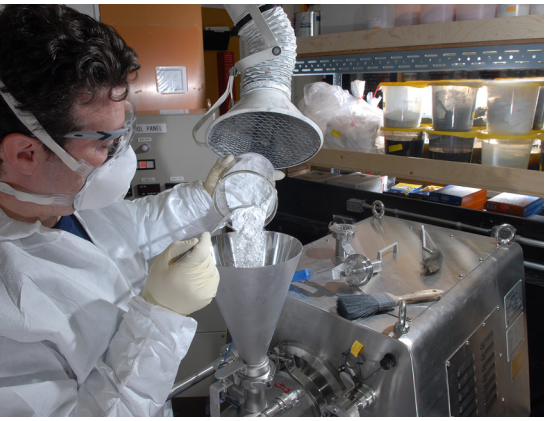


Materials for Battery Manufacturing

Hydro-Québec's research institute, IREQ, is contributing to the development of all-electric and plug-in hybrid vehicles. It is conducting extensive work on battery materials, particularly molten salts, lithium iron phosphate and nanotitanates. Its contribution is helping to develop safe, high-performance lithium-ion batteries that can be charged more quickly and a greater number of times.

Winning combination

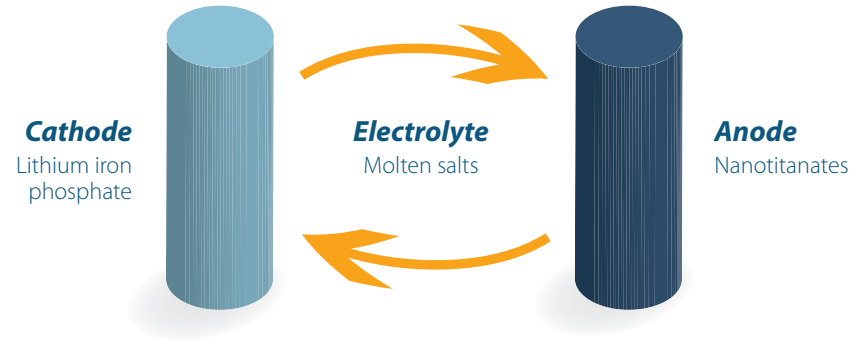
The future success of plug-in vehicles largely depends on the battery. Innovation efforts cover both high-power batteries and high-energy batteries. A battery has an anode, a cathode and an electrolyte.

- A very promising solution to increase the stability and safety of lithium-ion batteries, while reducing their cost, is to use a lithium iron phosphate ($LiFePO_4$) cathode. Hydro-Québec holds a North American and European patent for this material.
- As for the electrolyte, used to conduct lithium ions from anode to cathode, molten salts give encouraging results. Hydro-Québec estimates that it holds the major share of intellectual property worldwide in this area.
- Regarding the anode, IREQ is working on nanotitanates to increase battery service life and performance.

Promising future
The materials developed for manufacturing batteries offer great prospects in land transport applications:

- *Quick charge time of four minutes*
- *Enhanced energy and power performance*
- *Battery life improved to achieve 30,000 charge/discharge cycles*

Hydro-Québec intends to grant licences to a number of partners to encourage battery manufacturer suppliers to undertake high-quality bulk production of the materials it has developed.



Simplified drawing of a battery with a $LiFePO_4$ cathode

In the dry room, a technician operates a winding machine

Thin film coating system inside the dry room

In the nanopowder room, equipment used to create nanometre-sized powders

Leading-edge facilities

To boost the performance and cut the cost of lithium-ion batteries, researchers work in top-notch facilities equipped with leading-edge technology. The IREQ energy storage laboratory includes a dry room dedicated to lithium-ion battery assembly and a nanotechnology room where the various operations to create and use nanometre-sized powders are performed. IREQ is also equipped with a high-resolution electron microscope system, instrumental to progress in nanotechnology.

Battery characteristics

High-power battery

Cathode	Lithium iron phosphate ($LiFePO_4$)
Anode	Nanotitanate ($Li_4Ti_5O_{12}$)
Energy	67 Wh/kg
Power	8,000 W/kg
Number of cycles*	30,000
Demonstrated time to fully charge**	4 minutes
Applications: • Hybrid electric vehicle (HEV) • Plug-in hybrid electric vehicle (PHEV) • Ultracapacitor bus • Electric bicycle, scooter or truck • Storage • Charging station for PHEVs and EVs	

High-energy battery

Cathode	Lithium iron phosphate ($LiFePO_4$)
Anode	Natural graphite (NG)
Energy	100 Wh/kg
Power	2,000 W/kg
Number of cycles*	2,000
Demonstrated time to fully charge**	from 30 to 180 minutes
Applications: • Electric vehicle (EV) • Plug-in hybrid electric vehicle (PHEV) • Electric bicycle, scooter, truck or bus • Tools	

* *One cycle consists of one sequence of discharging and then charging.*
** *For a 16 kWh battery at a quick-charge station.*