SUCCESSFUL ELECTRIC BOATING

törkmar
Electric Boat Solutions Company

Thank you for downloading this guide.

Put simply, it explains our approach. However, we do recognise that when it comes to electric boating, there are many ways to get the job done.

That said, with many years of experience and after a great deal of R&D, we believe the Torkmar way has real merit.

So, what is it we actually do?

In essence, we provide equipment that works well together to create very efficient electric boats.

This includes electric motors, solar panels, batteries, complete electrical systems (including Victron equipment), generators, and monitoring equipment.

We work directly with both boat builders and individual boaters across a wide range of vessels including narrowboats, dayboats, sailing boats, or indeed any craft with an inboard motor.

Whether you are starting a brand-new build or converting an existing boat to electric propulsion, we can help.

Thank you once again for your interest, and please don't hesitate to get in touch.

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First, let's talk about the sheer joy of traveling the inland waterways in an electric boat.

All you hear are the birds, gentle water flow, the rustling of the leaves in the trees.

Boy is it a tonic and you're saving the planet!

If your boat is set up just right, you should be able to travel along consuming no more than 1kW.

That's probably less than what your hair dryer uses.

It's because once the boat has momentum and it takes very little to maintain it.

However, get it wrong and you can own an electric boat that consumes more diesel than a diesel boat.

This would be silly and it's why you need to have your boat designed and set up properly.

3 simple rules

The lazy engineer rule
Use as little energy as possible.

The grandma rule
Waste as little as humanly possible.

The car window rule
It's about the trip, not the destination.

AC vs DC.

Don't skim over this bit, it's important!

If you're on an electric boat, you'll be living on battery power, this is DC.

This means to use any AC appliances onboard (hob, oven, hair dryer) you will need to convert the DC battery power into AC and to do that you'll need an inverter.

Just like when you go on holiday and you change pounds to dollars you lose a little bit in the conversion. Converting DC to AC is the same. You lose.

You even lose again just by having your inverter on.

To save energy, turn your inverter off, if you need to charge your phone at night use a USB charger powered from your DC dropper.

Charger Inverters. One box with 2 parts.

A point worth making upfront is that you will only use your charger when you're either plugged into the shore or you are charging your batteries using an AC generator.

If your charger is turned on, it's consuming power. So turn it off.

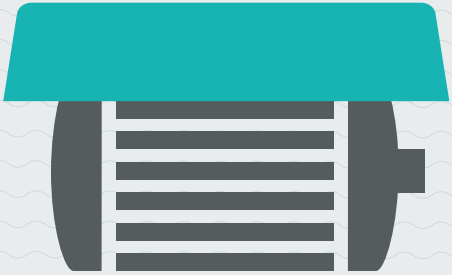
The inverter part (making AC)

Most electric narrowboats with a hob, an oven, a kettle etc. won't need more than 8,000 watts, 10,000 watts at a push. Add up how many devices you will have on at any one time. Be reasonable.

The charger part (Making DC)

More 32A shore chargers are slowly becoming available, which is roughly 7,000 watts, if you want to future proof go for a 10,000 watt charger.

You can plug a 16A charger into a 32A socket but you'll need to make sure your charger is down rated to 16A. However most marinas struggle to give you 10A.



Electric Motors.

We used to talk about horsepower and let's be honest nobody really understood what that meant, we just thought we 'needed' more.

Now, with electric boats, we're talking about kilowatts and again nobody really knows what that means.

It's because the amount of kilowatts that a motor uses is not a very reliable indicator as to how fast your boat moves.

On displacement boats, big, slow moving props are more efficient.

On boats that plane, (think of a speedboat skipping over the water) faster, smaller props work well.

Narrowboats are displacement boats.

Question: What do we need to turn that large propeller efficiently?

Answer: a motor with sufficient torque to turn a large propeller.

This is not because the propeller is heavy. It's because the prop is literally shovelling large amounts of water from one place to another.

Tractors have a lot of torque, Ferrari's don't.

If you are wanting an electric boat, make sure you ask about the torque rating of your electric motor.

It's a much better guide than kilowatts. And make sure you ask if it's continuous rating, or is it the instant rating.

Only compare continuous torque ratings.

Shore charging,
Galvanic Isolators vs isolation transformers.

Yes you do need one.

If you plug into shore power at a marina, your shore lines earth wire connects your underwater metals to every other vessel on the dock.

