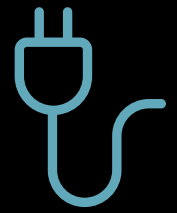
Energy Storage: How to Shape the Future

EEM451 - SAMET BAYAT - 22293730

Why Renewable Energy Storage Matters?!

Enable large-scale renewable energy

Storage is critical to enable large-scale renewable energy like solar and wind that have intermittent generation.



Improve power quality

Storage helps regulate frequency and smooth output from renewables, improving overall power quality.

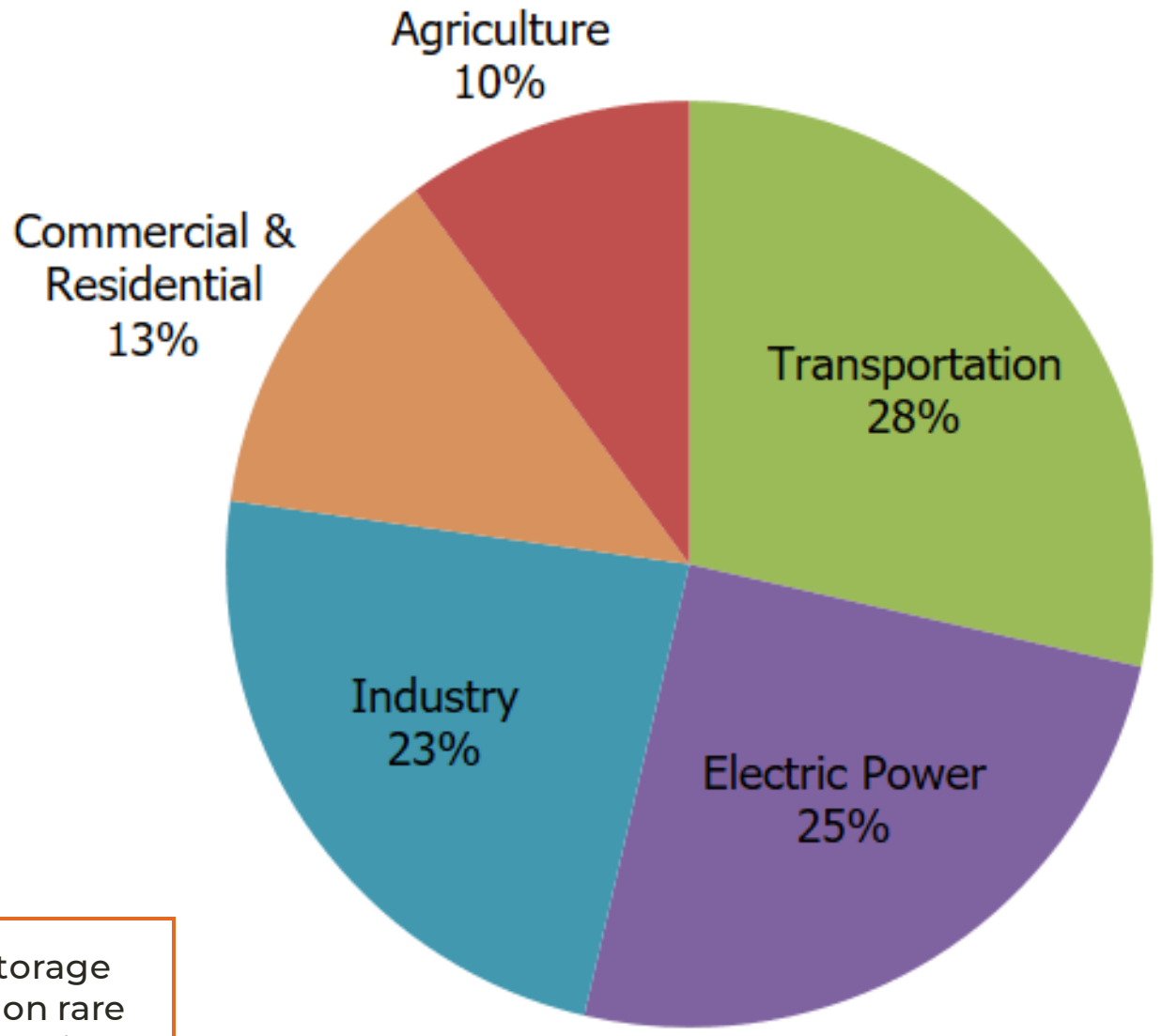
Reduce carbon emissions

By enabling renewable energy, storage helps reduce reliance on fossil fuels and lower carbon emissions.

