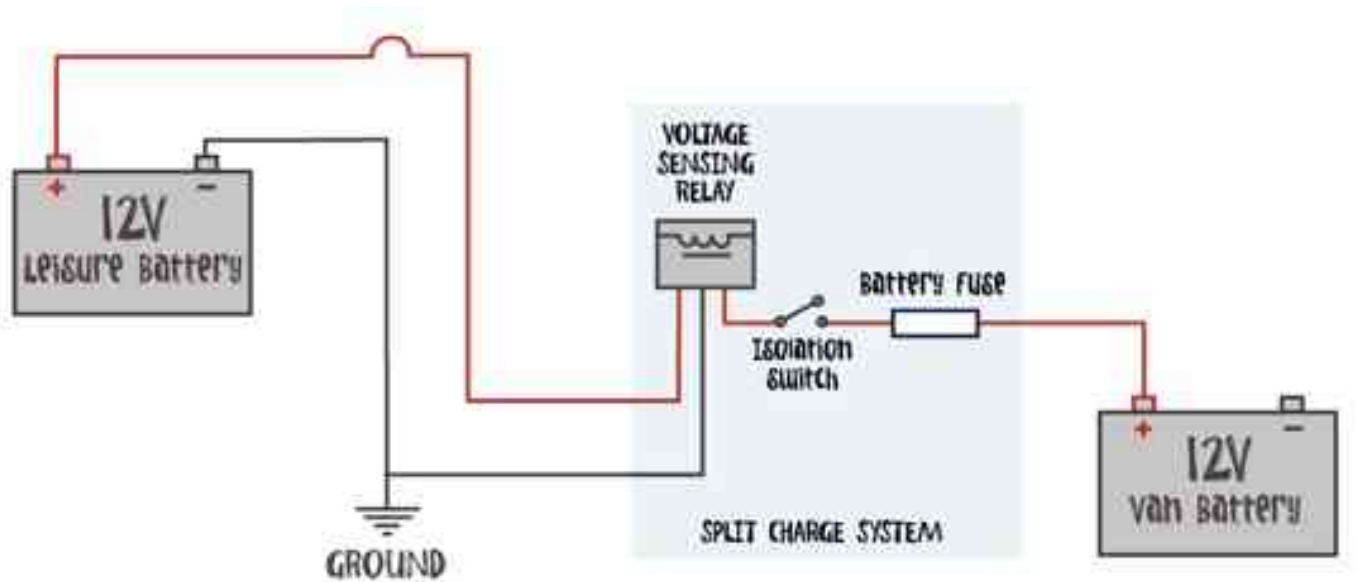
### Additional Cables

I needed to buy a couple extra cables to reach my solar charge controller. The cable type you will probably need to search for is 'MC4' cables.

I bought a 3m/9ft pair of cables with the connectors already attached.

### MC4 connectors

These are the standard connectors used for all solar cables. They are waterproof when connected and they come in two different parts. The parts 'click' when they connected properly and they can be released by depressing the little catches on the sides.



## Split charge relay installation

Above is the basic circuit for a voltage sensing relay (split-charger).

A voltage sensing relay is not recommended when charging Lithium batteries or if your vehicle is newer and it has a smart alternator. Generally, across the board, a battery to battery (DC-DC) charger the better choice, but Voltage-Sensing-Relays (VSR) are cheap and therefore have their uses for those on a budget.

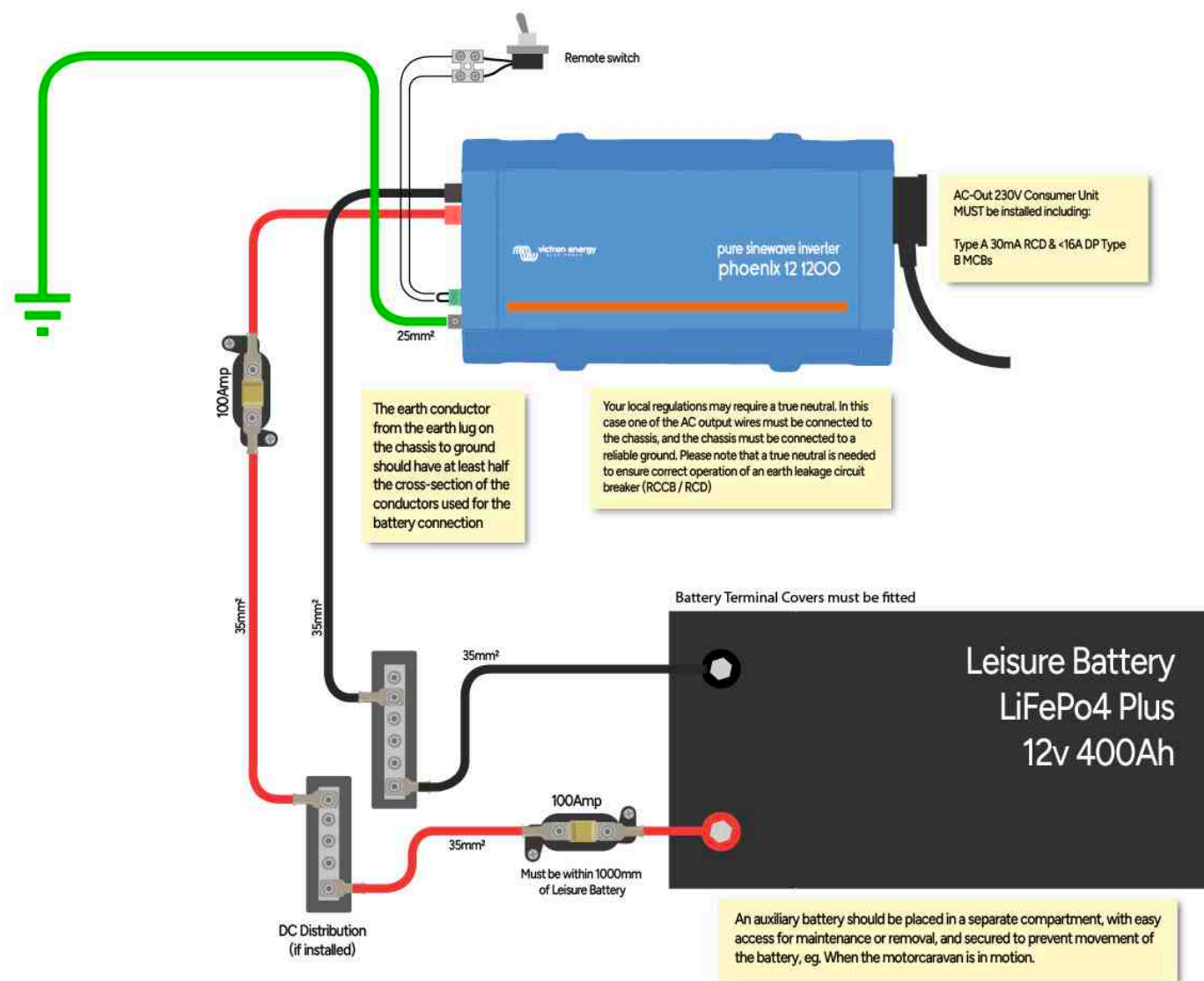
If you do install a VSR split chargers need connecting to the alternator (or ignition line) in the engine. I would recommend, for ease of installation, that you get one that just attaches to the starter battery.

