Increases in Solar and Wind demand storage. Are Electric Vehicles an option?

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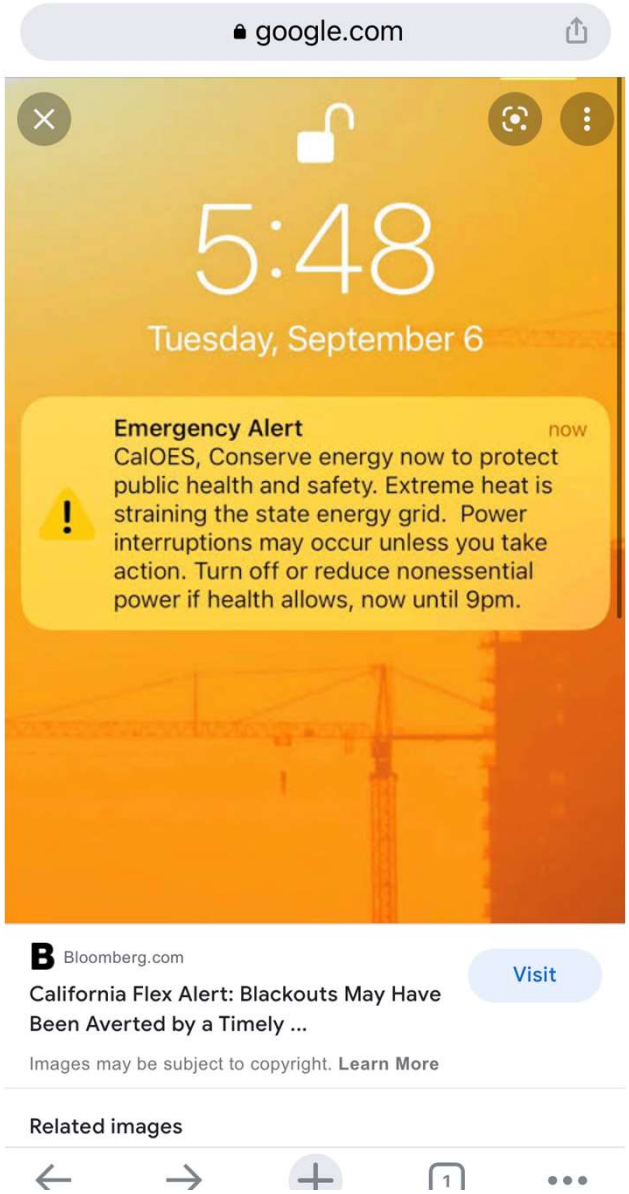
PQ Synergy

September 2022

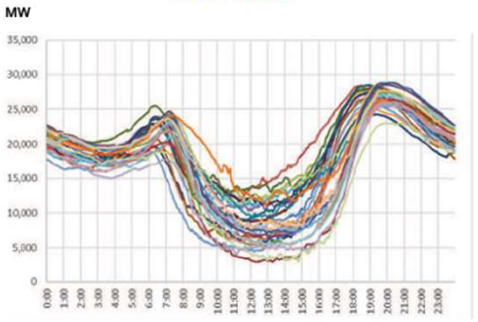
Emergency alert sent to 27M mobile phones in California



Clean Energy is growing fast.

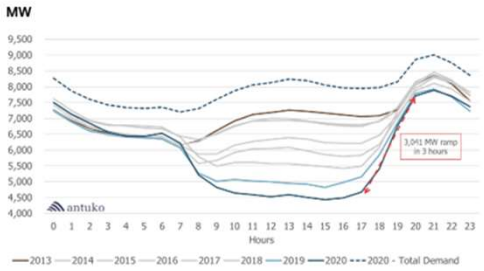
- **Wind and solar generated 10% of global electricity in 2021.**
- **Solar & Wind Account for Two Thirds of Global Power Capacity addition by 2030**
- **Australia already seeing negative demand.**
- **Denmark sometimes generates enough wind power to cover the whole country's demand.**
- **Different countries different demand curve.**

CALIFORNIA



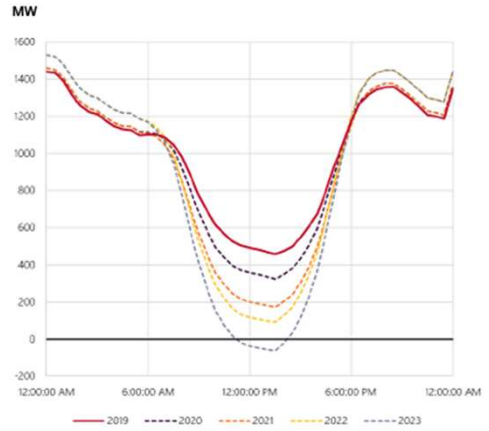
Daily Net Load Forecast for March 2021[1]
Each line represents the Net Load (MW) of a Day in March 2021.

