Survey of Global Renewable Technologies

I am sometimes asked: which renewable generation and storage technologies are truly scalable globally? So I thought I'd list the ones that come to mind.

Generation: solar photovoltaic, solar thermal, wind (both offshore and onshore), tidal range (barrages), smaller amounts of waste-to-energy.

Storage: adiabatic CAES (Compressed Air Energy Storage) such as Storelectric's, small (domestic) and medium (local area) scale heat storage. Pumped hydro, in the few locations where it's cost-effective, doesn't flood important land, and CAES can't be built; liquid air has the same conditions but higher costs and smaller scale.

Zero carbon but not strictly renewable: nuclear fission, provided environmentalists permit the permanent disposal of its waste somewhere, especially vitrified and placed in mines below the sea bed.

Fewer locations: hydroelectricity (but it causes big problems in rivers and river basins), tidal flow (turbines).

Very limited: biomass, geothermal (but I don't like the idea of cooling the earth's core), CCS generation where co-located with an industrial cluster that needs lots of CCS - though this last one isn't either renewable or particularly green (unless on a biomass plant) as it only captures up to ~80% of emissions.

We should add to this list the non-generation technology of Demand Side Response (DSR), which also goes under numerous other euphemisms such as Smartgrid and Super-Users. This involves turning off / down demand when needed, and making up for it later (or earlier). Used appropriately for short durations (10–30 minutes), the capacity for this is ~2% of the grid's generation capacity (~6% split into three tranches to use more than once during a short number of hours) for non-vehicle-charging; for vehicle charging the proportion and durations are significantly (maybe 3x) greater. To this extent it is the most cost-effective "generation" technology that exists; to a greater extent it becomes rolling brown-outs.

Interconnectors have their place too. They can only be relied upon for imports where the country at the other end of the interconnector has sufficient dispatchable (= on-demand) electricity to earmark for the other country; otherwise a reliance is bound to lead to black-outs. Apart from that, their proper place is to keep electricity generation prices low by adding to competition in each country.

Unlikely ever: tidal lagoons (3x the cost of a barrage, with much more limited energy output), wave (too hostile and variable an environment).

Joker in the pack: nuclear fusion, which has been 40 years away for the last 50 years - and still is. Progress is being made, but the sheer scale of the task is a little better appreciated. Maybe - one day.

Some will say electrolysed hydrogen, but that's not a generation technology - it uses generated electricity. It has a big future as an "energy vector", though, when large-scale electrolysis (not PEM - too small and expensive) is mastered and cost-controlled.

In storage I have NOT listed batteries:

- The earth's crust doesn't have enough lithium to back up the world's grids, or to power the world's vehicles - let alone trying to do both AND power the world's portable devices;
- Other batteries (lead-acid, sodium etc.) have more plentiful elements, but big disposal / recycling issues that (as lithium, together with their mining, refining and manufacture) take too much energy and cause too much pollution;
- Flow batteries are essentially swimming pools full of concentrated acid, not very environmentally friendly or scalable.

Nevertheless, batteries do have a valid contribution to make - that contribution just needs working out before we waste the world's scarce resources on what's not needed. For example, the killer benefit of lithium batteries is power density per volume and per weight - so why use it in fixed-to-ground applications where neither is needed?

A grid built and operated with an appropriate mix of these will be as reliable and cheap as today's in most parts of the world – and often cheaper and more reliable. Note that the "appropriate mix" will vary from place to place. And that there is no "best" technology: all are needed to power tomorrow's world.

About Storelectric

Storelectric (www.storelectric.com) is developing truly grid-scale energy storage using an innovative form of Compressed Air Energy Storage (CAES). This uses existing, off-the-shelf equipment to create installations of 500MW, 2-21GWh with zero or low emissions, operating at 68-70% round trip efficiency, at a cost of £350m (€500m) (estimated for 3rd – 5th plant), and a levelised cost cheaper than that of gas-fired peaking plants (OCGT). Capex is one-third that of pumped hydro per MW and 1/75th per MWh; similar to 10-year target prices of batteries per MW and less than 1/1,000th per MWh. There is potential in the UK to store the entire continent's energy requirements for over a week; potential in mainland Europe and the USA is greater still, with global roll-out planned.

The next stage is to build a 40MW, 200MWh pilot plant with over 62% efficiency (grid-to-grid), using scale versions of the same technology, for which Storelectric is currently raising funds. Construction will take 2-3 years from funding, and the first full-scale plant a further 3-4 years. The consortium includes global multinationals who cover all the technologies involved, their installation, financial and legal aspects.

Storelectric has a second technology, CCGT CAES, which is the only CAES technology that is retro-fittable to a suitably located gas-fired power station (either CCGT or OCGT). As such it is a very good value technology that can almost halve emissions and add storage-related revenue streams, giving new life to stranded assets. It is an excellent transitional technology.

In the future, Storelectric will further develop both these and hybrid technologies, and other geologies for CAES.

About the Author

Mark Howitt is a founding director of Storelectric. He leads Storelectric's technical and operations, minimising technological risk, maximising efficiency and environmental friendliness, and speed to market. His degree was in Physics with Electronics. He has 12 years' management and innovation consultancy experience world-wide. In a rail multinational, Mark developed 3 profitable and successful businesses: in commercialising his technology, in logistics and in equipment overhaul. In electronics manufacturing, he developed and introduced to the markets 5 product ranges and helped 2 businesses grow strategically.