Grid-scale electricity storage
using an innovative form of
Compressed Air Energy Storage

Synergies of Renewables with Storelectric's CAES

There are enormous synergies if Storelectric's CAES is built on or near the output cable of a renewable generation plant of any type. These benefit the renewables developer, grid operator and Storelectric alike. This analysis considers wind and solar in particular.

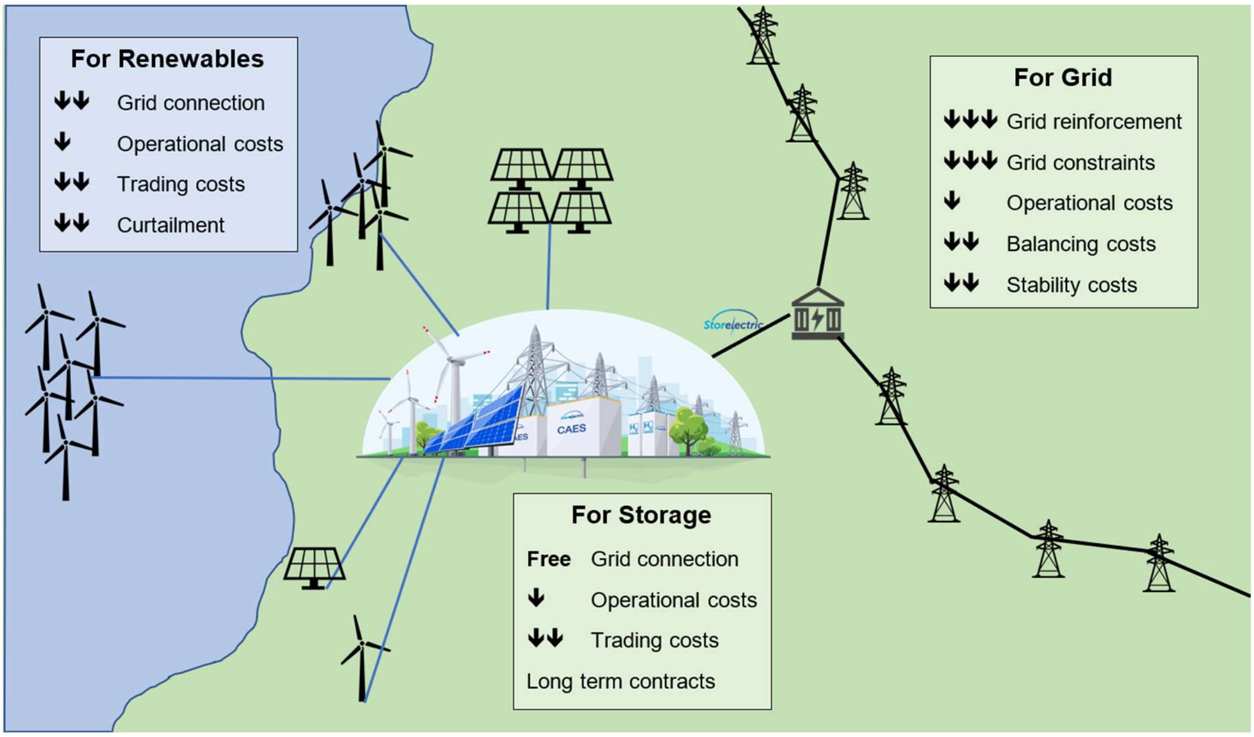
Unblocking the Pipeline

Many large renewable generation projects and interconnectors are stalled because the grid to which they would connect is weak and/or saturated, requiring hugely costly grid reinforcement before the renewables can be connected, which makes the project impractical.

Connecting More Renewables

However, if the renewable generation farm is connected to the grid in conjunction with large-scale long-duration storage (such as Storelectric's), the size of grid connection required is halved for wind or reduced by ⅔ or more for solar – it would be configured for each load case (required supply/demand profile). Put another way, if there is an existing 100MW solar farm, adding 100MW storage would enable the addition of a further 200MW solar farm (100MW if wind farms) to the same grid connection – in addition to improving grid stability (see below). This enables substantial increases in renewable generation even in locations with saturated or weak grids. All of these options benefit the developer in many ways, such as:

- Halving (or more, depending on the technology/ies input and the output demand profile) the size of grid connection –
  - Reduces capital costs for the renewables farm,
  - Proportionate reduction in annual grid connection charges,
  - Greatly reduces the grid reinforcement needed;
- Storage sharing the grid connection with the renewables farm –
  - Eliminating its grid connection costs and annual charges;
- The renewables farm "sells" its energy to the storage, down a "private wire" –
  - Eliminates grid access charges for energy sold by the wind farm,
  - Eliminates grid access charges for energy bought by the storage,
  - Gives a long-term PPA for both;
- The storage adds value-added services for the grid, including –
  - Output energy is dispatchable rather than intermittent,
  - Balancing services such as FRR and FCR
  - Inertia, reactive power/load, black start etc. (see below).