The size of the 'battery use' will depend on what you buy, see manufacturer guidance.

**Please note:** Different split charge kits will have different installation requirements – do check - most suppliers will provide a schematic for the system you purchase.

Below; The Durite VSR, a popular choice for voltage sensing relay systems.





## Inverter installation

If you want to run mains appliances off your 12V battery system you will need an inverter. The above diagram shows you how to install it (from DC distribution).

Most inverters have a plug socket on the back, this means you can put a plug with some cable straight into it - and wire the other end to a plug socket. This is what I do - however the best practice is to connect it up to a MCU/RCD (see earlier chapter on mains hook-up) and then run to your plug sockets or mains appliances.

The remote switch is worth installing as you can easily turn off your inverter when you are not using it - saving your battery.

The inverter should be fused on the positive cable, and it must be grounded using an appropriately sized wire.

See the section about choosing an inverter to figure out the size of inverter that you require (Watts).



# Battery Management System

Due to the inaccuracy of a volt meter it is useful to install a BMS. I recommend using the Victron Smart Shunt, it is a good product and you can connect to it using bluetooth.

To connect this product, see the diagrams to the right (they provide more options based on your battery configuration in the installation manual that comes with the product).

Installation process:

Connect the negative battery terminal to the M10 bolt on the "BATTERY MINUS" side of the shunt. Tighten the shunt bolt with a maximum torque of 21Nm.

*Note that there should be no other connections on this side of the shunt or on the negative battery terminal. Any loads or chargers connected here will be excluded from the battery state of charge calculation.*

Connect the negative of the electrical system to the M10 bolt on the "SYSTEM MINUS" side of the shunt. Tighten the shunt bolt with a maximum torque of 21Nm. Make sure that the negative of all DC loads, inverters, battery chargers, solar chargers and other charge sources are connected "after" the shunt.

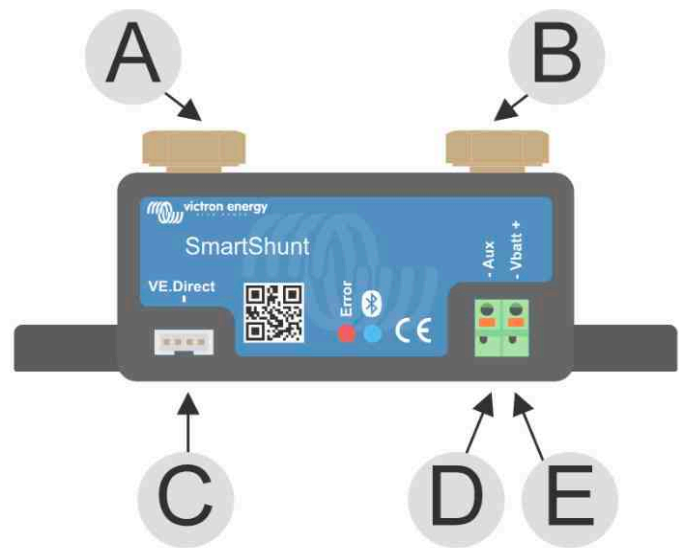
*Note that up until 2020, the SYSTEM MINUS connection was labelled LOAD MINUS.*

Connect the ferrule pin of the red cable with the fuse to the shunt by pushing the pin into to the "Vbatt +" terminal.

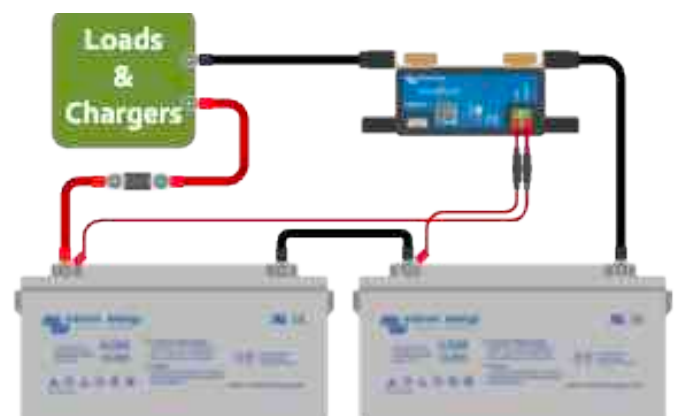
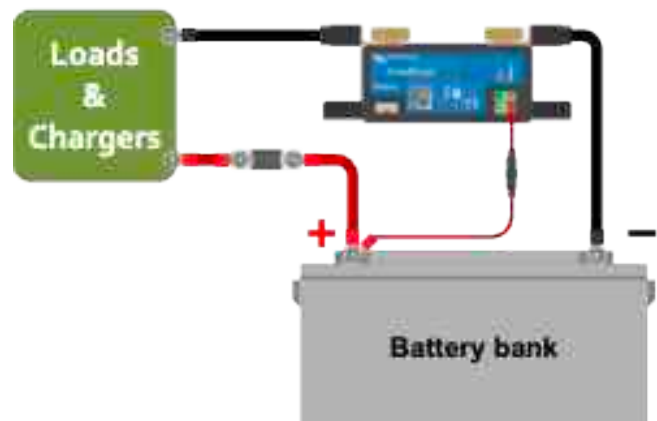
Connect the M10 eye terminal of the red cable with the fuse to the positive terminal of the battery.

The battery monitor is now powered up. the Bluetooth LED will start blinking and Bluetooth is active.