Provide backup power

Storage can provide backup power during outages and help stabilize the grid.

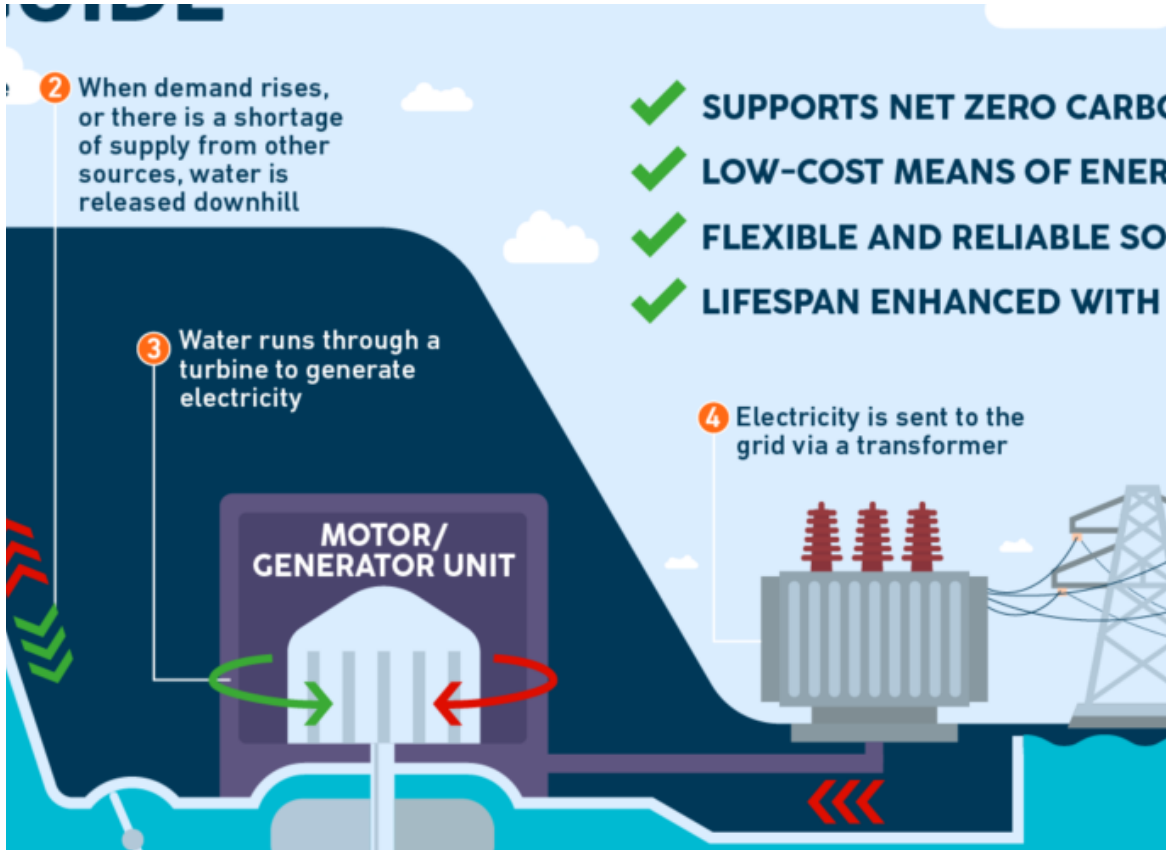
Energy storage is critical to enable the transition to renewable energy. While traditional storage like pumped hydro and lead-acid batteries have limitations, emerging technologies can provide more sustainable and efficient solutions.