Inertia, Grid Stability etc.

Weak and saturated grids also suffer from low stability. This is often because wind, solar and interconnectors are all DC coupled to the electricity grid, and so have no natural inertia. For this reason, additional renewable generating capacity would merely make the problems worse. Storelectric's CAES is naturally inertial and can therefore greatly improve grid stability, able to be designed with:

- Real inertia 24/7 at twice the rate of an equivalent-sized power station;
- Real reactive power and load 24/7 at ~6x the rate of a power station, and without consuming capacity;
- Voltage / frequency control without consuming capacity;
- Fault (e.g. short-circuit) current protection;
- Black start, if designed in at the outset;
- Curtailment reduction;
- Constraint reduction and reinforcement deferral / avoidance.

Capital and Revenue Cost Savings for All

Storelectric's CAES can enable a renewable plant to reduce its capital and operational costs. In some jurisdictions, this would have to be negotiated with the network operator (who gains by needing less reinforcement). But, with "they" being the solar developer:

- Renewables pay for a fraction of the size of grid connection (well under ⅓ for solar, half for wind) and related grid access charges; the storage plant piggy-backs on that reduced-size connection.
- Generation output is measured at the renewables farm boundary.
- As output goes directly to storage (via private wire), renewables pay no export grid use-of-system charges and levies;
- The energy purchased by storage includes no such charges or levies;

- Storage pays the grid access charges for export.

In summary:

	Renewables Farm	Grid Operator	Storelectric
Grid connection capital cost	⅓ the MW size (for solar; half if wind) of connection and related grid reinforcement	Similar reduction in grid capacity consumption, vastly reduced reinforcement (may be developer's savings, in some regulatory systems)	Zero-capex grid connection; pay for special electrical arrangement
Grid access charges (for size of grid connection)	⅓ (depending on input technologies and required output profile	N/A	Zero
Grid Use of System charges (for electricity sold)	Zero as it sells all to storage via private wire	No charges, but reduces reserved capacity by ⅔ (or half); constraints reduced, grid less saturated and better balanced	Zero for electricity bought. Unchanged for electricity sold.
Imbalance charges	Zero - the storage takes the risk	Less grid imbalance	Unchanged
Other benefits	Less curtailment	Fewer / lower curtailment charges	Deliver higher-value services

There is a configuration (subject to NDA) wherein the energy output of the combined plant is 75-85% (depending on scale) of the output of the renewable farm alone.

Synergies with Interconnectors
When there is no demand across the interconnector, energy can still be transported for future needs if transported into storage. In the same way, it can still be bought and stored for future transportation against future needs.

If solar generation alone is connected to an interconnector, the volume of electricity carried daily can increase roughly 6-fold with storage between the solar farm and the interconnector. At the other end of the interconnector, storage can convert inertia-free baseload input into dispatchable output with natural inertia and reactive power / load.

Additionality; Configurations
All the above benefits are without reference to the many revenue streams of a stand-alone Storelectric CAES plant, and therefore increase their profitability.

Rates and durations of charge / discharge are all independent variables in Storelectric's plants. Different load cases will be optimised by different configurations. The renewable farm's "load factor" (amount of energy generated, divided by the potential if generating at nameplate capacity, 24 hours a day) and the balance between ancillary services, balancing services and baseload output will all affect the specification.

About Storelectric

Storelectric (www.storelectric.com) is developing transmission and distribution grid-scale energy storage to enable renewables to power grids reliably and cost-effectively: the world's most cost-effective and widely implementable large-scale energy storage technology, turning locally generated renewable energy into dispatchable electricity.

- Innovative adiabatic Compressed Air Energy Storage (Green CAES ™) will have zero / low emissions, operate at 68-70% round trip efficiency, levelised cost significantly below that of gas-fired peaking plants, and use existing, off-the-shelf equipment.
- Hydrogen CAES ™ technology converts & gives new economic life to gas-fired power stations, reducing emissions and adding storage revenues; hydrogen compatible.

Both technologies will operate at scales of 20MW to multi-GW and durations from 4 hours to multi-day. With the potential to store the entire continent's energy requirements for over a week, global potential is greater still. In the future, Storelectric will further develop both these and hybrid technologies, and other geologies for CAES, all of which will greatly improve storage cost, duration, efficiency and global potential.

About the Author

Mark Howitt is Chief Technical Officer, a founding director of Storelectric. He is also a United Nations expert advisor in energy transition technologies, economics, regulation and politics – invitation here.

A graduate in Physics with Electronics, he has 12 years' management and innovation consultancy experience world-wide. In a rail multinational, Mark transformed processes and developed 3 profitable and successful businesses: in commercialising a non-destructive technology he had innovated, in logistics (innovating services) and in equipment overhaul. In electronics manufacturing, he developed and introduced to the markets 5 product ranges and helped 2 businesses expand into new markets.