



Understanding Electric Outboards

Electric outboard motors are clean, quiet, low maintenance, and are better for the natural environment. Learn all the basics in this short overview from Rowing BC.

rowingbc.ca

RowElectric

Go Clean Go Quiet

The aim of the Row electric pilot is to accelerate the transition from gas to electric outboards by providing users with firsthand experience and reliable, relevant information on costs and performance.

Electric outboards reduce CO₂ emissions and air, water and noise pollution, benefitting athletes and coaches, the community, the climate and the environment.

For more information, please visit rowingbc.ca/rowelectric



This overview is part of Rowing BC's RowElectric Pilot Project, which is testing the use of electric outboards at four rowing clubs in BC.

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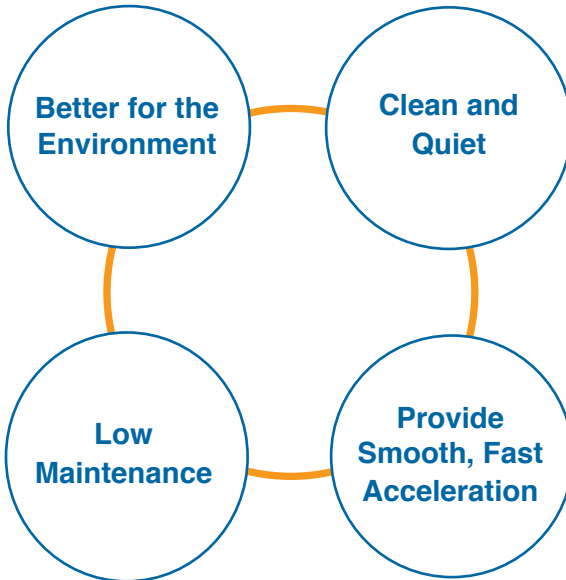
St. Michaels University School
University of Victoria Vikes Women's Rowing

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Why Go Electric?

Electric outboards are:



Electric outboards come in sizes from small portable motors of 1kW or less suitable for tenders, up to powerful motors of 225kW capable of speeds of 30-40 knots.

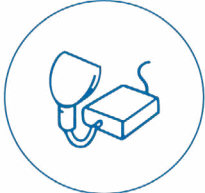


With current battery and motor technology, electric outboards are best suited for:

- operating at low to moderate speeds
- short trips
- uses that involve a lot of idling, slow speeds and changes between forward and reverse
- environments where clean and quiet operation are important
- uses where there is access and time to charge or “top up” the batteries between uses (e.g., day use, coaching, travelling between marinas or to a “mothership”).

Electric outboards are being used on rigid hull inflatables, runabouts, pontoon boats, cruisers, workboats, water taxis and sailboats. They are being used for pleasure cruising, sailing, recreational fishing, wildlife viewing, coaching, and commuting.

Components of an Electric Outboard System

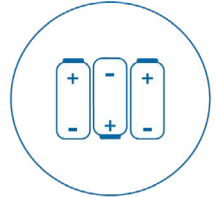
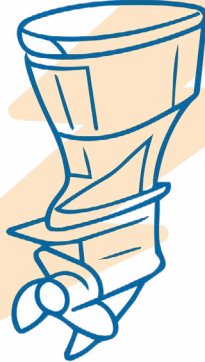


Charger

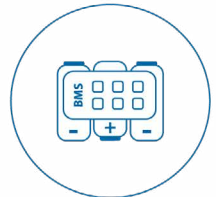


Throttle (either tiller or remote), Display Unit, Cables, Accessories

Electric Motor & Propellor



Battery Bank



Battery Management System



Some manufacturers sell all the components as an integrated system, whereas others sell only the motor, with users sourcing the other components separately.

Electric Motor

The motor may be housed in a waterproof casing at the bottom of the leg (direct drive) or at the top of the leg (L drive) like a gas outboard.



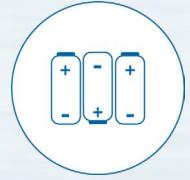
Power

The power of an electric outboard is measured in kW (not hp like a gas outboard). Some manufacturers give “horsepower equivalence”- an estimate of how the electric outboard will perform compared to a gas outboard, taking into account its greater torque and efficiency.

As a rule-of-thumb, a 6kW electric motor is similar to a 9.9hp gas outboard, a 12 kW motor is similar to a 20-25 hp gas outboard, and a 90 kW motor is similar to a 120hp gas outboard.



Batteries



Electric outboards are powered by rechargeable lithium-ion batteries. Motors up to about 12kW can be powered with low voltage batteries (24V or 48V); more powerful motors are powered by high voltage batteries (96V or greater).

The battery's capacity – the amount of energy stored in the battery bank (in kWh) – determines runtime. Most systems allow several batteries to be linked in parallel to increase capacity. The battery bank's power – the amount of energy delivered per unit of time (in kW) – determines the power that can be delivered by the motor. For example, a 12 kW motor needs a battery bank capable of delivering about 12 kW of power to operate at full capacity.



Battery Management System

The Battery Management System (BMS) monitors and manages the battery during charging and use (discharging), balancing the voltage and current of the individual cells that make up the battery, and monitoring temperature and other variables. The BMS is critical for optimizing battery performance and lifespan and ensuring safe operation. It may be a separate unit or (more commonly now) integrated into the battery bank.



Charger

The charger converts AC power from the electrical grid to DC power for the battery. It plugs into the battery at one end and a regular 110V or 220V power outlet at the other end. Several chargers can be connected in parallel for faster charging. Some batteries are being designed to also use DC (Level 3) “fast” chargers that plug directly into the battery, bypassing the normal AC charger. Batteries can also be charged or topped up using solar panels (which deliver DC power directly to the battery).



