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

Emissions Benefits of Storelectric's CAES

This report analyses the emissions benefits (avoided emissions) of Storelectric's TES CAES and CCGT CAES plants. For CCGT CAES, a methane-fired version is considered; if hydrogen-fired, then the figures for TES CAES apply approximately. For ease of scaling, the figures are based on a 1GW 5-hour (=5GWh) plant of each type. Figures are in tonnes of CO_2e (carbon dioxide equivalent) savings.

These figures are based on[1] those previously been accepted by ENTSO-E and the European Commission within their Projects of Common Interest programme[2]. But they do not evaluate all the benefits because OCGTs are not as broadly capable as Storelectric's plants. For example, un-evaluated benefits (and reasons) include:

- 24/7 inertia (would be provided by a synchronous condenser / flywheel);
- Grid reinforcement avoidance / constraint management (would be provided by building more grid lines and substations);
- These figures assume stand-alone plants. Putting Storelectric's CAES between generation and the grid increases the throughput energy to ~75% of generated energy for offshore wind, rising to 80-85% for solar (TES CAES; CCGT CAES benefits are roughly ¼ of this.

	Storelectric TES CAES & hydrogen CCGT CAES 1GW, 5GWh	Storelectric CCGT CAES (methane) 1GW, 5GWh
Total tCO_2e savings p.a.	**2,220 million**	**743 million**
Compared with OCGT[3]	1,633 million	604 million
Curtailment avoidance[4]	297 million	110 million
Up-lift from location[5]	290 million	29 million

[1] These figures are 3.6 times the figures in the PCI sheets as those were based on (a) smaller plants and (b) 5 hours per day operation against 9.7 hours for maximum utilisation (comparing like with like, as all promoters base their performance figures on maximum / optimum utilisation). Location uplift was not included in PCI calculations as those were for stand-alone plants.

[2] Calculations based on comparing the plant with the emissions from delivering similar services from an Open Cycle Gas Turbine (OCGT) power station, which is usually used for peaking services. They assume maximum CAES plant utilisation, 9.7 hours per day for a 68% efficient plant. UK government figures (460t/MWh) are for CO_2 emissions EU figures (481 t/MWh) are for all CO_2e emissions;

[3] 350 days/year x 9.7 hours operation. Average carbon emissions intensity of an OCGT is 481 tCO_2e/MWh. CCGT CAES uses gas for 73.26% of its output energy, therefore emissions benefits are 37% of those of TES CAES – though its emissions drop to zero if hydrogen powered; CCGT CAES is dual-fuel and therefore will burn hydrogen when available at suitable volumes and costs.

[4] 3.6TWh were curtailed in 2020, when we had 10.5GW wind. Reducing this by 75% would require ~5GW of suitably located Storelectric CAES (this % would increase if CAES duration were increased). Benefits per GW storage are therefore 3.6TWh /5 x 75% x OCGT emissions. To deliver an 80GW grid (FES 2020 forecast) by 2050, we assume (conservatively) that this will increase pro rata: conservative because the greater the proportion of renewable generation, the more "peaky" grid energy becomes. Stability issues (largely due to lack of natural inertia etc.) also multiply disproportionately.

[5] This up-lift is for putting Storelectric's TES CAES between generation and the grid. Assume 78% throughput (i.e. mostly wind, some solar); this is a 15% increase in all other emissions savings for TES CAES; 4% for CCGT CAES.

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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.