*In order to be fully functional, the battery monitor needs to be configured - check the manual that comes with the product for the full details.*



#	SmartShunt connection	Terminal type
A	LOAD MINUS	M10 bolt
B	BATTERY MINUS	M10 bolt
C	VE.Direct	VE.Direct terminal
D	Aux	M10 ring terminal
E	Vbatt+	M10 ring terminal





# Building Furniture

Beds, seats, cabinets, draws & kitchen units



## Building furniture

When it comes to building furniture – or the general structures within your van - I recommend using screws rather than glue. This allows you to change things if you get it wrong and, as the screws create an instant joint, it allows you to build quickly.

When buying wood, be selective – look at each piece down its length (from one end) to check if it is straight, check for any damage or knots that have fallen out, and reject any wood which is not very good. This is a normal and perfectly acceptable thing to do in a wood-store, and bent wood will not make your life easier!

For almost all the stud-work I used the following dimensions of wood

- Main studwork: 33 x 33mm (1 3/8 inches square)
- Bed-slats/various: 20 x 45mm (0.78 x 1.77 inches)
- End-of-bed, drawer fronts/other; 93 x 20mm (2.75 x 0.78 inches)

Anything which is approximately this size will do the job. Check the video out in the mini-course, it has some basic advice for how to easily build your structures.

## Mini-course Video



The image above shows the kitchen and seat in progress. You will see that I build my stud-work around the things that need to fit there. This way you can be space efficient and know that everything will fit.

Although you have a general plan this part of the build feels a little like sculpture, you will need to problem solve as you go, and adapt plans, and stud-work to fit your constraints.

It is also a great stage because after doing all the groundwork of insulation, laying cables and putting holes in your van, it finally starts to look like the van you have been dreaming about.





I always use a steel square to check each joint in my structure to make sure my build does not go awry.

### Water & space heater housing / seat

The following pictures show a seat that houses a Propex Gas air heater, a Propex Malaga water heater, a gas manifold and a gas fill point.



As there was space at on the left hand side, I put in a removable false floor and panelled it in to make an under-seat cupboard.



### Fridge Slider

Under the opposing seat, I housed the fridge on runners. Behind the fridge is a safe, this provides a place to keep valuables - passports, laptops - if parking and leaving the van somewhere which seems less safe.

The gap in the studwork (at the front of the fridge) was to allow the fridge lid to open - and lift up a flap/folding cushion section. (See the van tour for this van)



Below, the fridge sliders in action.



The fridge was glued to this board.





## Building the top cupboard

I installed a corner cupboard. The first thing I do is to screw up a 'top beam' temporarily and then, using clamps and bits of wood, try and work out the size that feels right for the space.



Once this is done I fix the top stud in permanently. If there is a metal van structure I will use a riv-nut, and then back it up with plenty of screws where I can. We do not want this coming loose!

I then spend time making sure I have everything square and horizontal - and build out the basic frame.



After adding uprights, I traced round the cupboard on to 5mm ply and glued clamped it in place. I then used filler to fill any gaps.



I used 9mm (3/8 inch) ply to make the cupboard doors. I made them bigger than the cupboard holes.



I then clamped the cupboard door to the frame and drew around it (to make sure it all fits - there is some variation due to the sloping roof).



I cut the doors out, filled the gaps, painted them, attached piano hinges, and screwed them in place.



To finish the cupboard, I added painted ply to the ends, added knobs to the cupboard doors and screwed in a couple magnetic draw catches (below).



## Lean-on bed-side cupboards

In my first van I created these cupboards and they worked remarkably well in-terms of given an additional comfortable place to sit. The lean-to design makes the whole side of the bed a nice place to sit.



They rise above the bed (about 3 inches on the bed-side edge) and include the full height of the mattress. It is easily enough for two people's clothes (assuming they know how to pack) and more.



I have actually had four people sitting comfortably along this to watch a film. I used mahogany – just because I had it – it presented some added challenges. I think using 22mm (7/8 inch) birch-faced ply (or similar) would have been easier – and you could get a nice effect.

The cupboard also has my main light switches. This is nice as you do not have to leave bed to turn them on. I tend to just use my toes to do so! The switch layout is designed to avoid needing labels.



This means you can have your phone or other device charging at a place you can easily reach it to kill that alarm..



This photos shows the end piece.

This adds to the structural support of the metal brackets I fixed inside the cupboards. Another USB point is fitted here.



## Above-cab & bathroom cabinet



I had this idea of finding a bathroom cabinet and just screwing it in to the space above the cab. I have done the same on a previous van and it is a quick way to create a little cupboard with a mirror on it.



For my first van I found this stainless steep cabinet. This is it on Amazon.



I think the metal cabinet was the better buy as it was easier to install and functioned better.

## Above-cab cupboard



For this cabinet I screwed into two uprights (each side of the unit) and once attached to the cabinet unit I put it in place and screwed these into the wooden stud-work.



I added two pieces of wood to the bottom of the cupboard areas. This is because the doors need to be a little higher than the shelf to stop them getting blocked by stuff on the shelf.

Wood under the doors giving clearance for the shelf.



Using cladding and spare wood I made the doors to fit – cutting out the hinge profile to keep them tidy.

Cut out hinge profile. The wood the hinges are

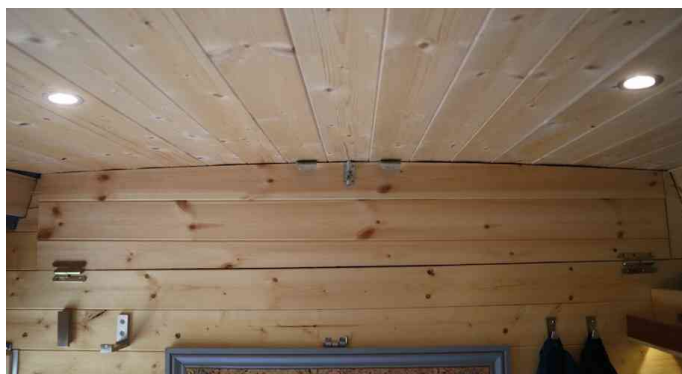
screwed into was offset to the right of the edge of the cladding.

Cupboard door construction – basically using left over wood!

Although you can find all sorts of fancy push-button cupboard door handles I just went for a couple of locking slider bolts.

I think the brass looks good on the pine and I aligned them to the push button on the bathroom cabinet.

## Fold-down cupboard



The over-head cab storage on my latest van was not so tall. I opted for a single fold down cupboard where I could store the table and other things.