This creates a “battery” effect where low-voltage DC currents flow between boats, causing galvanic corrosion that will dissolve anodes, propellers, and hulls.

Both galvanic isolators and isolation transformers break this circuit, but they offer different levels of protection:

Galvanic Isolator

A compact device installed on your shorelines earth wire. It uses diodes to block electrical flow on the earth wire but allow +ve and -ve AC to flow.

Pros: Inexpensive, small, and easy to fit.

Cons: Can be bypassed by high “stray” currents; no protection shore spikes.

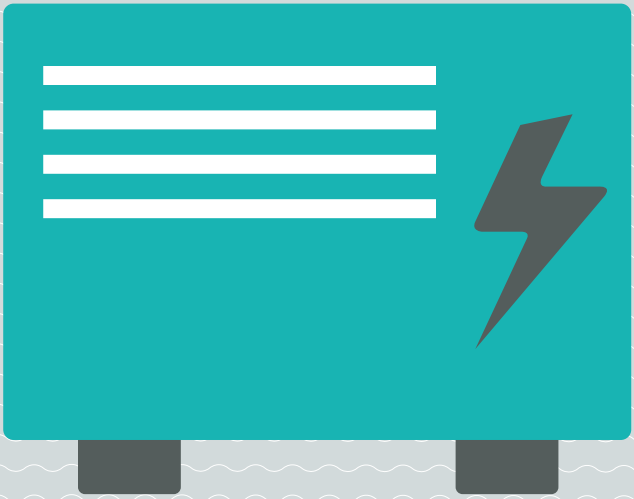
Isolation Transformer

The premium solution. It transfers power via a magnetic field, meaning there is no physical wire connection between the shore earth and your boat.

Pros: Total protection from galvanic corrosion; can step voltage up or down and “cleans” the power supply.

Cons: Expensive, heavy, bulky and will draw some current when left connected with no load.

Verdict: A galvanic isolator is standard for GRP boats. However, for steel hulled vessels an isolation transformer is the “gold standard”.



Generators.

If you can get away with not having a generator, so much the better. They're a big space eating pain.

Fitted think £15,000. However, they do offer a lot of freedom in the winter months on the inland waterways where charging from the shore is patchy.

Consider the noise and tone of the generator, the rumble of a generator at 1500rpm is so much more agreeable than those of a higher rpm which tends to be higher pitched.

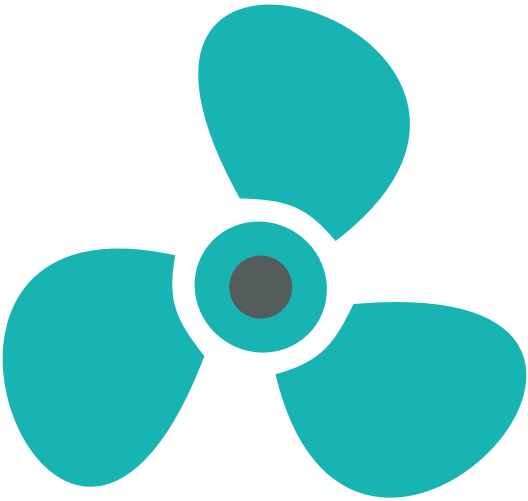
Don't bother with variable output generators because the sole purpose of your motor is to charge your battery as quickly as possible.

Don't over specify the size of the generator, it's best if they run for at least an hour, and it will give you a tank of hot water.

Smaller generator far easier to maintain than a large generator in the confined space of a narrowboat stern.

Watch out for kVA versus kW, it's kW that you're interested in. Aim to use at about 80% of its rating, example: configure a 6kW generator to output 5kW.

Hospital Silencers are nice to have and make sure they are lagged to further reduce noise and protect from burns.



Propellers.

Put Newton's Third Law of Motion and Bernoulli's Principle of Pressure Differential to one side. Think about flippers or as divers call them, fins.

Fins are more efficient than bare feet. Divers wear them because they efficiently propel them forward underwater.

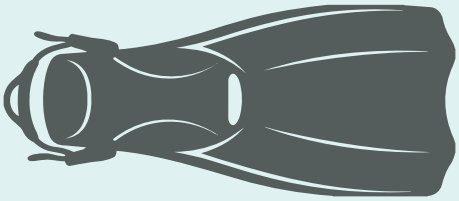
However, if you've ever worn fins yourself, you will have noticed how tired your legs soon become, it's hard work. It's why divers often develop strong thighs.