CHILE



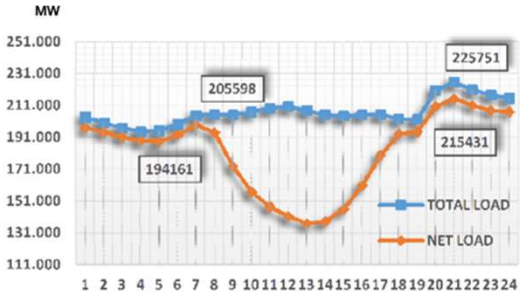
Hourly Net Demand in Chile (Sunday, October)[4]

AUSTRALIA



Effect on South Australian Demand from Increasing Distributed PV Generation[5]

INDIA

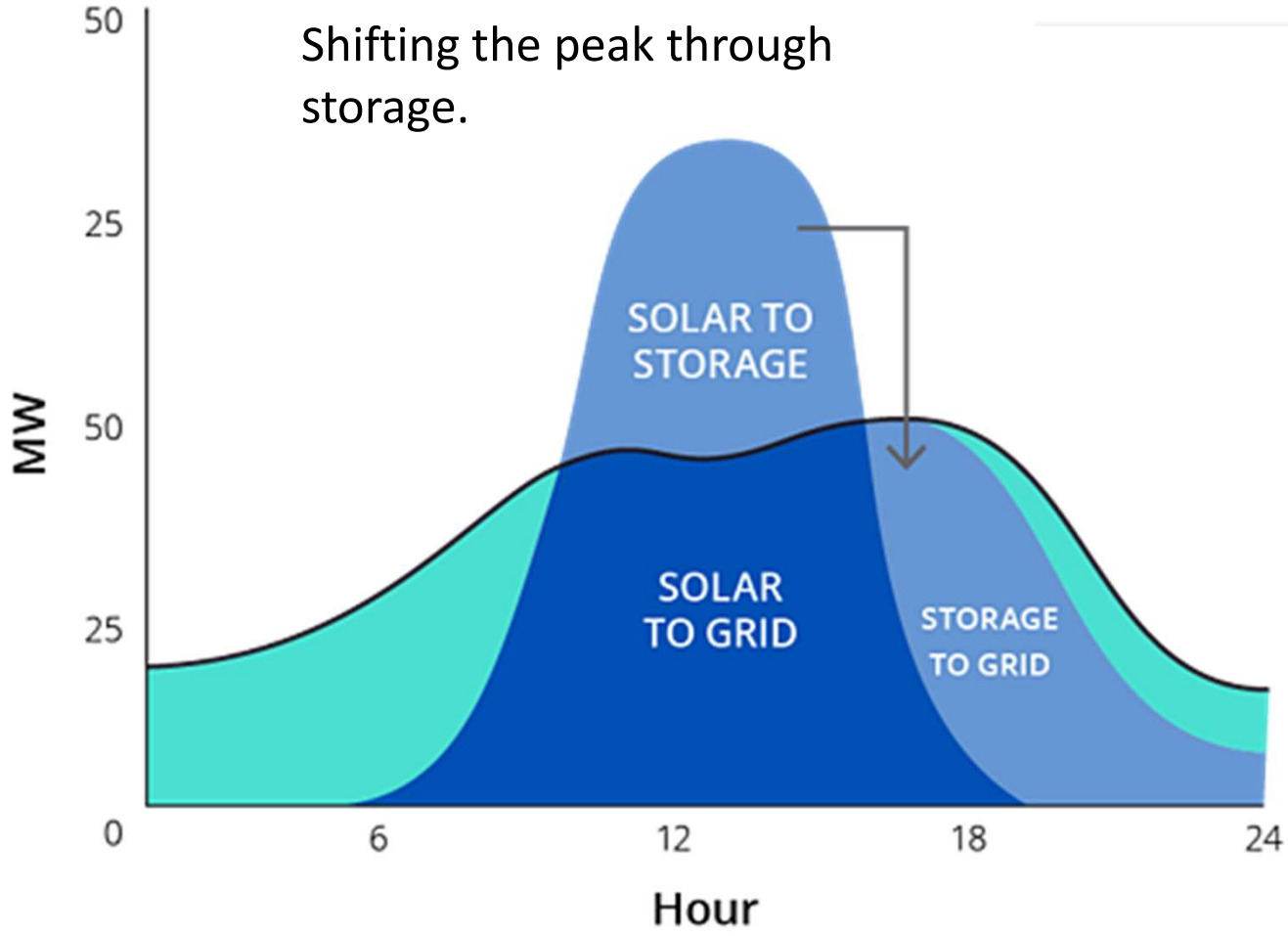


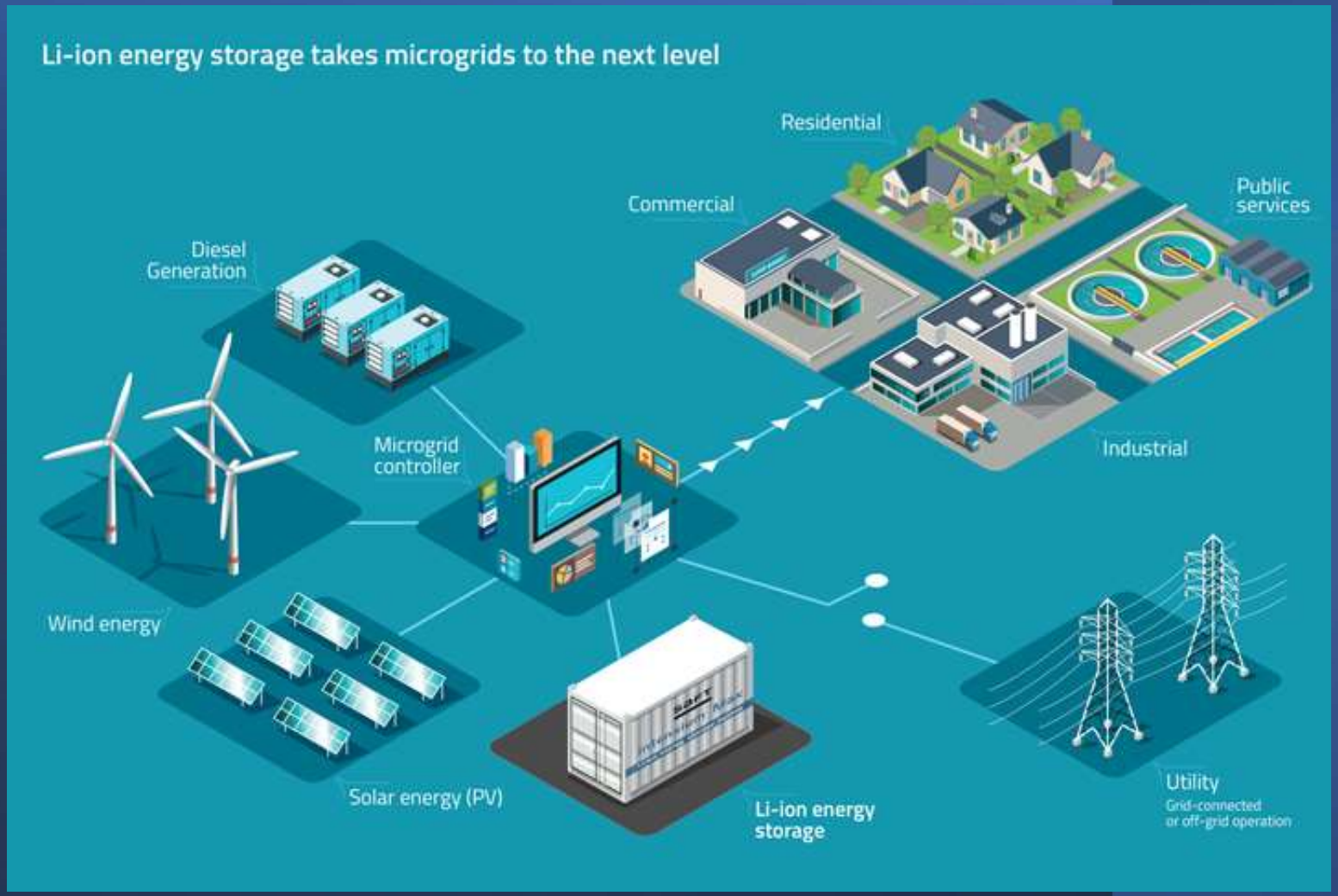
Project Hourly Load and Net Load in India (2021-2022)[6]

