Electric Vehicles as Grid Assets

GIV Technology and Policy Considerations

For

The National Governors Association

Electric Vehicle Grid Integration Policy Summit

By

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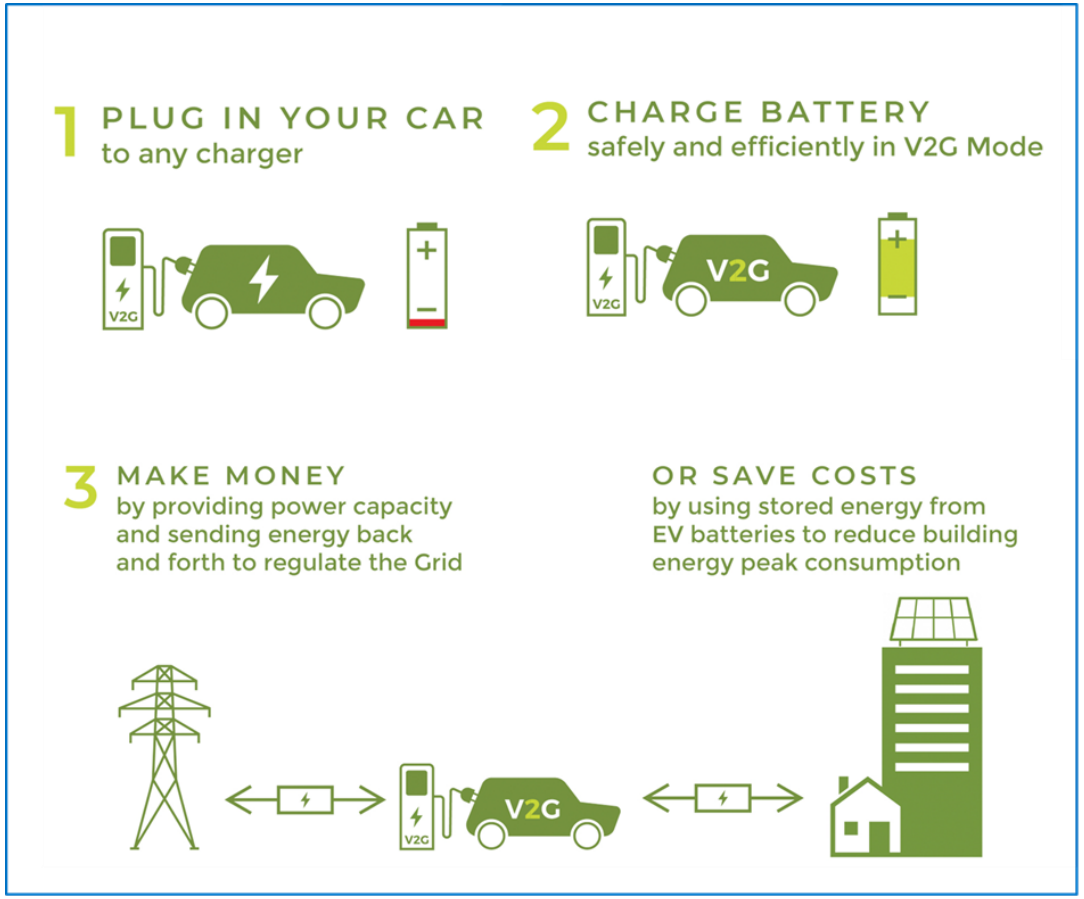
Grid-Integrated Vehicle (GIV) Systems Concept

GIVS can provide a variety of benefits to consumers, ratepayers, and the grid.

- Bring down TCO of EVs
- Turn an uncontrolled influx of demand (EVs) into a controlled load
- Mitigate the variability of high integration of renewables
- Provide a cheaper, readily-available storage resource for grid services

Technology is proven and maturing, with OEMs producing V2G-enabled vehicles and aggregators realizing market value.