Think of the blades of a propeller as fins. The bigger they are the better you move forward.

While we typically categorise propellers by their diameter, the surface area is the more critical metric for performance. It is striking to note that a 20" propeller actually provides 56.25% more surface area than a 16" model.

Propeller decisions should be made early and in order to effectively use a large propeller you'll need a deep enough swim. That's the distance from the underside of the swim to the bottom of the hull. 24" is good, however if you don't have this you can always lower the skeg.

Ask your shell builder about this early.



Can I convert my diesel narrowboat to electric?.

Yes you can.

It will cost you between £30,000 and £60,000. And it will totally transform your boating experience.

Electric motors make boating more enjoyable. Instantly you will love the near-silent operation.

The noisy vibration, rumble and smelly fumes of the diesel engine disappear.

Instead, you glide peacefully through the water. This allows you to fully appreciate the tranquillity of your surroundings.

Electric motors offer instant torque and precise control. This makes low speed manoeuvring in locks and marinas far smoother.

Additionally, electric motors possess fewer moving parts than complex diesel engines. This dramatically reduces maintenance requirements.

Transitioning to electric propulsion helps you future-proof your narrowboat.

And you'll get 25% off your licence fee too. It all helps!

Cabling, Terminations, Torque Settings, Fuses. The Craft.

Boats are a collection of parts made in the controlled environment of a factory. However, boat yards are often not such places and it's where in often challenging environments these parts are fitted together. *It's where things go wrong.*

All cables on boats should be tri-rated, this means that they conform to BS 6231, UL and Canadian standards.

Load (Amps)	3M Run	5M Run	15M+ Run
50A	10 mm^2	10 mm^2	25 mm^2
100A	25 mm^2	25 mm^2	50 mm^2
200A	50 mm^2	50 mm^2	95 mm^2
400A	95 mm^2	95 mm^2	2 x 70 mm^2
600A	150 mm^2	2 x 70 mm^2	2 x 120 mm^2
800A	2 x 95 mm^2	2 x 95 mm^2	2 x 185 mm^2

Terminations

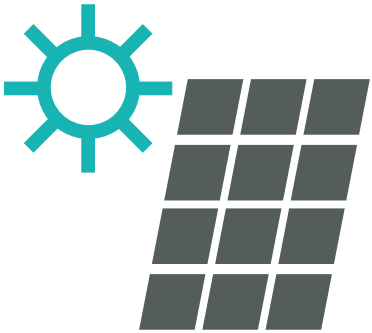
This refers to how a cable is finished, a lugg, a ring connector, a spade connector, etc. It's an underrated skill, not done correctly it can lead to catastrophic failure. Insulating heat shrink should also be used. Ensure the heat shrink doesn't interfere with the connection. It's a common mistake that leads to electric arcing and fire.

Torque Settings

If you are running a cable to an isolation switch or battery, check the torque setting. Both over tightening and undertightening can lead to issues in the future. Follow the manufacturer's instructions.

Fuses

Make sure you use fuses that are rated not only to the correct amperage but also to the correct voltage. Most electric boats operate at over 48VDC, most fuses are rated below this.



Solar panels.

On a boat, you have to be practical. Ask yourself, what are you going to be using the boat for and how much you will be traveling? But in essence the more panels you have, the better your boat will be for it.

Semi-flexible panels look better. They can be walked on, which makes them better for a cruising boat. However, if you are going to be stationary for much of the time, rigid panels on a tilting bracket are a good option. They are cheaper and because they can be tilted, they will harvest more energy.

If you go semi-flexible, they often have junction boxes and cable connectors on the back of the panel. You'll need to cut holes in the roof. Easy on a new build.

Table showing types of solar cells and their properties.

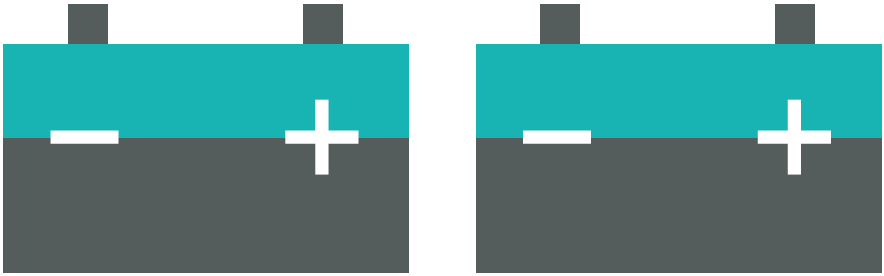
Monocrystalline	19%-22% efficient	Semi-flexible / rigid
Monocrystalline PERC	20%-23% efficient	Semi-flexible / rigid
Monocrystalline Bifacial	20%-25% efficient	Rigid
Polycrystalline	15%-19% efficient	Semi-flexible / rigid

Perovskite Tandem, CIGS (Thin-Film), Organic (OPV), Amorphous Silicon, Gallium Arsenide also exist but are economically unviable.