Solar will create excess energy mid day. (Negative demand)

- Shifting power through storage is needed for both wind and solar.
- Li Batteries are current leaders.
- Flow batteries , pump storage and fuels cells will play a role also.

Shifting the peak through storage.

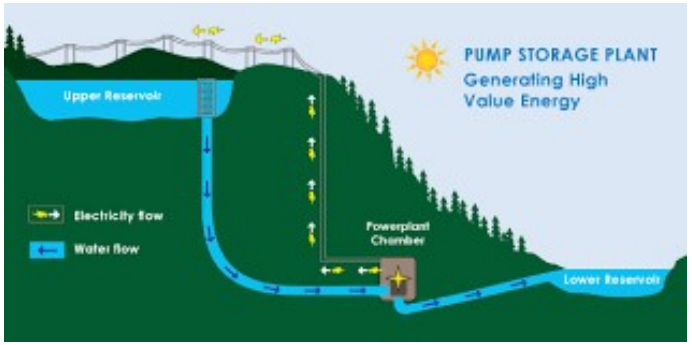



Li-ion energy storage takes microgrids to the next level
Residential
Commercial
Public services
Diesel Generation
Microgrid controller
Industrial
Wind energy
Solar energy (PV)
Li-ion energy storage
Utility
Grid-connected or off-grid operation

Clean energy > Need more storage

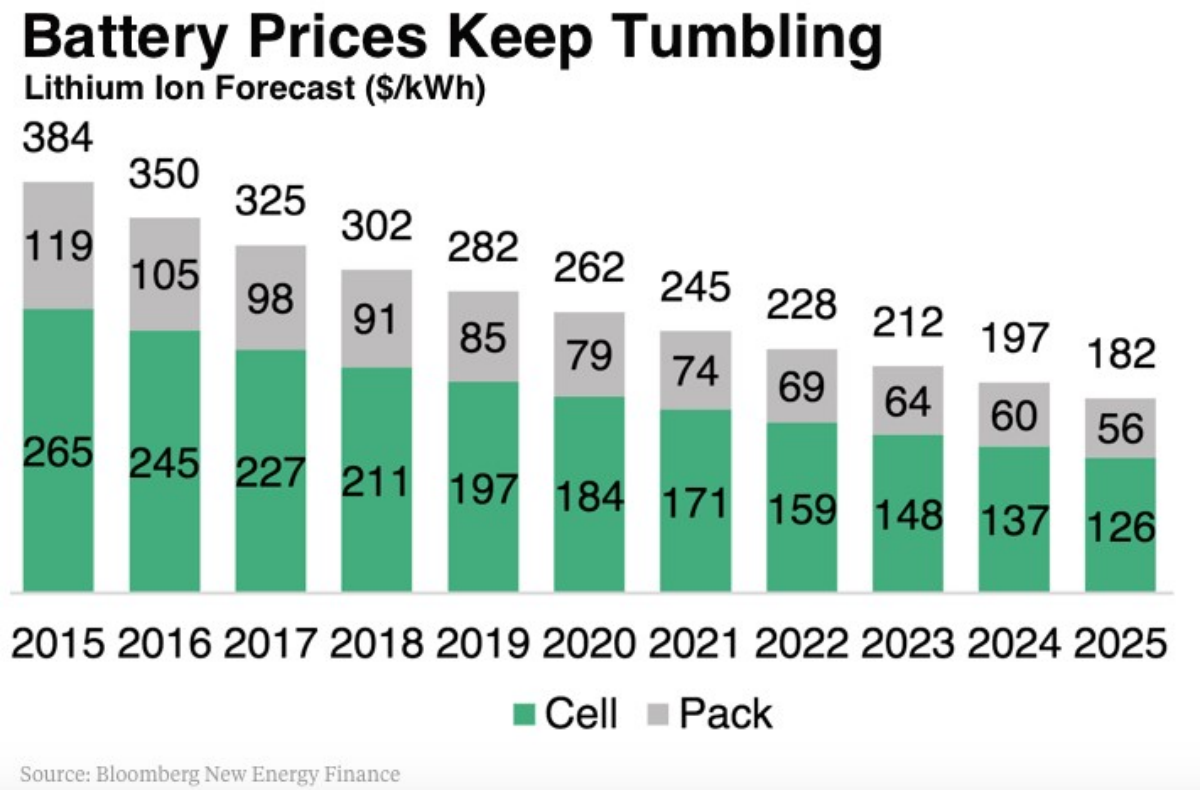
- The global energy storage market is slated to attract ~$1 trillion in new investments over the next decade.
- The US market could attract over $120 billion in investment and achieve growth rates of 32% CAGR thru 2030 and 15% CAGR thru 2050.
- Lithium-ion will continue to dominate the market, but there’s no one-size-fits-all.