The door is basically a square of wood with cladding to fit the shape of the van roof. The wood which 'stops' the door going further is bent in place and held with screws – I put a piece of cladding behind this, drew a line which matched the shape of the curve and used this as my top piece.



## Kitchen

The above shows a sketch-up model with detailed designs. You can get the dimensioned full model [here](#). You can play with it using Sketch-up which is a relatively easy to use free online CAD package.

### Kitchen Unit

The videos in this section give examples on my latest van and probably give a pretty reasonable idea for how it was constructed. The text below gives information on my first kitchen system.

Building stud-work for the kitchen:



### Mini-course Video

Cutting and installing a kitchen top:



### Mini-course Video

### Compact kitchen unit



The finished kitchen unit. The cooker's lid has been closed.

It features a reclaimed mahogany kitchen top, redwood pine front, four draws with limited oak flooring fronts.

My kitchen unit over hangs the step a little, people criticized this as being a bit strange but I am really glad I did it. It has given me a couple of inches extra width in my cupboards and, importantly, on my work top. Without this cooking would be that little bit harder. It also means that the big recliner chair is, well big and you do not feel squeezed against the kitchen unit.

The space it takes is essentially dead space.. but you cannot have it too close to the door else you cannot reach the handle to open it!



I screwed the studwork in to the floor or the bulkhead behind the unit. This was also attached to the seat unit studwork (under which would contain the heater).



Using the gas canister and the two 20ltr containers I was able to precisely work out how much space I could get away with using for my drawers.

Once done, I added panels to the back and sides to give it structural support.



### **Door**

I made the door using 9mm (3/8 inch) ply and some old hinges I had from a previous project. These were easy to adjust to make sure that the door swung correctly.

The door was just painted with some grey paint I got from Ikea, it turned out I should have primed it, and it took about 8 coats to look good. It did the job, it looks good, and I was not in the mind to lose time to go shopping for primer.

### **Reclaimed wood kitchen-top**

For my first van I was able to find some reclaimed mahogany which used to be part of some school book shelves.

I used two layers of these and after sanding them down, glued them together using lots of G-clamps and a few screws for good measure.

### *Glueing!*



### *Clamping*



Once done I cut the sides down to-size and cut the hole for the sink unit.. and then spent a long-time sanding.

I also used a scraper (cabinet makers use it for furniture) to get out some of the deep scratches that unruly school children had left in the surface.

I saved some of the wood dust from sanding, mixed it in to some wood glue, and used it as filler for any holes in the wood.

### **Treating the kitchen top**

I used Danish Oil, the same oil I used for the rest of the van to treat the kitchen top. A bit of online research suggested it is safe enough for food. Do check yourself based on whatever you buy!



## Drawers

I found making the drawers really boring, if I were to have a weakspot it would be doing repetitive boring things well. That said, I do like the effect they have when finished.

I would definitely consider buying draws & runners from Ikea or other places so that that you can build-around them and have less work to do.

You can simply buy a kitchen unit with draws and cupboards and it works really well however the advantage of self-build is you can really build things around your kit and be very efficient with space.

### Method 1 – vertical blocks

The photo below shows the basic drawer structure. Back, sides and a base. These are glued and screwed to four blocks in the corners. The front is screwed on and is made from wooden flooring.



Lastly the handle is an IKEA-bought handle I simply screwed on.



I got 45cm drawer runners and attached them to the bottom edges.

The drawer-side runner sits about 5mm from the front of the on the draw.



Inside the kitchen unit I added another upright to allow me to attach the drawer runners and just spent some time attaching and adjusting them, so they ran nicely.



## Method 2 – Glued Blocks Under-frame



### Mini-course Video

I think this is a better and easier method of making a drawer – even if it is less space efficient. It looks nicer too. I am a convert!



Tip: The key is to make sure that the draw sides are properly square as you glue it. A big wood-working square is a good investment for your van conversion project.



Sides; 9mm - 3/8 inch - Hardwood Ply

Base; 5mm - 3/16 inch Hardwood Ply

Front; two bits of wood screwed together edge to edge and sanded down

For these draws I just put in simple runners (blocks of wood) which the draw slides along. Nothing fancy but it works.



A close-up photograph of a polished brass handle, likely for a door or window, set against a dark blue background. The handle is curved and has a smooth, reflective surface. The lighting creates a bright highlight on the upper part of the handle, while the rest is in soft shadow. The background is a textured, dark blue fabric or material.

# Finishing touches

Tiles, slat-wall, fabric-panels,  
upholstery, flooring & curtains

## Kitchen tile back-splash

I wanted to add a row of kitchen tiles behind my counter-top. This is partially to stop the cladding from getting stained but also to add a nice splash of color.



### Mini-course Video

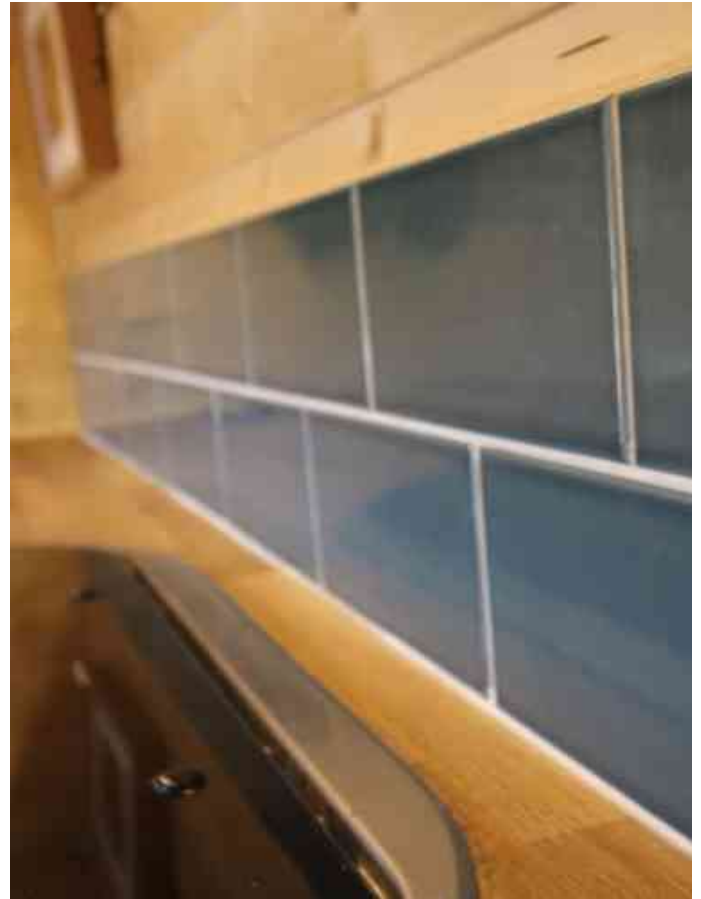
The problem:

- This part of the van curves a little
- The cladding is not solid – it can easily flex

Curving and flexing is bad news for tiles – I did not want to tile directly to the cladding as it would probably not last very long.