Why Carbon Emisson Matters for Energy Storage

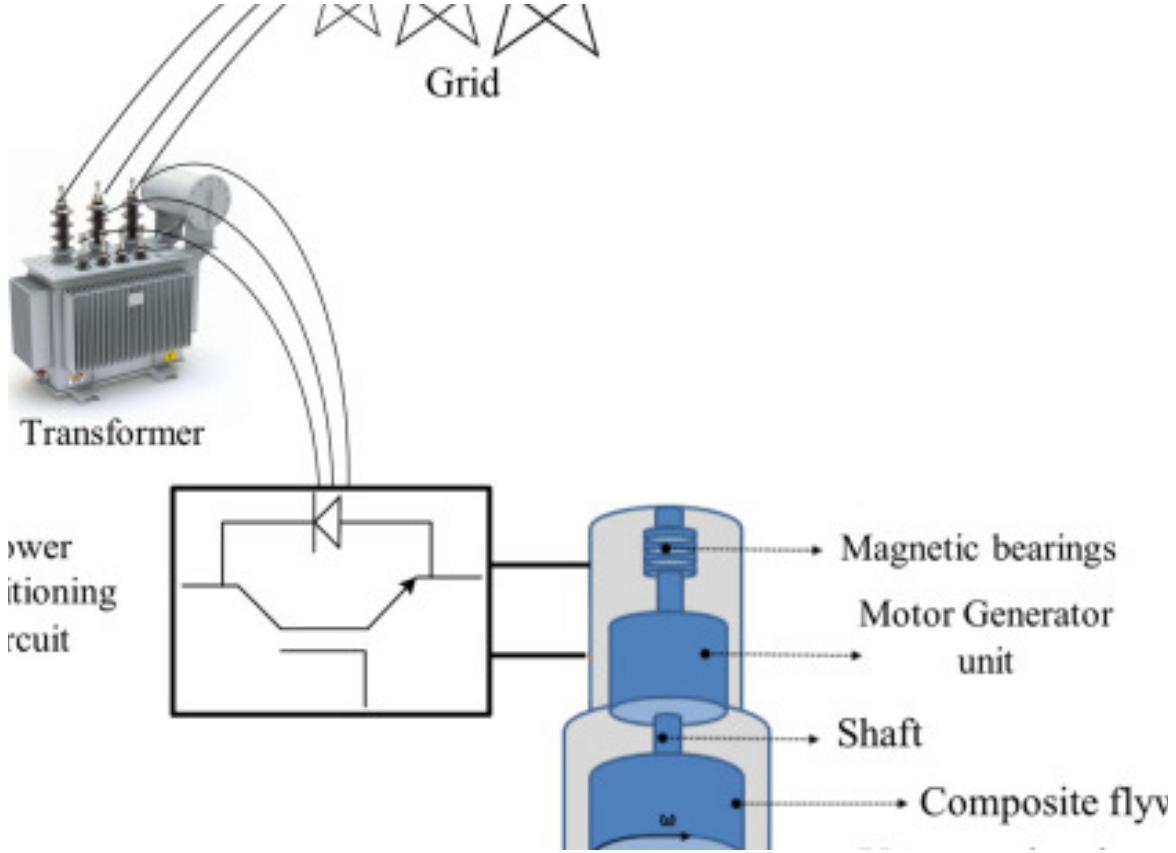
Reducing carbon emissions is crucial for developing energy storage solutions. Batteries and other storage technologies often rely on rare earth metals that have a large carbon footprint to extract and refine. By transitioning to renewable energy sources and improving energy efficiency, we can reduce emissions associated with energy storage.

Traditional Solutions



Pumped Hydroelectric Energy Storage

Pumped hydro facilities store energy in the form of gravitational potential energy by pumping water to an upper reservoir.