Storage options

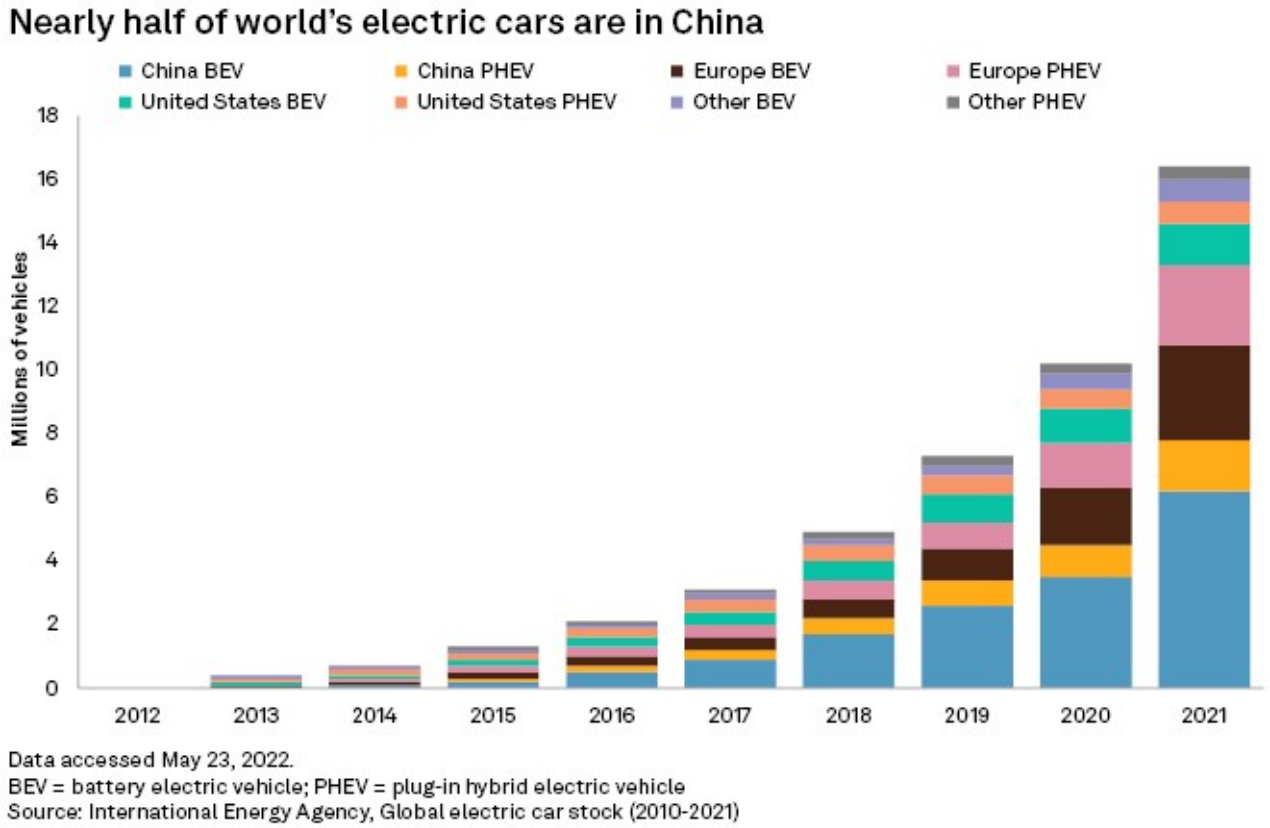


- Very large battery banks near solar farms and Utility sub-stations.
- Home batteries. (ex. Tesla and Nissan)
- Pump stations, where water is pumped up and down to store energy.
- Electric car batteries will be part of the solution; but there are issues.
  - V2G (Vehicle to Grid). Using car batteries for storage when the car is parked.
  - Used Li batteries from cars are refitted for power banks.

- Li ion batteries are now competing with peak gas turbines.