For motors bigger than about 5kW, the charger is normally mounted in the boat, as, for practical purposes, the batteries are too heavy to remove for regular charging. Many small electric outboards (<5kW) are designed to be portable and can be easily removed for charging.

Throttle, Display Unit, and Cables



The throttle controls the power output of the motor. Smaller outboards (e.g., 12 kW or less) are usually available in either tiller or remote throttle models; large outboards are typically available with remote throttle. Cables connect the motor, battery and charger, transferring power and data between the different system components.



Weight

The total weight of an electric outboard system will depend on the size of the motor and the size and number of batteries. Generally, the combined weight of an electric outboard system will be heavier than a comparable gas outboard plus fuel. For example, a 12kW electric outboard with two 5000 kWh batteries weighs about 135 kg, compared to about 85 kg for a 25 hp gas outboard with a 25l tank of gas.

Most systems include a display unit or phone app that displays state of charge, power, speed, distance travelled, error messages, and other information.

Operation

Operation of electric outboards is generally much simpler than gas outboards. Turn the system on, allow a short time for the system to initialize, and then turn the motor on. Unlike a gas outboard, there is no choke and the engine does not need to be warmed up. Engage the throttle to go forward or reverse. There is no shifting lever, and no need to throttle down before going into reverse. Charging simply requires turning the motor off (but leaving the system on) and plugging the charger into the shore power outlet.



Performance

Runtime

Runtime – how long you can go for – is determined by battery capacity (i.e., how much fuel you have) and how much power the motor is using. As a guideline, a 10 kW electric outboard with a fully charged battery bank of 10kWh will run for about one hour at full throttle, about 2 hours at half throttle (i.e., using 5kW of power) and 6 hours or more at slow speed.

Range

Range – how far a boat can go- is strongly affected by hull design, speed, weight, current and other factors that increase drag and decrease fuel efficiency. Keep in mind that the drag created by water is much more than the drag created by air, so factors that affect “fuel efficiency” and are even more important with boats than with cars. For this reason, it makes more sense to think in terms of runtime.

You can increase runtime by choosing a battery with more capacity, adding another battery in parallel, or reducing your speed.

Charging Time

Charging time is determined by battery capacity, state of charge and the power (W) delivered by the charger. Charging time can be reduced by choosing a more powerful charger, combining several chargers in parallel, or using a 220V circuit. Charging will also be slower in cold temperatures, and chargers will not charge at temperatures below 0C.

As an example of charging time, a 10kWh battery bank will take about 4 hours to fully charge using one 2900 W charger plugged into a 220V circuit. Using 2 chargers would reduce charging time to about 2 hours. A DC fast charger will fully charge a 43kWh battery in less than one hour.



Speed and Acceleration

An electric outboard will accelerate faster but have a lower top end speed than a gas outboard of comparable power. Top end speed is strongly affected by hull design and load (for both gas and electric outboards), making it difficult to generalize about speed.

Electric outboards accelerate (and decelerate) quickly, feel more responsive, run smoothly even at low speeds and idle without difficulty. The smoother, more precise controls and instant response make it easier to maintain a constant speed and to maneuver in tight quarters.

Larger motors (e.g., 90 -225 kW) can give top end speeds of over 55 –75 kmh (30-40 knots).

A 16-foot coaching catamaran with 1 person on board, powered by a 12kW motor, had a top end speed of 28 kmh (15 knots).



Maintenance

Electric outboards require relatively little maintenance compared to gas outboards. For direct drive motors, maintenance includes inspecting connections regularly for signs of corrosion, lubricating moving parts and changing anodes as needed. Larger motors (over 12kW) may have cooling or gear systems that require servicing and winterizing. Be sure to check with your dealer for recommended service intervals.

Safety

The combination of water, electricity and lithium-ion batteries raise concerns about risks of electrocution and battery fires.

Manufacturers mitigate these risks by:

- encasing the batteries in a watertight case that protects them from water, dust and physical damage
- using sophisticated battery management systems that will shut the system down before it can overheat
- using thermally stable Lithium-Iron-Phosphate (LFP) batteries.

Boaters can minimize risk by:

- following recommended procedures for installation, operation and maintenance
- choosing low voltage batteries
- using standard precautions that apply to the use of electricity in marine environments (e.g., using GFCI outlets with waterproof connections, inspecting connections for corrosion etc.)

Cost

Electric outboards have higher upfront costs but lower operating costs than gas outboards. The upfront cost of the electric outboard system is largely determined by the size and sophistication of the motor and by battery capacity. The battery bank can be one-third to one-half of the total price. The charger, throttle, display unit and other accessories are smaller contributors to the overall cost. Be aware of what components are included in advertised prices, to make sure you are comparing apples-to-apples.

Electric Outboard (including motor, batteries, charger, throttle etc.)	~ 6 kW motor 8 kWh battery	~ 12 kW motor 10 kWh battery	~ 40 kW motor 32 kWh battery
Purchase Cost	~\$15,000- \$18,000	~ \$30,000- \$35,000	~ \$50,000
Fuel Cost (\$0.1172/kWh)	~\$0.94	~\$1.17	~\$3.75
Gas Outboard (motor only)	9.9 hp	25 hp	50 hp
Purchase Cost	~\$4000	~\$5900	~\$10,500
Fuel Cost (\$1.61/l)	~\$6.44	~\$14	~\$30

Fuel Cost- for one hour of runtime at full throttle.

