



# Alternative Grid-scale Energy Storage Technologies

## Lithium-ion Batteries

- Global grid-scale battery storage currently dominated by lithium-ion
- Declining lithium-ion costs due to technological innovations and improved manufacturing capacity
- 80% - 90%+ round-trip efficiency

## Lithium-iron Phosphate (LFP) Batteries

- Don't decompose, heat up or collapse like lithium-ion and environmentally-friendly
- Low cost, longer lifecycle than lithium-ion, handle extreme temperatures, safer and lower toxicity
- Currently used in Tesla Model 3 EV's
- Tesla planning to manufacture LFP batteries in Sparks, Nevada for use in Megapack grid energy storage units
- High energy density with round-trip efficiency as much as 90%

## Sodium-ion Batteries

- Sodium cheap and sustainable alternative to lithium-ion
- Lower power density than lithium-ion
- 92% round-trip efficiency

## Sodium Solid-state Batteries

- New Huahui New Energy battery is high energy density sodium solid-state battery combined with polymer composites
- Close to energy density of current LFP batteries in Tesla Model 3 cars
- Low fire risk
- Toyota, ProLogium and Samsung commercializing own solid-state batteries by 2027
- Technology could have large future implementation in grid-scale energy storage

## Redox Flow Batteries (RFBs)

- Redox flow batteries replace solid electrodes with liquid electrolytic compounds such as vanadium, iron-chromium or zinc-bromine separated by membrane
- Can store large amounts of energy, which make them ideal for grid energy storage
- In 2024, TC Energy completing 81 MW (40 MWh) project in Alberta
- Over 70% round-trip efficiency

## Salgenx Saltwater Redox Flow Batteries

- Store grid-scale power and thermal energy (including cogeneration)
- Desalinates seawater and produces exfoliated graphene
- 4-6 hour flow battery charge rate can be discharged at any time
- Stored energy held almost indefinitely and batteries easily recyclable
- Lower energy density than lithium-ion
- 90% round-trip efficiency

## Liquid Metal Batteries

- Have minimal degradation and can last over 20 years
- Extremely reliable but also safe as no gases and no possibility of thermal runaway
- Composed of two molten metal alloys separated by an electrolyte
- Simple to manufacture but require high temperatures to keep metals in liquid state
- Sodium sulphur batteries being used for grid storage in Japan and USA
- Ambri battery uses antimony cathode, calcium alloy anode and calcium chloride salt electrolyte
- Over 80% round-trip efficiency

## Electric Vehicle (EV) Battery Storage

- Millions of EV's could provide large amount of energy storage
- Most EV's charged up at night during electrical grid off-peak hours
- EV's would then utilize excess energy during peak hours
- For cars unused during peak hours, owners could sell back excess power to grid

## Gravity Storage - Lifted Weight Storage (LWS)

- Uses surplus energy to lift solid weights vertically
- When extra energy needed, mass is lowered and pulley turns a generator
- Two projects (168 MWh) deployed since 2023 by Energy Vault in China
- More projects planned
- Up to 86% round-trip efficiency

## Gravity Storage - Rail Energy Storage

- Uses excess electrical energy to haul heavy train cars uphill during low energy demand
- Electrical energy released later using regenerative braking as cars roll downhill
- Utility-scale (50 MW) facility by Advanced Rail Energy Storage
- 86% round-trip efficiency

## Compressed Air Storage

- In 2019, Hydrostor built first CAES facility in world on deserted mine salt cavern near Goderich
- Uses excess grid electricity to produce compressed air stored in cavern
- Stored air released back to atmosphere through air turbine/generator
- Plant can generate 10 MW for about 5 hours at claimed half cost of similar capacity battery
- Can store energy for weeks and offers lowest levelized cost of storage for large-scale applications
- Round-trip efficiency about 67% and has service life of 50 years

## Hydrogen Production

- Excess electricity from grid used to produce "green" hydrogen by electrolysis
- Can be stored and used in fuel cells, engines, or gas turbines/generators
- Several companies working to develop hydrogen-powered cars
- Portable, high energy density fuel
- IESO currently funding hydrogen research

## Flywheel Storage

- Accelerates large mass rotor to high speed and maintains power as rotating energy
- Device shaped like cylinder and contains large rotor inside a vacuum
- Advanced designs have composite rotors suspended by magnetic bearings
- Reaches energy capacity more quickly than other forms of storage
- Long lifetime, requires little maintenance and can be placed almost anywhere
- Many flywheels connected together to create multi-MW storage facility
- Stephantown Flywheel Energy Storage Plant in New York has capacity of 20 MW
- Round-trip efficiency as high as 90%

## Thermal Storage

- Heat storage system uses liquid or solid medium
- Water, sand, rocks or molten salt heated or cooled to store collected energy
- Nevada Crescent Dunes project uses molten salt to store 1,100 MW of power
- Can store that energy for 40 years without degradation
- Round-trip efficiency of 72% - 80%

For more information visit  
[savegeorgianbay.ca](http://savegeorgianbay.ca)