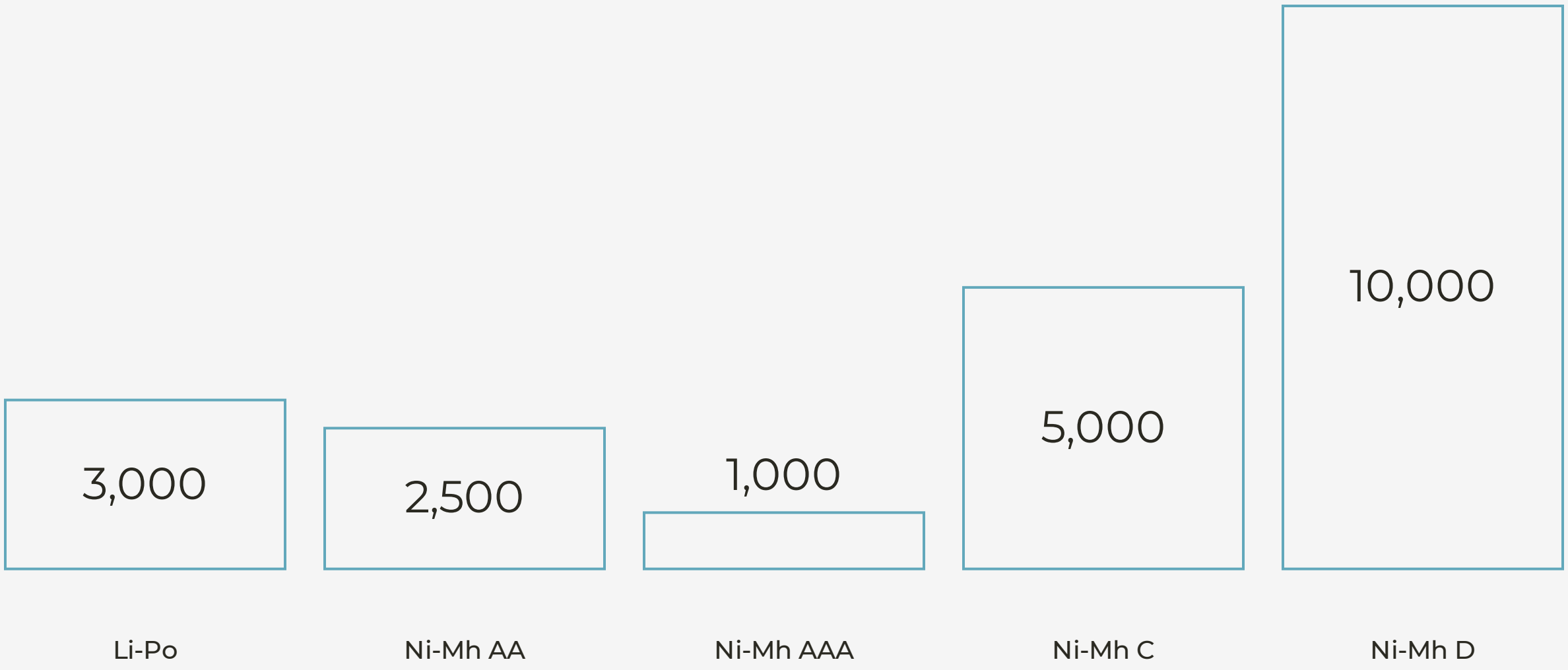


Flywheel Energy Storage

Flywheel facilities store energy in the form of rotational kinetic energy by accelerating a rotor to a very high speed.

Li-Po vs. Ni-Mh Batteries

Battery Comparison (capacity in mAh)



Why Li-Po Batteries Rather Than Ni-MH

Higher energy density

Li-po batteries have a higher energy density than Ni-MH batteries, allowing more energy to be stored in a smaller, lighter package.

Faster charging

Li-po batteries can be charged faster than Ni-MH batteries, often reaching full charge in 1-2 hours compared to 2-4 hours for Ni-MH.