The solution: I tiled onto 9mm (3/8 inch) hardwood plywood and then glued that to the cladding. This gave more structural support – I used some pine edging above the tiles to hid the ply and make it look tidy.

- Step 1. Glue tiles to ply using plenty of polyurethane wood glue – use tile spacers and push down the tiles ever so often as the glue foams and can displace the,
- Step 2. Use silicone as grout – its messy and a bit tricky but now they silicone flexes not the tile reducing the chances of breakage
- Step 3. I used some corner pine trim to cover the edges of the tiles and ply.



## Fabric & side panels

As I do not want my van to look like a sauna, and I want to create a separation between the kitchen and sleeping area, I decided to make these fabric-covered panels.

### Mini-course Video



I did this on my first and second van. I think the fabric & side light combo is a winner – both aesthetically and also in terms of use.

The panels were covered with 5mm foam, and then fabric, so they are nice to touch – which is nice in the sleeping area. I also think that it gives the van better acoustics.

To hold the panels first I attached some upright batons to the van. These were screwed in directly to the metal work.



### Upright studs

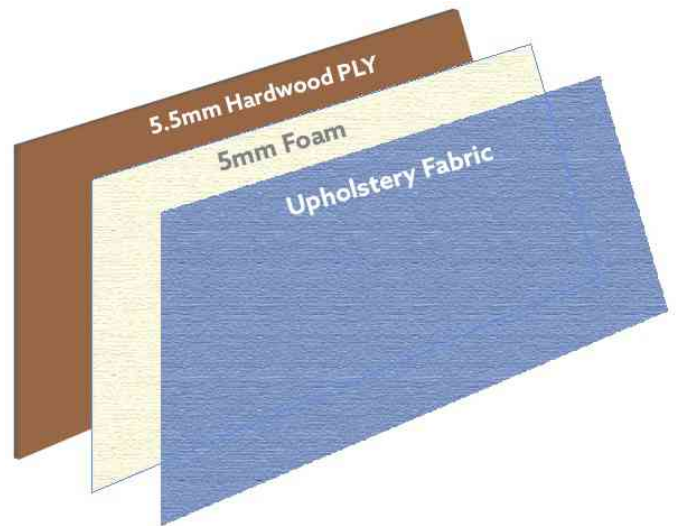
I then screwed on a narrow strip of wood for the LEDs to sit on and created a way to attach the panels to the wall.

The length of the overlap of the top panel over the bottom panel was based on the eye-line angle. I did not want you to be able to directly see the LEDs without really going to some effort.

This also means that the light is all reflected off the yellow fabric which makes for a great lighting effect.

### Making the panels

They are easy to make – just using 5mm ply, 5mm foam and fabric. You need spray glue and a staple gun. One tube of spray glue was (just) enough for the four panels.



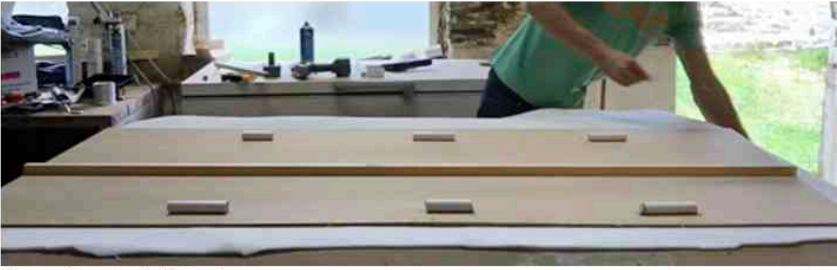
Below shows the panels in place (as I checked them for size). I just screwed them up - temporarily - to do this. It is always good to double check things!



The panels are pretty simple to make;

- Spray glue on to the wood
- Lay down the foam
- Turn the panel over and staple the foam edges to the back
- Note: use lots of staples evenly spaced on the edges to make the shape of the edge to look uniform
- Cut off excess foam with a sharp blade
- Spray glue on to the foam
- Apply the upholstery fabric, turn it over and staple the fabric, as above staple evenly to keep





*Spray glue, apply foam, turn over.*



*Staple down, cut off excess.*



*Spray glue on to foam, put on the fabric/smooth down, turn over*



*Staple fabric (evenly) and cut off excess.*

the edge looking straight

- Cut off excess fabric!

### **Plastic pipe clips & electrical pipe**

The pipe is screwed in through the ply into the dowel inside the pipe. I actually sanded down the corners of some wooden block as I did not have dowel to hand - I tapped them in with a hammer.

The pipe can now just 'pop' on to the clip without any visible fixings on the outside of the fabric.



# Trash

As with a house you different types of waste and they are best treated differently. We are unlikely to want several different types of bin, but it is recommended to separate organic waste from other trash.

By doing this we have organic waste, which can be buried if necessary, and we can just sort the rest of the trash - which is not gross due to rotting food - at a recycling location.

## Trash

I got this bin from Ikea.



*Bin in situ and, right, the blocks that wedge the bin in to place.*

Simply I made this slot for it in the corner. I screwed a couple of blocks of wood in – tight to the bin. Now the bin push-fits in and does not move.

I do not tend to put big bits of rubbish in this bin – just finding a bin for them during the day. It is most used during cooking for food waste or other bits and pieces.

## Counter top, organic Waste Bin

This was cut into the kitchen top to fit a glass Ikea food-storage container. The container has a good seal and I bought two just in case I break one and Ikea decide to discontinue the product!

I cut the section out of the kitchen work top making a convenient place for the container. The fact that it is not too big is a good thing, you do not really want things decomposing in there for too long - a small container forces regular disposal!







## Upholstery

I am not a fan of sewing work, so I tend to either cheat, or very nicely ask my mum to help! This section gives a couple of ways to make simple cushions.