Courtesy NUVVE

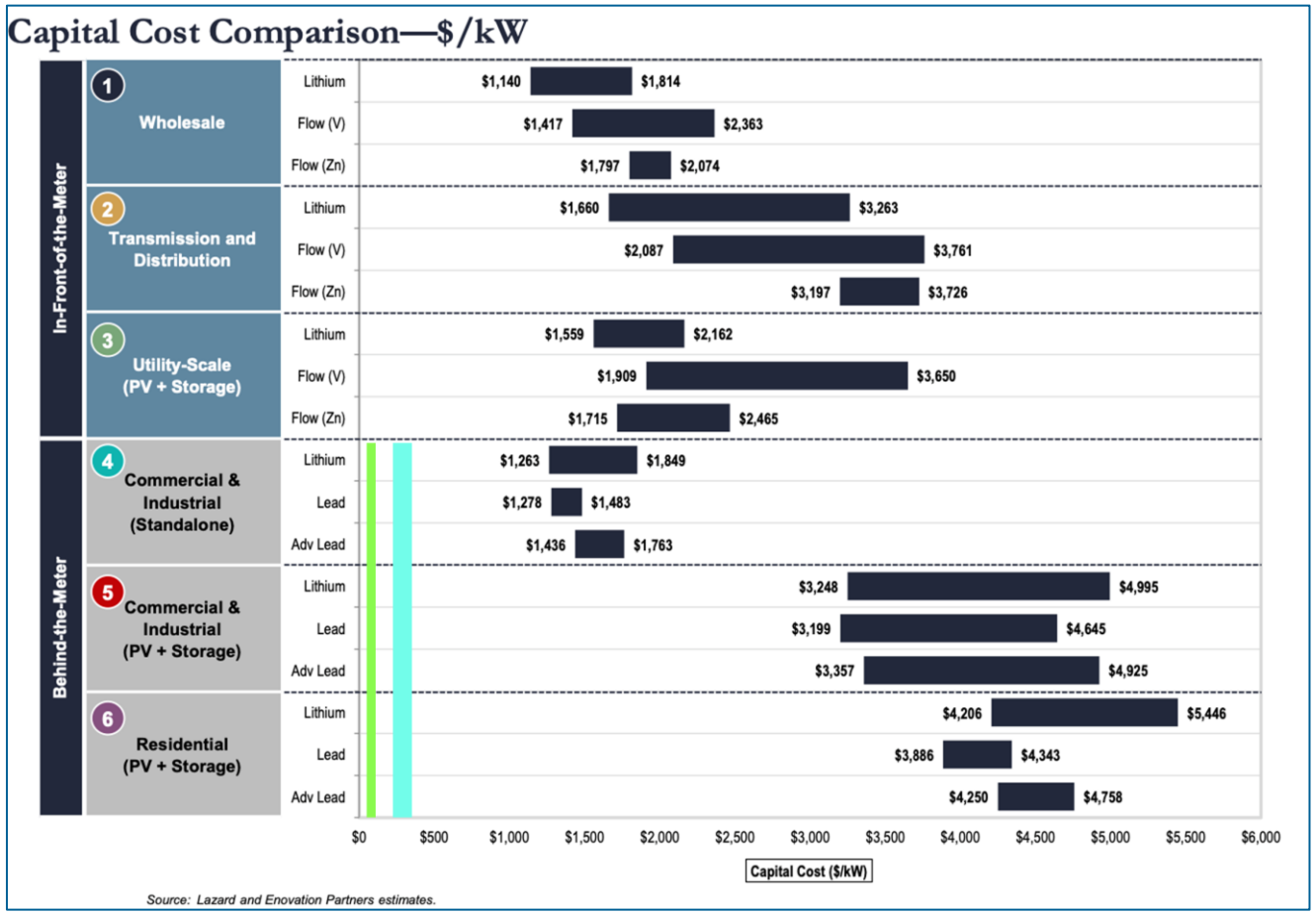
Vehicles as Grid Assets

- EVs have battery and power conversion equipment (charger and motor drive) for grid storage
- Average light vehicle is parked 95% of the time, typically near a plug
- To provide grid services, may need minor adjustments, e.g.:
  - Change charger to bidirectional charge and discharge (vehicle-to-grid, V2G)
  - Add controls and signaling to respond to grid, not just by time of day
  - Integrate into aggregation to meet trip needs of any individual and meet aggregate need for RTO