Lower self-discharge

Li-po batteries experience much lower self-discharge than Ni-MH when not in use, retaining 85% of charge for 6 months vs just 50% for Ni-MH.

Li-po batteries are the preferred choice over Ni-MH for most applications due to their higher energy density, faster charging, and lower self-discharge.

Ardahan vs. Chat GPT

ChatGPT's energy use is significant

ChatGPT consumes the electricity of 17 thousand homes per day according to a New Yorker report

This is equal to 493 thousand kWh daily

With average home using 29 kWh per day, 17k homes use 493k kWh per day

That's 15 million kWh monthly

Over 30 days, 493k kWh daily becomes 15 million kWh monthly

Ardahan

Population : around 100k

ChatGPT's energy consumption is very high and solutions are needed to make it more sustainable

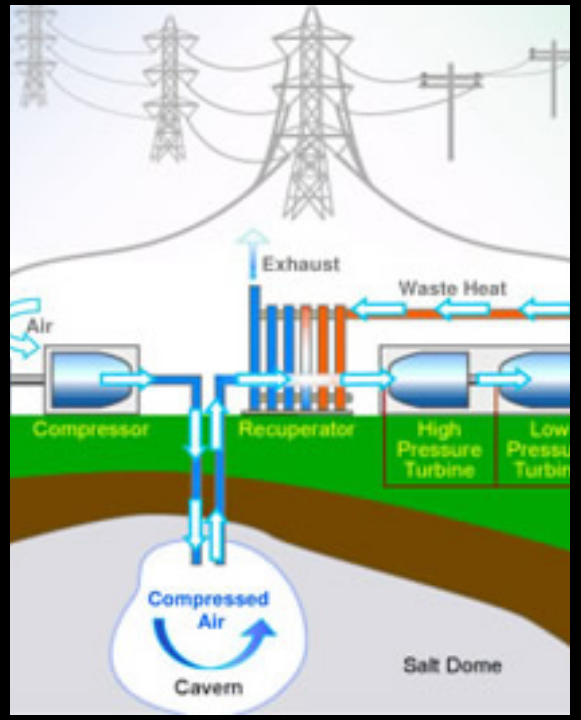
Emerging Renewable Energy Solutions

Sand-based thermal energy storage

Sand heated to high temperatures can store thermal energy for electricity production.

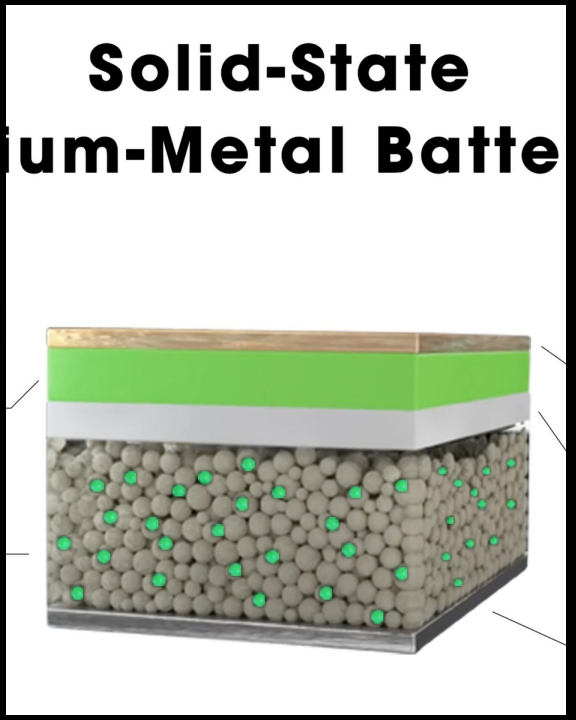
Gravity energy storage

Lifting heavy weights uphill stores potential energy that can generate electricity when released.



Compressed air energy storage

Air compressed in underground caverns stores energy that can drive turbines to produce electricity.



Solid-state batteries

Solid electrolytes enable all-solid-state batteries with increased safety and energy density.

