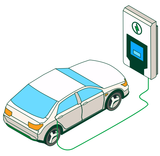
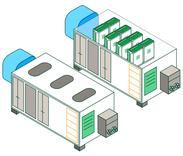
Advantages and challenges of electrical energy storage technologies

Energy storage will be key to the future of electrification and decarbonisation. This technology will not only be available to large industries, but users can also operate it at the user level, creating a decentralised network that allows self-consumption through renewable energies.

V2G	BESS	Virtual batteries
		
What is it?		
Use of the electric vehicle battery to **feed into the grid (V2G)** or power internal loads **(V2H/V2B)** through bidirectional charging and control.	**Stationary physical battery** (usually Li-ion) with inverter, protections and control system (EMS).	It is not physical storage: **it is a compensation/ surplus "wallet" mechanism** (kilowatt-hours or €) with a retailer or in a similar scheme.
Type of storage		
EV battery (mobile and primarily used for transport).	**Dedicated battery** (fixed, sized for cycling).	**None** (only energy/ economic accounting).
Required installation		
Bidirectional charger + protections + Energy management system (EMS) and compatible EV.	Battery + inverter/PCS + battery management system (BMS) + protections + metering + EMS.	**Smart meter and contract with supplier** (no additional equipment, except PV if there are surpluses).
Initial investment		
Medium: bidirectional charger + integration + electric vehicle.	**Medium-high:** battery + power electronics + installation.	**Low or none**: normally only change/registration of contractual service.
Main benefit		
Flexibility and optimisation using an existing asset; potential for networks services where permitted.	**Savings through self-consumption**, time arbitrage, peak shaving, supply quality and resilience.	**Maximise the value of surpluses without a physical battery;** administrative simplicity.
Maintenance		
Medium: charger maintenance.	**Low to medium**: maintenance, monitoring, possible long-term replacements.	**Low**: costs included in the contract terms.
Power		
Limited by the charger and connection; typically several kilowatts, depending on the EV model.	**Scalable**: from residential to hundreds of kilowatts to megawatts in buildings and industry.	**Does not store power,** only compensates
Energy availability		
High potential, but only if the car is connected and has available charge. The charge can be moved to another V2G-enabled location.	**Limited to battery size and available charge.** Fixed in space.	**Not applicable** (does not store energy).
Efficiency		
High: with losses in AC/ DC conversion (depending on the system).	**High:** depends on chemistry, inverter and strategy (round-trip).	**Not applicable** (does not need to convert or store energy).
Back-up		
Possible in well-designed V2H/V2B and if the EV is present; pure V2G does not imply backup by itself.	**Very good if the BESS includes a backup/** island function and is correctly configured.	**None:** does not maintain supply during outages.
Key restrictions		
EV — charger — regulations compatibility; car availability; impact on battery/warranty; permits if exported to networks.	**Space, electrical permits, initial cost;** degradation and end of life; correct sizing.	**Total dependence on commercial conditions** (limits, expiry, surplus value, contractual compatibility).
V2G	BESS	Virtual batteries