Put simply, semi-flexible panels have 4 layers. A top transparent film, wires, the solar cells and the substrate. The substrate is very important. Low quality panels have PET substrates whereas higher quality panels have epoxy fibreglass substrates.

Important? Yes, as the sun heats a steel shell it causes it to expand. This stretches low quality panels, forcing electrical connections between cells to be pulled apart.

For longevity and higher yields, choose semi-flexible panels that have a good substrate. Then choose an adhesive that allows for movement.



Batteries.

New terms to become acquainted with:

SoC	State of Charge	The percentage of energy currently in the battery.
SoH	State of Health	Current capacity re. original capacity; tracks ageing.
DoD	Depth of Discharge	The percentage capacity that has been used up.
OVP/UVP	Over/Under Voltage	Stops charging too high or discharging too low.
OCP	Over-Current Protection	Cuts circuit if load is more than battery can handle.
OTP/UTP	Over/Under Temp.	Shuts down if the battery becomes too hot or too cold.
CAN bus	Controller Area Network	How the BMS talks to inverters or motor controllers.
	Thermal Runaway	Cell's temperature rises uncontrollably; BMS will stop.
	Charge Efficiency	The % of charge is actually stored when charging.
	Cell Balancing	Equalising the voltage across cells in a series string.

As with many aspects of boating, there is more than one way of achieving the same goal. Batteries are no exception. That said, it is important to get the right batteries for you and your boat and how you intend to use it.

There are always new and better battery technologies written about in the press but right now the two most common types of battery found on a boat are lead carbon and lithium ion phosphate (LiFePO4).

	LiFePO4 (Lithium)	Lead Carbon
Charge Efficiency	95% – 98%	80% – 88%
Weight	Ultra-light (40kg for 100Ah@48V)	Very Heavy (150kg for 100Ah)
Cycle Life (80% DoD)	4,000 – 6,000+ cycles	1,500 – 2,500 cycles
Upfront Cost (UK)	High (£350 – £550 per kWh)	Low (£180 – £250 per kWh)
Lifetime Cost (TCO)	Lowest (due to longevity)	Moderate
Recyclability	Complex but improving (80%+)	Exceptional (98%+ Closed-loop)
Communication	Easy	Need shunt
Temperature Range	Poor below 0°C (unless heated)	Excellent (works well in the cold)

Where to put your batteries

You wouldn't store other fuel types in your boat's cabin so it's best not to put batteries there. The engine room makes good sense.

That said, there is, for the moment, no rule saying not to and sometimes it is the only suitable place.

There is no issue putting lead carbon batteries in a boat's engine room as they have a high IP rating.

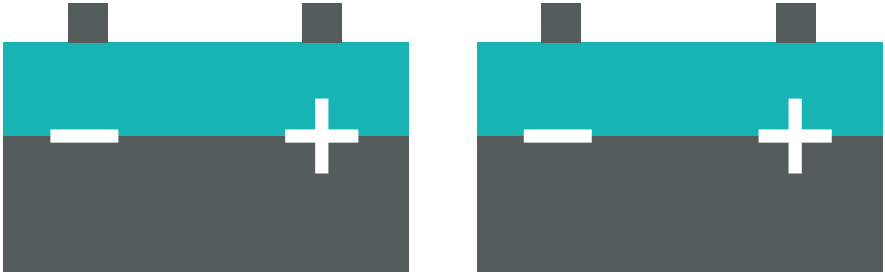
Fortunately there are now more affordable LiFePO4 batteries becoming available with suitable IP ratings that can survive in the engine room of a boat.