### Terrible (but functional) upholstery

Some relatives were throwing out an old futon so I used it to make the recliner chair.



The recliner chair, not the best photo!

The base of the chair is in two parts. They can be removed independently to access various areas for potential maintenance reasons.

I simply stapled the fabric to the base parts.



Not my best work.. but it is effective!

The back is an independent cushion with a shape that works in a reclined position. I have a sleeping bag I store behind it to keep it in place. It's a good place to put the sleeping bag and serves a purpose.

I took the staples off once a year to wash the fabric and then simply stapled it back together again.



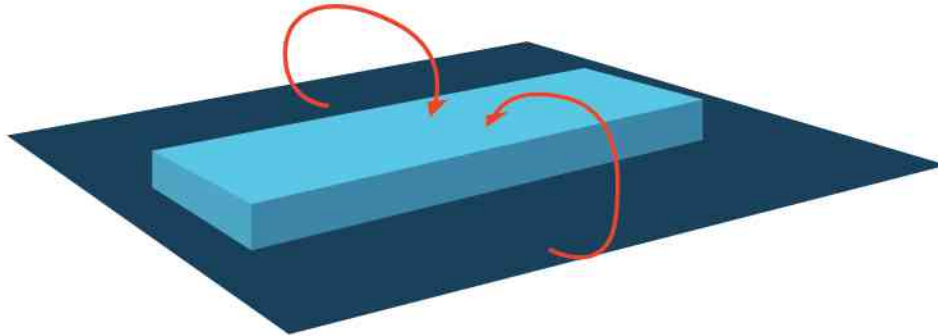
## Better Upholstery

Cushions are a pain to make. A lot of people will just get them made to size via a local company – this is good but also fairly expensive.

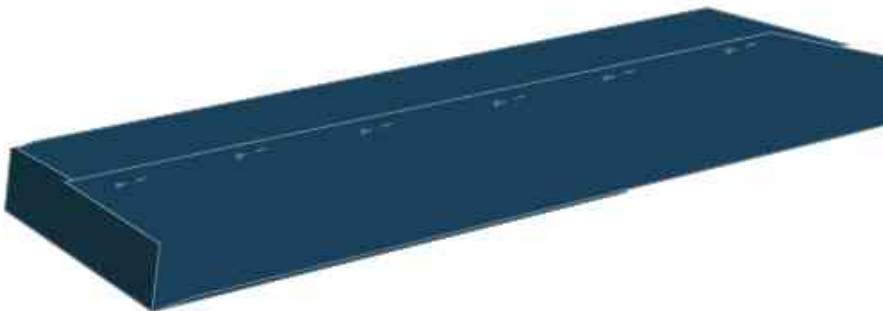
The following method is a simple way to do make some cushion covers. Professionals will make it with end pieces and extra seams but I want to keep it simple – and if you know how to do it better – then you don't need this section anyway!

This is how we made the covers.

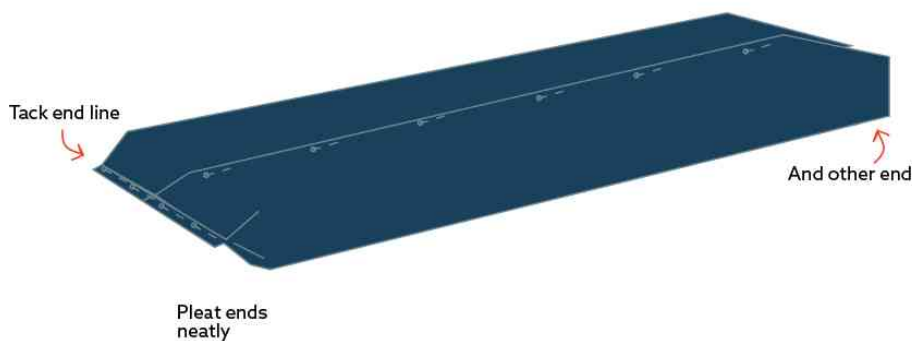
**Step 1.** Wrap fabric snugly around the foam block. I got my foam – high-density upholstery foam – It is better to go harder for seating because inevitably over time it will soften up.



**Step 2.** Tack the line using dressmaking pins. This will hold the form neatly in shape.

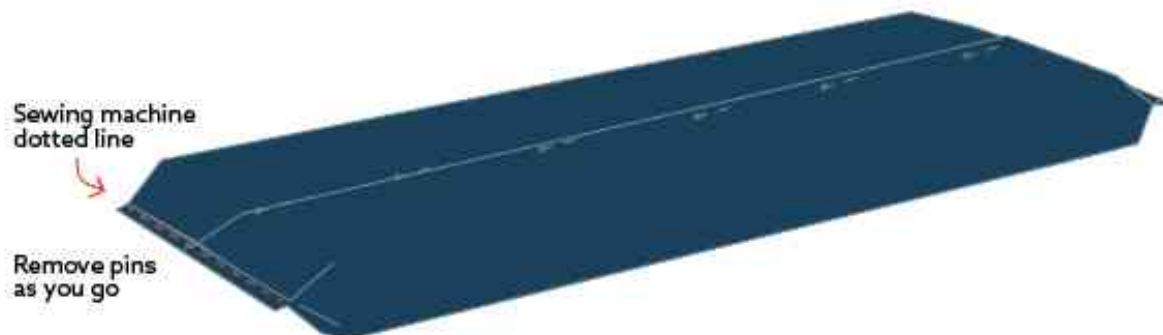


**Step 3.** Tack the end.. pull the shape of the fabric tight to the end of the cushion (the end result should be as square as possible. Try and fold your corners in neatly.



#### Step 4.

- a. Remove the tack pins you put in during Step 1.
- b. Remove the foam cushion carefully
- c. Sew along the line at the end of the cushion cover – ideally with a machine – travel backwards to finish the line.



**Step 6.** When both ends have been sewn you can turn it inside out and put your cushion in. It will have slight 'ears' which you will need to poke inside the cushion.

If you want to make the cushion cover flatter and more secure you can put on a few bits of Velcro to the long opening.

## Window sills & blinds

Making a window frame can be a little tricky. The shapes involved are a bit complicated as are the angles – but nothing a bit of patience cannot fix.

### Sill

I used a bit of redwood to give a different color compared to the usual pine. I cut the shape of the wood to fit inside the panelling and, under the back edge, sanded it down so it fit with the curved profile of the metal work.

