



Innovations & New EV Technologies



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Newer Technologies

1) Plug and Charge – (ISO 11588)

- 1) EV owner registers the vehicle with a service provider
- 2) EV nears EVSE and EV and EVSE complete “handshake”,
- 3) ☐ Access *without* an RFID card or cellphone app.
- 4) EV owner needs to register the vehicle and attach a method of payment, just like other access management tools.

ISO 15118

- Resilience to cyberattacks
- Seamless user experience
- V2G
- Scalability and interoperability

2) Parking Service Parking and Charging

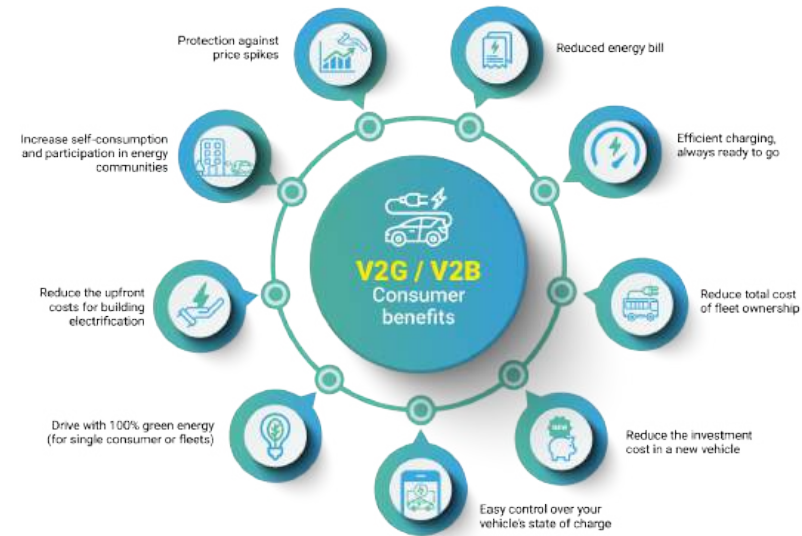
- 1) Combines parking services with Plug and Charge
- 2) Includes accessing means of payment, as authorized by driver.
- 3) Valet need only park, connect, disconnect when done and move the EV when charging is complete
- 4) Messaging about charge status available to valet and driver





Vehicle to “X”

- “X” – Grid, Home, Business, etc.
- Vehicle to Home / Business (V2H/V2B)
 - EV can provide backup power to the home or building during an outage.
 - Charge management can use EV power during high priced peak demand periods
 - Available today.
- Vehicle to Grid (V2G)
 - EV batteries can provide grid support services.
 - Can tie charge time to cost of electricity to optimize trading with grid
 - Large fleets and parking structures are being evaluated for this application.
 - Protocols being deployed.





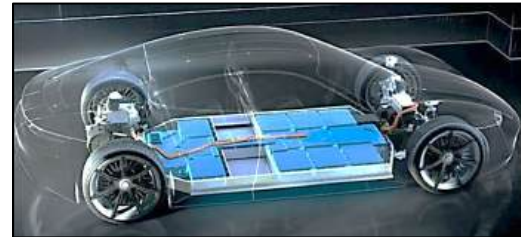
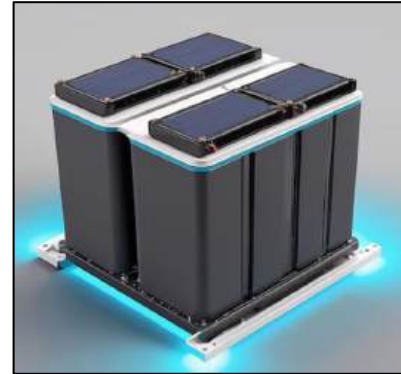
Solar + EVSE

- Further offset the cost per mile by generating energy on site (“solar powered EV”).
- Solar systems can be sized to cover the added electrical load based on daily driving habits.
- When charging is performed overnight, energy storage will be required to fuel up with the sun’s energy.
- With ***Electric Vehicle Power Export Equipment*** (EVPE), the vehicle can be used as a Mobile Energy Storage (MES) during power outages.



Energy Storage: Batteries

- **Stationary Energy Storage**
(**SES**) – dedicated systems typically tied to renewables and grid
- **Mobile Energy Storage**
(**MES**) - Electric Vehicle Batteries





SES + EVSE + MES

- SES paired with EVSEs, and EV batteries (MES) can offset utility demand charges
- SES can offer limited charging when utility power is not available or reliable.
- SES and MES can provide power backup
- SES paired with Solar can support clean energy for EV charging.





Other EV Advancements

- Autonomous EVs (Waymo)
- Wireless Charging, static and dynamic
- Solar integrated EVs – permanent or mountable
- Smart charging – EV charging, EVSE, SES, Renewables, grid tied together and use algorithms to reduce demand charges and V2X functions





EV Battery Advancements

- Li-ion batteries account for 30 to 40% of vehicle cost
- Current most used = Lithium ion
- Factors
 - Cost
 - Energy density
 - Rate of charge
 - Efficiency
 - Power discharge rate
 - Material availability
 - Safety
 - Durability
 - Cold operation
 - Geopolitics
- Options
 - **Li Phosphate (LIP)** - LiFePO_4 cathode with carbon anode
 - **Lithium Manganese Oxide (LMO)**: High power out, lower energy density than Li-ion
 - **Nickle metal hydride** – good safety, lower cost - issue with energy density
 - **Sodium Ion - Sodium** more abundant, less costly, work in cold better, 3X weight
 - **Aluminum ion** – Aluminum and graphene . Lighter weight, reduce EV battery cost by 75%
 - **Solid State Batteries (SSB)**: plastic polymer instead of liquid electrolytes. Higher energy density, safer, faster charge times, more expensive (currently). Toyota prototyping.





Battery Reuse and Recycling

- Batteries still can hold a charge if removed from vehicle □ secondary use
 - Stationary energy storage applications (regional, commercial storage)
 - Other mobile energy storage (e.g., railroad, ships, ferries)
- OEMs are contemplating end of life solutions for recycling and materials recovery, but not standard.
 - Recycling often means breaking down the cells and housings into parts, often using shredding, followed by material separation techniques
 - Battery construction and chemistries changing
 - Still early and market is slow to develop
- Argonne and others have been working on process for several years





Battery Recycling Process

- Packs are shipped to a facility specializing in battery disassembly and recycling their components.
 - Certain parts are easy: steel, copper, and aluminum scrap metal usually go into the nationwide metals-recycling stream.
 - Plastics may not be recyclable, but they're a small proportion of the total contents of an EV battery pack.
- Prize is their lithium, cobalt, manganese, nickel, and, to a lesser extent, aluminum.
- Cells are ground up, the resulting stream is purified in various ways, and the end of the process is a pure supply of the desired metals.
- End-of-life EV battery materials offer a future source of those valuable metals, already extracted from the ground and neatly packaged in a box.
- Goal is to eliminate landfill disposal and maximize returning key materials into new batteries





Thank You

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