Vehicle to Grid and Shared Mobility

Vehicle to Grid (V2G) and Shared Mobility are two of the big buzz-phrases rolled out in the transportation sector, as magical solutions to energy storage needs of the grid (V2G) and to all the woes of transport-related climate change. They have both advantages and disadvantages which need to be considered in planning and policy making.

Vehicle to Grid

This is the use of vehicle-mounted batteries to supply peak grid power demand, charging at off-peak times.

- Some countries' energy transition plans assume that all the cars in the country, if turned into EVs that are 100% used for grid-connected storage, would account for only a part of the storage needs – they consume similar amounts of energy to the entire electricity grid, with only a 2- 4-hour range, only half of which at most (if the system works flawlessly) would be available to the grid. Therefore it lacks the duration to provide true back-up for renewables.
- Where they charge from solar power (office, shopping), which is the proffered model, differs from where they would operate as grid-connected batteries, and nobody has proposed a cost-effective model for the financial flows.
- Most people don't want their vehicles on less than half charge, which halves (or less) the energy/storage available.
- The bulk of the need for the storage is in the evening, when vehicles' charge is lowest, yielding a grossly disproportionate multiplication of point 3.
- If the 40-60 gigafactories currently planned world-wide are built, they would exhaust the lithium deposits in all current and under-development fields in 2-10 years according to figures from The Economist[1]. Cobalt and other "rare earth metals" are in much shorter supply.

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[1] https://www.economist.com/news/briefing/21726069-no-need-subsidies-higher-volumes-and-betterchemistry-
are-causing-costs-plummet-after -

Electric Vehicles, 2016		25 GWh	750,000 vehicles
Mid-range:	2040 Bloomberg	15,500 GWh	465,000,000 vehicles
	2040 OPEC	5,000 GWh	150,000,000 vehicles
	2040 ExxonMobil	3,000 GWh	90,000,000 vehicles

Total lithium mined, 2016		180,000 tonnes in one year
	2040 Bloomberg	111,600,000 tonnes in one year, just for vehicles
	2040 OPEC	36,000,000 tonnes in one year, just for vehicles
	2040 ExxonMobil	21,600,000 tonnes in one year, just for vehicles

Total available lithium in planet 210,000,000 tonnes
Years' output: 2040 Bloomberg 1.9 years, just for vehicles

- To roll out cars-with-solar widely, a high proportion of the parking spaces in the country would have to be fitted with chargers - who would bear the cost of that?
- Distribution grids need upgrades at enormous cost and ahead of actual demand in order to accommodate variability between forecast and actual EV take-up.

The above-listed challenges would need to be answered for V2G storage services to be reliable. And it appears that FES 2019 assumes 100% efficiency in V2G services, which will not be attainable: a perfectly new battery requiring no cooling yields ~96% efficiency, whereas one approaching its end of life yields ~75%, so a reasonable assumed average efficiency would be ~85%; then there are converter efficiencies – 90% is reasonable[2], which has to be applied twice – once for charging and once for discharging. The total round-trip efficiency is therefore .85 x .9 x .9 = 0.6885 or 69% round trip.

Shared Mobility

Shared mobility means that, instead of owning vehicles, we call them up. They are fully autonomous, driving themselves to where you are to take you wherever you wish to go.

Advantages:

1. Fewer vehicles in existence. But that will not be apparent because the greater mileage (see below) will mean that more of them are on the road at any one time.
2. People will not have to buy a vehicle, they'll just hire one for the journey like a cheap-rate taxi.
3. Cheaper than taxis as it's based on autonomous vehicles.

Disadvantages:

1. More vehicles on the road and more mileage driven per annum overall: if privately owned vehicles take 3 people to work, that's 3 journeys in the morning. A shared vehicle needs to go from work place 1 to home 2, from workplace 2 to home 3, and then from workplace 3 to workplace 1 to take the first guy home. So it doubles the number of journeys - though good scheduling will mean it doesn't double the mileage, but mileage is still increased substantially. This in turn will lead to much more emissions unless and until the energy system is zero-carbon - and increase the cost of making it so.
2. Unpredictable vehicle: you won't know what you'll get or what condition it'll be in.
3. Can't keep your stuff in the vehicle / pre-load vehicles for journeys / postpone unloading.

[2] https://www.electronicdesign.com/power/understand-efficiency-ratings-choosing-ac-dc-supply graph

4. Shared vehicles: would you like to share substantial journeys with complete strangers, in close confines? Would you like your children / daughters to? You can't security vet everyone - and if you could, how would those who fail the vetting get around? And there's no way at all to vet whether the other guys are nice or obnoxious, sober or drunk, well-washed or not.
5. Will greatly reduce the use of public transport, thereby increasing emissions and making many services un-viable.

The Challenge

The challenge for policy-makers is to show a viable solution to all these issues; only then can we accept that V2G and Shared Mobility will benefit the system and the population as a whole.

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.