### Mini-course Video



*Mug on redwood pine sill*

### Sides

The sides, at each end these are angled – to work it out was tricky – but when you get it right and they fit in it looks great.

At the top outside corner I cut a profile to match the blind when it is installed. The blind will run behind the side piece.



I cut profile at the bottom of both sides to allow the blind to run behind it and allow it to 'lock' in.



### Curtain 1. Black-out blind



There is no point in making a stealthy van if lots of light escapes and clearly shows off your presence! Plus I like darkness in the mornings if I want to sleep in.

By sheer coincidence the width I needed matched an Ikea standard blind width.



I screwed the blind onto the top of the window frame, after I glued the two sides in and the window was finished!

The black out blind (not all the way down) it works well

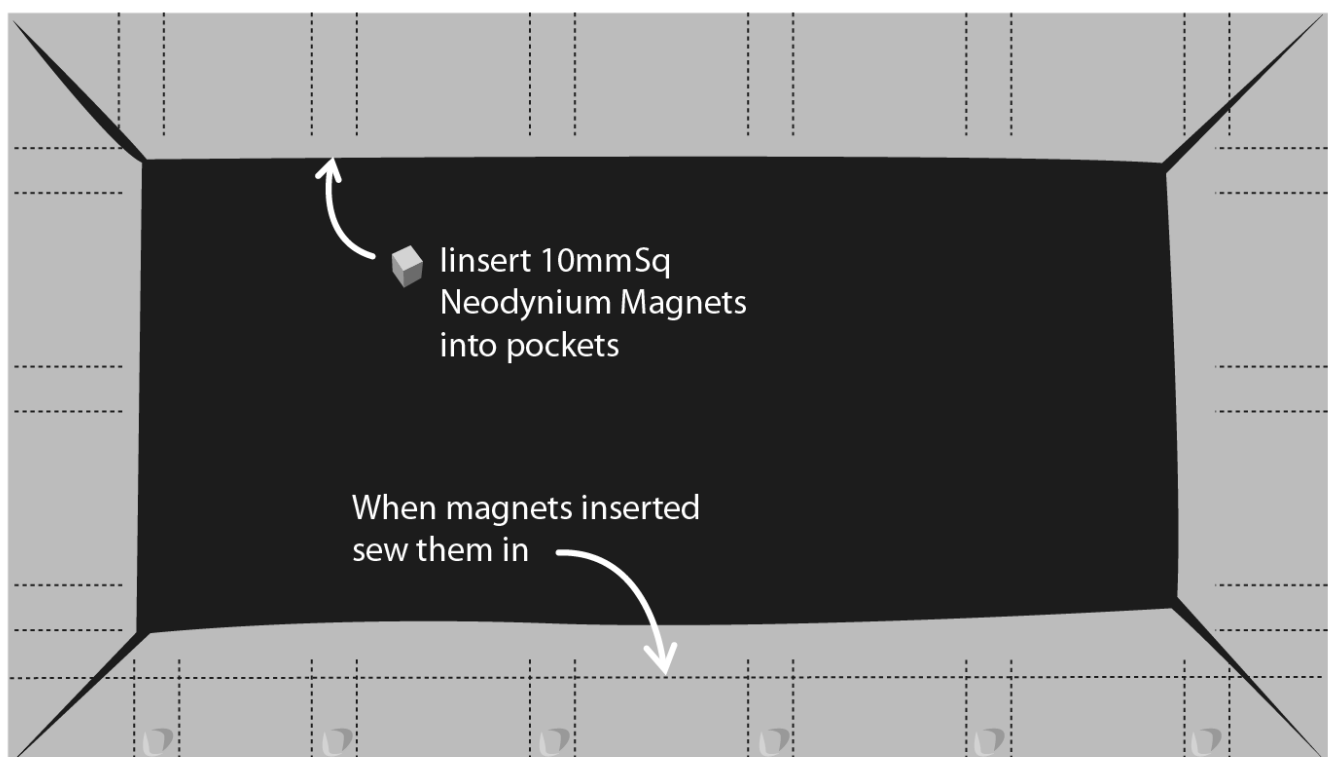
### Curtain 2 – Magnetic PVC Backed Canvas For bonded windows

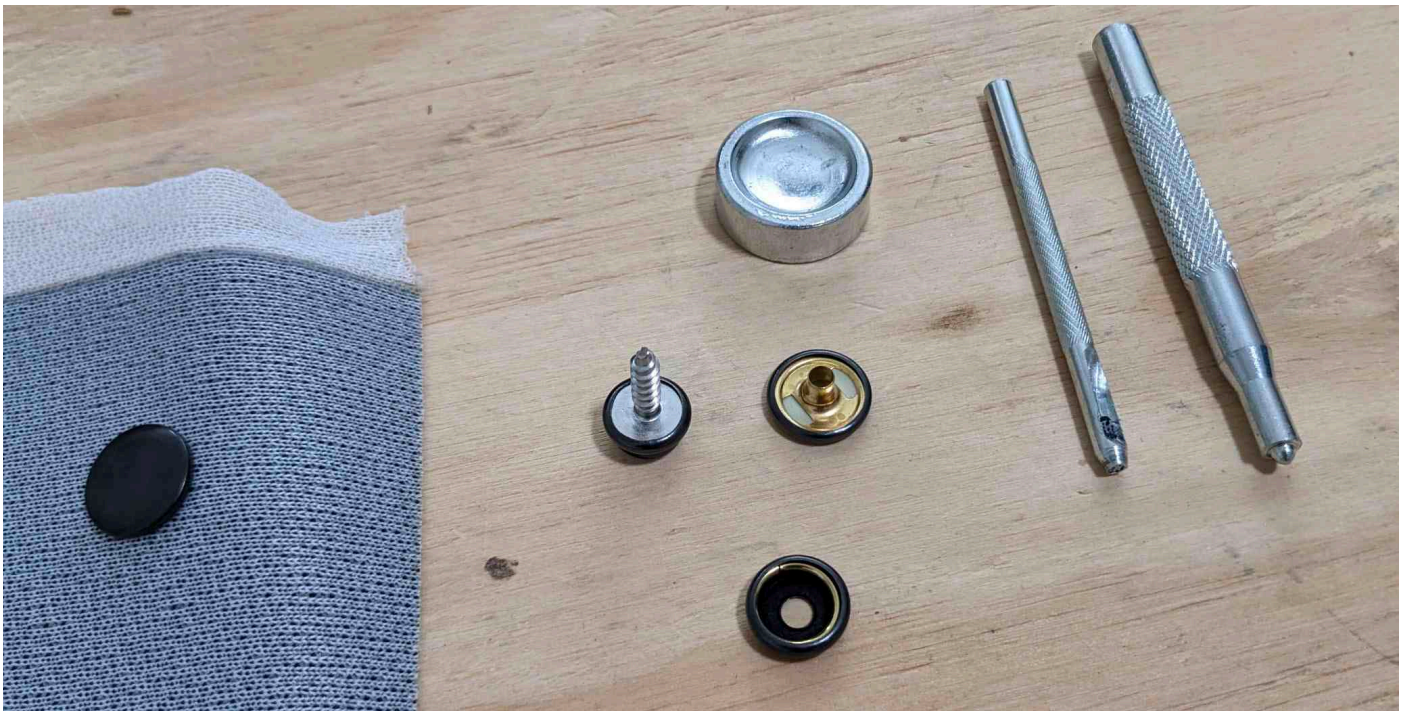
I made simple magnet-based black-out curtain using neodymium magnets sewn into PVC backed canvas. The PVC backing makes the fabric black-out.