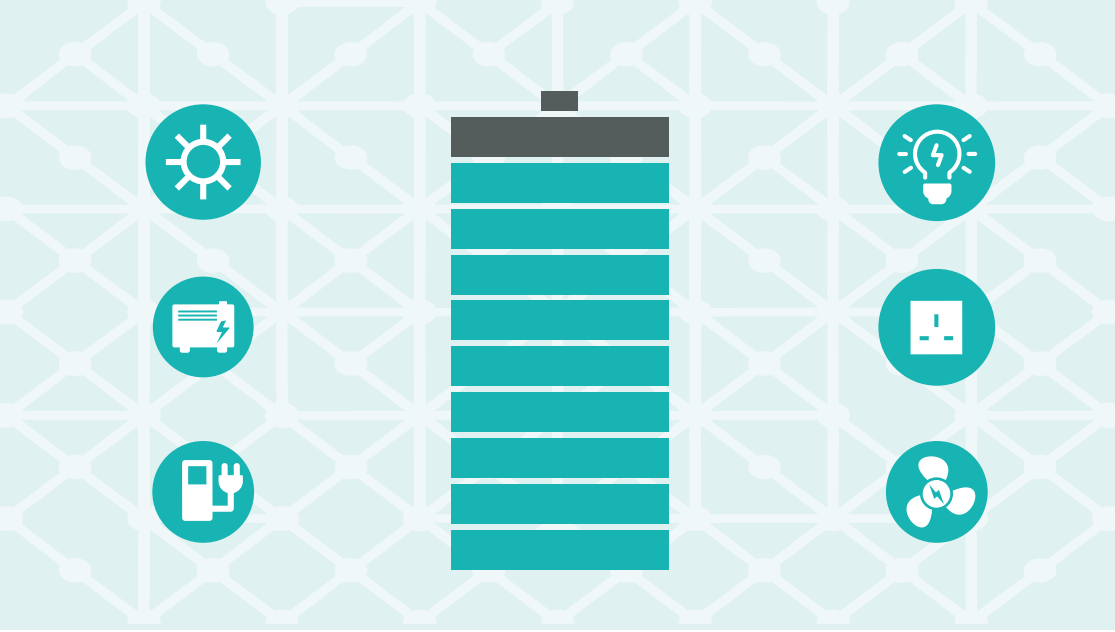
Equalisation of cells

Both LiFePO4 and Lead Carbon cells need to balance and equalise. Failure to do so will mean that over time cell voltages will vary wildly which will lead to a cell failing. To equalise you need to get the battery bank up to 100%. If you are using a shunt, equalising will also allow the shunt to reset.

Summary and Gold Standard.

Battery	48V LiFePO4 linked in parallel.
IP rating	At least IP54 but IP 65 is better.
Heating	A good idea but make sure it doesn't flatten the battery.
Compatibility	Must talk to Venus OS, check to see what data is shown, it varies.
Fuses	Use Class T fuses on each lithium battery





Everything needs to talk to everything else.

In a modern electric vessel, understanding power generation and consumption is where true efficiency is found. For you on board or remotely from home, it means providing actionable intelligence at a glance.

Data that means something

Don't glaze over when you look at the screen. Find a system that you can easily understand and doesn't require a degree in computer science.

Instantly know, SoC, solar input, motor draw (could there be weeds round the prop), motor temperature, motor controller temperature, your boat's range, etc.

The informed skipper

Having this level of oversight means you can adjust your plans with confidence. Whether you are managing power on an overcast day or navigating a flight of lock, integrated sensible data ensures that every decision is backed by facts rather than guesswork.

The peace of mind dividend

We go boating to unwind; having clear and relevant information that means something, adds to the joy of electric boating. Enjoy the peace of the inland waterways, this technology should be on your side.

You are in charge.

Over time, you will develop a natural feel for your boat.

Much like a good accountant who senses an irregularity in the books and pauses to recheck the figures, you should learn to trust your instincts and query the information whenever something feels off.

Be a good sailor.

Big claims

While modern pleasure boats are light years ahead of where they were a few years ago, don't be swayed by huge promises made online. Or for that matter on the cut. There is no doubt that wonderful things will come but there will also be some lemons too. Be grounded in your choice. Go for what works today.

You are wearing the captain's hat

Let's be honest, you might get to wear the captain's hat but for happy boating choose a system that works for everyone else on board and you will undoubtedly have many years of great cruising on the inland waters.

Enjoy the countryside. Look after the environment. And be kind to canoeists who won't be able to hear you coming. Well maybe!

To find out more visit torkmar.com

The site offers a wealth of practical advice and there is a competitively priced shop to explore.

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