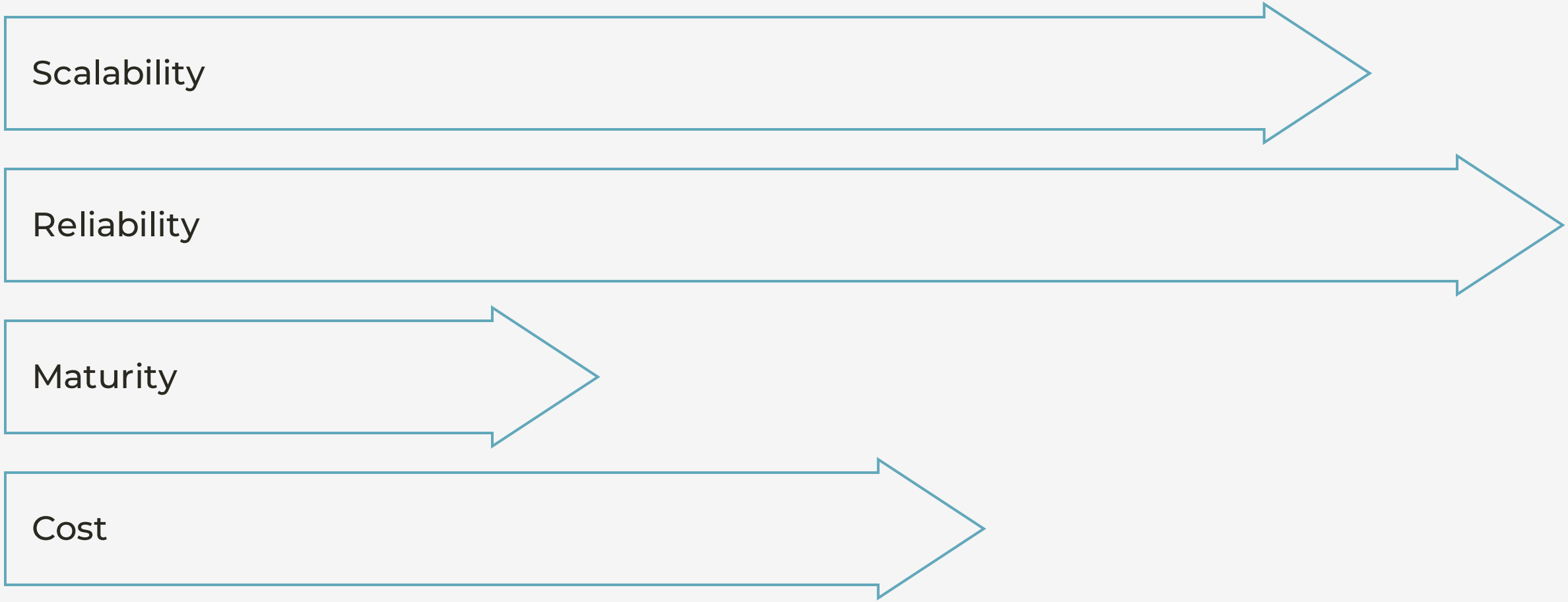
Solid State Electronics

Solid state electronics refers to electronic devices built from semiconductor materials rather than vacuum tubes. Semiconductor devices include transistors, diodes, and integrated circuits. These devices enabled the development of modern electronics by allowing miniaturization and low power consumption.

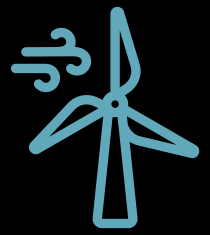
Sand-Based Energy Storage

Sand-based energy storage systems use abundant and low-cost materials like sand to store energy. For example, sand can be heated to high temperatures and the thermal energy stored for later use. Or, sand can be used in gravity-based storage by lifting it to store energy and lowering it to generate electricity.