The magnets attach to the window edging (which has steel forms within it to give it strength).

The image below shows the rough plan for how I put it together (using a sewing machine). It is important to get the size of the curtain right otherwise the magnets won't be able to connect with the edging.

This magnetic curtain is fast to put up and, during the day, I roll it up and put it into a small cupboard I created for it. (See below).





### Curtain 3 - Pop-up black-out curtain

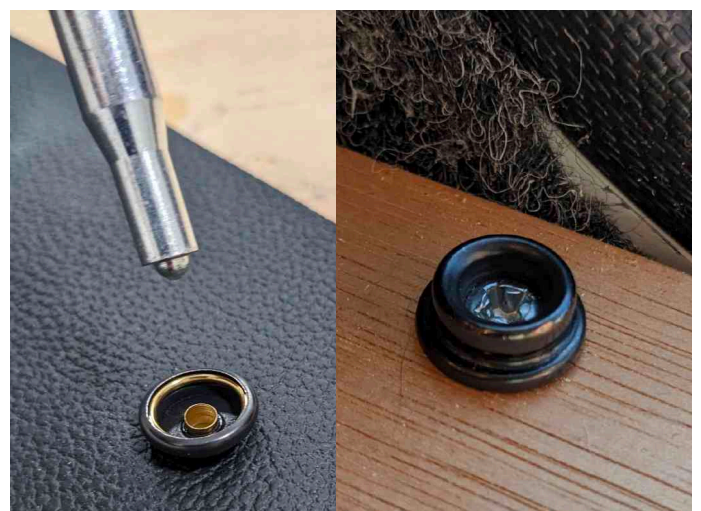
I have saved the best until last. This system of making a curtain gives an excellent result and requires no sewing machine.

It uses fabric poppers with screws and PVC backed fabric (does not fray). This means you can put the female part of the popper on the fabric, and the male part is screwed into the wood. (pre-drill this first)

To insert a fabric popper:

1. Punch hole in fabric
2. Insert front part
3. Put back part on to front part
4. Use punch tool (on metal anvil) to hammer it in place (it deforms the metal sleeve)
5. Screw in corresponding popper (male part) where you want it to be placed.

You can add a popper part way down the curtain so that you can roll-up and 'pop' in place the blind so it is out the way (see image below).





# Flooring

The usable flooring space is generally pretty small in most vans. I bought some Oak laminate flooring and used polyurethane wood glue to glue it down.

This stuff is really easy to lay, you just measure the length, cut it, lay it down and use the off-cut as the start of the next section.

The depth of the oak flooring acts as a stop for my food drawers.

Notice the wear on the laminate flooring, this was because the edges of the bottom of the crates were quite rough – I have now rounded them off and they do not seem to mark the laminate too much. Either way I am careful when sliding the, in and out.

When I did this a second time I got engineered oak wood flooring where there is 4mm of real wood so wear is not so much of an issue (it could be sanded down a bit and re-varnished).







## Finishing touches



The picture frame has part of an angle bracket (same as used for the stud-work build) cut short and glued on to the frame with polyurethane glue. The hooks are from Ikea.



## Redwood details

The head end of the bed has this redwood piece I cut to make a nice shape.. perfect for lounging over while looking at the view!



The other end has a red-wood plank too – as does the shelf, the window sill and the front of the kitchen unit. It is a nice touch that accentuates key parts of the build away from the standard pine color.



## Aluminium edging

I used this aluminium edging and cutting it to size created a protective edging. I glued and screwed this down to the flooring (it is screwed into the original stud work I put down when I

insulated the floor).



The edging. I also put some wood at the back of the step – it just hides some of the white metal work.

I had a spare bit of this edging, putting it at the back protects the wood from sliding things in and out



### Fake plants

I got some fake plants from Ikea.. they look nice (people are often fooled) but at the same time they do not increase the humidity of the van.



### Edging

It is hard to make everything match up precisely on all edges with the shape of the van.. so you can use this edging material to tidy up or cover up screws. You can use panel pins (small nails) or it is much easier to use a brad-nailer (nail gun) if you have access to one.

The aesthetic difference is subtle but it adds up to improve the over-all effect.



### Door matt

I got a simple design door matt from Ikea and cut it down to size. This I glued down with ample amounts of Sikaflex to the metal step.

The doormat (one cut in to strips) looks great and fits nicely with the colours and design of the van.





## Thank you!

When I converted my first van and shared how I built it on YouTube I would never have imagined that over 11 million people would have seen the video. The questions were overwhelming, so I wrote this book which has grown to be a broader guide about how to convert a van rather than 'how I converted my van'.

I kept updating the guide to match the new products and additional questions people had and it is people like you who help make that worthwhile. At nearly 150 pages with many diagrams, photos, videos, and links it takes a lot of time to update and to be frank selling a few guidebooks makes that worthwhile. On that basis, I want to say thank you for supporting what we do – your support goes directly back into more content, sharing of more ideas and improving information for you and other people like you.

Even after converting three vans and seeing, filming and editing a hundred or so van tours I still find van conversions, the ingenuity of self-builders and the idea that a home-on-wheels can set you free endlessly fascinating. I hope this eBook and my YouTube channel can, at least in a small way, help people live their dreams on their own terms.

Thank you again, and good luck with your build!

All the best,

Nate



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