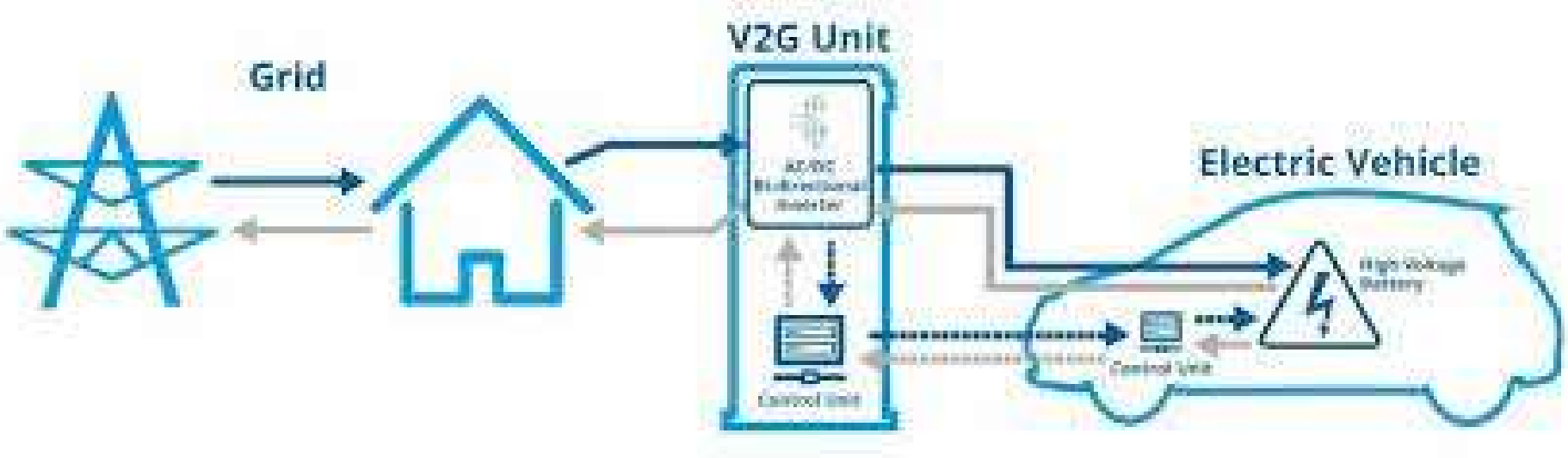


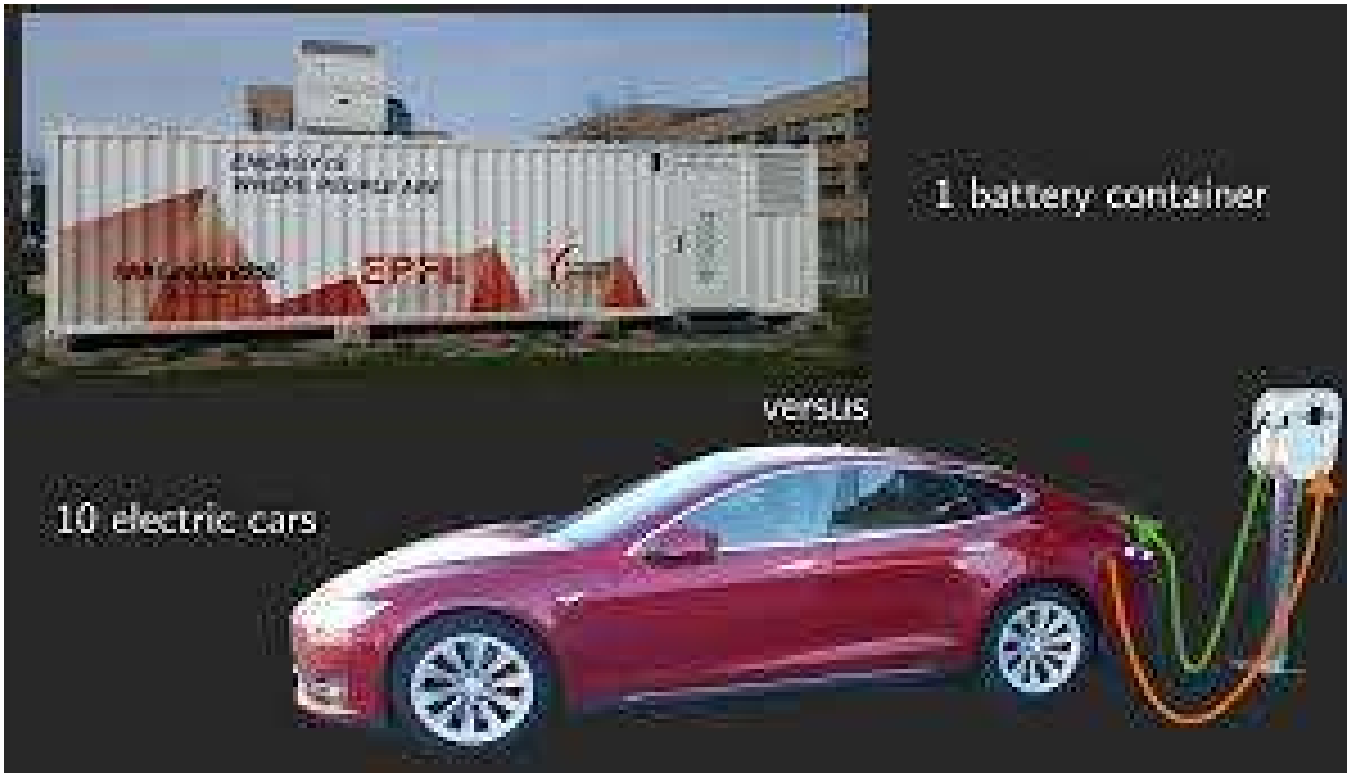
Electric Vehicle sales are growing fast due to incentives and mandates. By 2035 no petrol cars will be sold in California and many European countries.