Gravity Storage

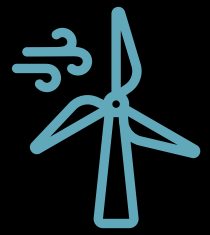


Compressed Air Energy Storage (CAES)



Air is compressed and stored under pressure in underground caverns / depleted gas fields

Excess electricity can be used to run compressors that pump ambient air into storage caverns. This compressed air can later be released and expanded through a turbine to generate electricity.



CAES allows large-scale energy storage to balance renewables

The stored compressed air acts as 'potential' energy that can be released when energy demand increases or supply from renewables decreases.

CAES improves grid stability and load management

The release of stored air can rapidly adjust electricity supply to meet demand, enhancing grid flexibility.

Compressed air energy storage is a mature technology that provides large-scale, long-duration energy storage to complement renewables and enhance grid reliability.


I THINK
YOU'RE
OVERREACTING

Challenges with Electric Car Batteries

- ## Limited driving range

  Most affordable EVs only have a range of 100-250 miles per charge

- ## Long charging times

  It can take over 8 hours to fully recharge an EV battery using a home charger

- ## High costs

  EV batteries are expensive to manufacture. Bringing down costs through advances in battery chemistry is needed.

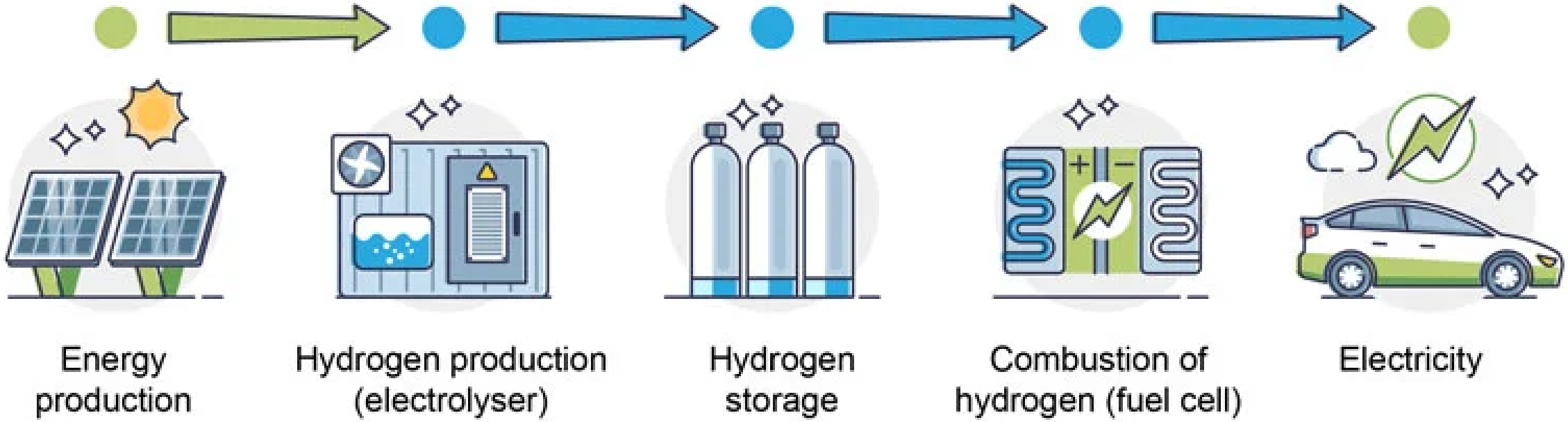
- ## Safety issues

  Some EV batteries have had issues with overheating and fires. Improving thermal management is important.

- ## Limited raw materials

  Many batteries rely on scarce resources like lithium and cobalt. New chemistries could reduce dependence on limited materials.

HYDROGEN ENERGY STORAGE SYSTEM



Conclusion

In conclusion, the future of energy storage holds immense promise, with emerging technologies poised to revolutionize how we capture, store, and utilize energy. As we stand at the brink of a renewable energy revolution, it is clear that traditional solutions are no longer sufficient to meet the growing demands of our modern world while addressing the urgent need to mitigate climate change.