Service	Gross Annual Revenue Range (Per 100 kW bid)	Hours per year needed or standby	
Arbitrage	$500 - $3,000	2,200	BTM
Customer Peak Reduction	$0 to $2,500	100	BTM
Deferral of Distribution Upgrades	?	70	DSO
Capacity	$3,000 - $7,000	?	RTO
A/S Regulation	$5,000 - $18,000	8760 (or bid 24*n)	RTO
A/S Spinning Reserves	$2,500 - $4,000	8760 (or subset)	RTO

Approximate numbers

EV Storage Economics



- On-board (AC) charger, **lower capital cost.**
  - AC charging 1/3 to 1/2 cost of DC charging equipment
- Bidirectional (V2G), **higher revenue.**
  - 13x revenue of controlled charging, but more complex.
- Higher power per car, **higher revenue.**
  - Charging power is key (more kW in/out), may not need bigger kWh battery.
- Consistent driver plug-in when parked, **higher revenue**
- Policy amendments for **market access**

EV storage:
Demo $227/kW
OEM production $45/kW

UD “Demand-side Resource”
PJM regulation: $1,200 / EV / year

Energinet.dk Primary reserves market, earning €1,600/EV/year

Testing 3-phase charging standards at National Renewable Energy Lab, Golden, CO

Examples of GIV Systems in Operation

UK, Commercial GIV Fleets, multiple grid services – installed 2019/2020

Participating OEMs

OEM= Original Equipment Manufacturer,
(i.e. Automotive Manufacturers)

"V2G AC Resources represent a potentially lower-cost form of mobile storage that supports renewable integration and improves vehicle-grid integration for the purposes of distribution planning."
– Auto Alliance in submission to CA PUC.

- BMW (demonstrations)
- Honda (Pre-production EVs with AC V2G built-in)
- Nissan Europe (selling Leafs & eNV200s warrantied for V2G via DC)
- The Lion Electric (selling AC V2G busses)
- BYD (40 kW AC V2G demonstration, 28 transit buses)
- Bluebird (DC V2G buses, pre-production)
- Renault (mass produced AC V2G capable vehicle)

Most of the above have done detailed studies of effect on warranty and battery life and decided that is not a problem.

Auto Alliance indicates need for 5-year lead time from design to mass production. Regulators must demonstrate markets will be accessible.

Policy Actions for Market Entry to Reveal Full Value

- ❑ Modify storage policies to recognize both stationary and mobile storage systems (i.e. GIVS). This ensures DC GIVS can interconnect.
- ❑ Review and potentially raise fast-track interconnection pathways, to enable low-cost study when appropriate.
- ❑ Modify inappropriate safety standards to incorporate policy flexibility and adopt SAE J3072 for the interconnection of AC GIVS.
- ❑ Ensure technology not penalized at retail level through mechanism such as credit-for-export
- ❑ Work with utilities to design and implement phase 0 implementations of the technology

Adopted or Available	DE	NY	MA	NJ	CA	Denmark
Controlled Charging	✓	✓			✓	✓
DC Projects	✓				✓	✓
AC Projects	✓	✓				✓
ISO Participation	✓		✓			✓
Backfeeding	✓		✓		✓	✓
SAE for AC Interconnection	✓					✓ (Parallel Standard)
Credit-for-export	✓		✓			✓
Utility directive to investigate V2G	✓	✓		✓	✓	

Thank You.

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Or visit:

https://crew.udel.edu/v2g/

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