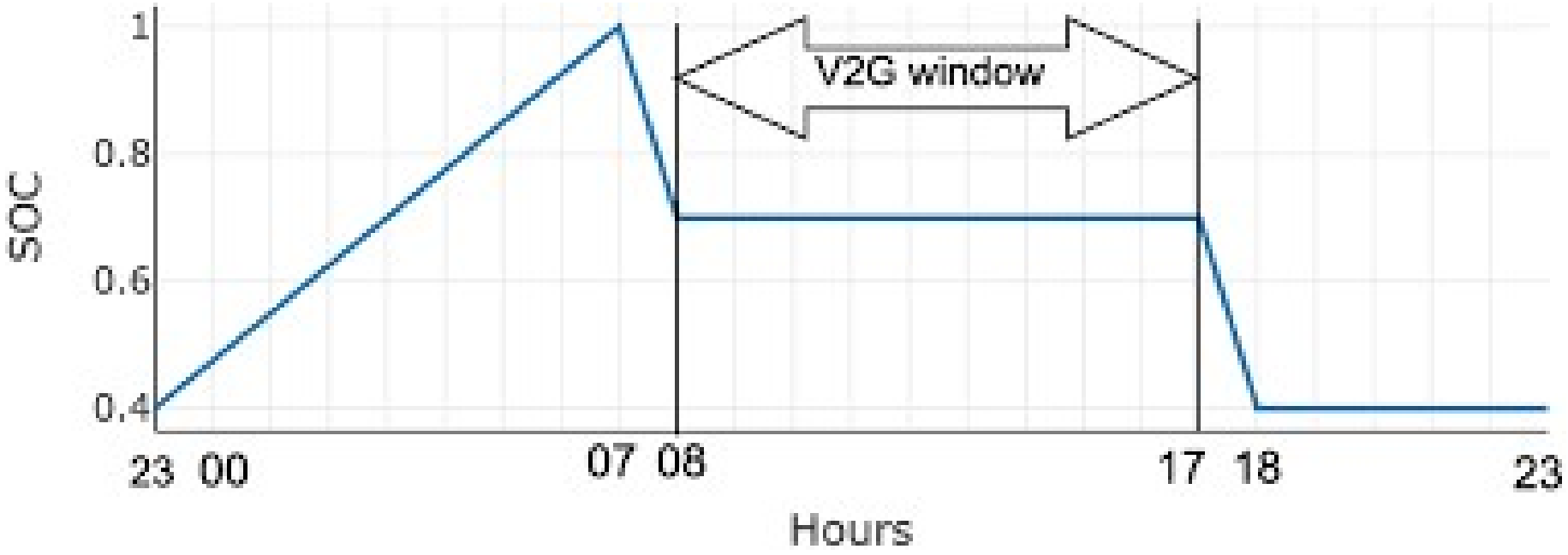
V2G

Vehicle to grid (V2G) storage is going to be multi B$ industry.




1 battery container
versus
10 electric cars

G2V and V2G



Estimated Capacity by 2030

- Over 1 TWH of potential V2G storage
- U.S. uses .45 TWh/hour on average (.45TW)
- World average 2.6 TW

Estimated Battery Capacity from V2G by 2030

Estimated Battery Capacity From V2G (2030)	Units	Global	US
EV Population			
(a) Total Vehicles (ICE, PHEV, BEV)	vehicles	1,786,734,404	322,842,325
(b) = (a) x (d) Total BEVs	vehicles	170,702,622	29,311,500
(c) = (b) x (e) Total BEVs with V2G Participation	vehicles	21,337,828	3,663,937
Participation Rates			
(d) EV Participation Rate (BEV)		9.6%	9.1%
(e) V2G Participation Rate		12.5%	12.5%
EV Mileage			
(f) Average EV Mileage	mi	300	300
(g) Mileage Reserved for Driving	mi	50-100	50-100
(h) % Mileage or Battery Capacity Reserved for Driving		16.7%-33.3%	16.7%-33.3%
Battery Capacity			
(i) % Mileage or Battery Capacity Reserved for Grid Use		66.7%-83.3%	66.7%-83.3%
(g) Battery Capacity Per EV	kWh	70-80	70-80
(k) = (j) x (i) Battery Capacity Reserved for Grid Use, per EV	kWh	47-67	47-67
(l) = (k) × (c) Battery Capacity Reserved for Grid Use, Total EVs	GWh	996-1423	171-244
Midpoint	GWh	1,209	208

References: ICE: Internal combustion engine; PHEV: plug-in hybrid electric vehicle; BEV: battery electric vehicle

Source: RBC Capital Markets estimates

V2G issues and opportunities

- Pilot projects have already shown that vehicle-to-grid (V2G) could be a viable distributed energy source in the future.
- V2G holds promising benefits for utilities, consumers and regulators. Regulators need to allow incentives to consumers.
- A key hurdle to commercialization lies in restrictive battery warranties, which stop their use in V2G projects.
- Utilities will be working more closely with the automakers, EV supply equipment manufacturers, and EV operators to help share risk and reduce capital needs.

California public Utility commission approves protocol for submetering of EVs

- Submetering makes EV charging cheaper and encourages off peak charging.
- The special rate structures is applicable to EVs for less costly power during off-peak times
- The submetering also should allow EV charging to participate in V2G demand response programs by decreasing the electric vehicle charging load or feeding power back into the grid.
- The decision sets a 1% accuracy requirement for the submeters and also specifies the connector and communication requirements for the charging equipment, which are consistent with recently approved California utility EV programs.
- California is considered a leader in EVs with more than 1 million units sold in the state, comprising nearly half of the nationwide sales.

Summary

Storage is key to expanding wind and solar beyond current levels.

Li batteries are the leading but not only solution.

Increasing sales for Electric Vehicles will allow time of use charging and a source of storage.

Estimates are that over 1 Twh of storage could come from Electric Vehicle batteries.

Thank You