ECE 398GG – ELECTRIC VEHICLES

18. EV DEPLOYMENT AND EVCI STATUS

George Gross
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GLOBAL ANNUAL EV SALES: 2010 – 2021

Global EV sales in 2021 more than doubled to 6.6 million with respect to the 3 million EVs sold in 2020.

Global EV sales in 2012 amounted to 130,000 – roughly the weekly sales in 2021.

The EV market share in 2021 was 9% of the global vehicle shares up from 4.1% in 2020.

Tesla — the world's biggest EV manufacturer and considered to be the barometer for the health of the global EV market — delivered 936,172 vehicles in 2021, up 87.4% over 2020.
2020 AND 2021 MONTHLY EV SALES IN THE MAJOR CAR MARKETS


numbers are in thousands

China

US

Europe

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

1,000 900 800 700 600 500 400 300 200 100 0

numbers are in thousands
GLOBAL MONTHLY PEV SALES: 2019 – 2021

2021 numbers in thousands

Source: EV volumes; available at https://www.ev-volumes.com/

Monthly PEV sales


Numbers in thousands
GLOBAL BEV AND PHEV SALES: 2012 – 2021

all numbers are in thousands

plug-in hybrids

battery electric vehicles

registration share in %

y-o-y growth in %

Source: EV volumes; available at https://www.ev-volumes.com/
2021 GLOBAL BEV & PHEV SALES BY REGION

Source: EV volumes; available at https://www.ev-volumes.com/

<table>
<thead>
<tr>
<th>Region</th>
<th>2020</th>
<th>2021</th>
<th>Global Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe (W&amp;C)</td>
<td>1,401</td>
<td>2,332</td>
<td>2,000</td>
</tr>
<tr>
<td>China</td>
<td>1,331</td>
<td>3,396</td>
<td>1,000</td>
</tr>
<tr>
<td>Northern America</td>
<td>735</td>
<td>2,020</td>
<td>1,000</td>
</tr>
<tr>
<td>Others</td>
<td>375</td>
<td>286</td>
<td>133</td>
</tr>
<tr>
<td><strong>Global Total</strong></td>
<td>3,500</td>
<td></td>
<td>3,500</td>
</tr>
</tbody>
</table>

year-on-year growth in % of EV sales

Europe (W&C): 66%
China: 155%
Northern America: 96%
Others: 115%
Global Total: 108%

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TOP 5 AUTOMAKER GLOBAL EV SALES BY REGION: 2021


numbers are in thousands

<table>
<thead>
<tr>
<th>Automaker</th>
<th>Group</th>
<th>China Sales</th>
<th>US Sales</th>
<th>Europe Sales</th>
<th>r.o.t.w.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesla</td>
<td></td>
<td>936</td>
<td>170</td>
<td>352</td>
<td>321</td>
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<tr>
<td>Volkswagen (VW)</td>
<td></td>
<td>763</td>
<td>549</td>
<td>154</td>
<td>15</td>
</tr>
<tr>
<td>BYD</td>
<td></td>
<td>598</td>
<td>595</td>
<td>1</td>
<td>33</td>
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<tr>
<td>General Motors (GM)</td>
<td></td>
<td>517</td>
<td>486</td>
<td>25</td>
<td>1</td>
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<tr>
<td>Stellantis</td>
<td></td>
<td>385</td>
<td>324</td>
<td>142</td>
<td>14</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tesla</td>
<td>936,172</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BYD</td>
<td>593,878</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SGMW</td>
<td>456,123</td>
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<tr>
<td>Volkswagen</td>
<td>319,735</td>
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<td></td>
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<tr>
<td>BMW</td>
<td>276,037</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Mercedes</td>
<td>228,144</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SAIC</td>
<td>226,963</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Volvo</td>
<td>189,115</td>
<td></td>
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<tr>
<td>Audi</td>
<td>171,371</td>
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<tr>
<td>Hyundai</td>
<td>159,343</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Kia</td>
<td>158,134</td>
<td></td>
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<tr>
<td>Great Wall</td>
<td>137,366</td>
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<tr>
<td>Renault</td>
<td>136,750</td>
<td></td>
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<tr>
<td>GAC</td>
<td>125,384</td>
<td></td>
<td></td>
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<tr>
<td>Peugeot</td>
<td>125,263</td>
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<tr>
<td>Toyota</td>
<td>116,029</td>
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<td></td>
<td></td>
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<tr>
<td>Ford</td>
<td>111,879</td>
<td></td>
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<tr>
<td>Chery</td>
<td>99,109</td>
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<tr>
<td>XPeng</td>
<td>98,698</td>
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<td></td>
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</tr>
<tr>
<td>Changan</td>
<td>97,911</td>
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<td></td>
<td></td>
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### Source
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesla Model 3</td>
<td>27,445</td>
</tr>
<tr>
<td>Renault Zoe</td>
<td>11,393</td>
</tr>
<tr>
<td>Dacia Spring</td>
<td>8,148</td>
</tr>
<tr>
<td>Tesla Model Y</td>
<td>8,085</td>
</tr>
<tr>
<td>VW e-Up</td>
<td>7,789</td>
</tr>
<tr>
<td>VW ID.4</td>
<td>6,790</td>
</tr>
<tr>
<td>Nissan Leaf</td>
<td>6,214</td>
</tr>
<tr>
<td>Skoda Enyaq</td>
<td>5,930</td>
</tr>
<tr>
<td>VW ID.3</td>
<td>5,926</td>
</tr>
<tr>
<td>Mini Cooper EV</td>
<td>5,129</td>
</tr>
<tr>
<td>Mercedes GLC300e/de</td>
<td>5,116</td>
</tr>
<tr>
<td>Audi Q4 e-tron</td>
<td>5,078</td>
</tr>
<tr>
<td>Hyundai Ioniq 5</td>
<td>5,024</td>
</tr>
<tr>
<td>Fiat 500e</td>
<td>4,961</td>
</tr>
<tr>
<td>Volvo XC60 PHEV</td>
<td>4,604</td>
</tr>
<tr>
<td>Peugeot 208 EV</td>
<td>4,338</td>
</tr>
<tr>
<td>Renault Twingo EV</td>
<td>4,304</td>
</tr>
<tr>
<td>Kia Niro EV</td>
<td>4,271</td>
</tr>
<tr>
<td>Peugeot 3008 PHEV</td>
<td>4,243</td>
</tr>
<tr>
<td>Volvo XC40 PHEV</td>
<td>3,964</td>
</tr>
</tbody>
</table>

Source: CleanTechnica; available online at https://cleantechnica.com/2022/01/30/29-of-cars-sold-in-europe-were-plugin-electric-vehicles-in-december/
### The Share of 2021 Plug-In Vehicle Sales of the Top 5 European Car Manufacturers

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volkswagen group</td>
<td>24%</td>
</tr>
<tr>
<td>Stellantis</td>
<td>13%</td>
</tr>
<tr>
<td>BMW group</td>
<td>10%</td>
</tr>
<tr>
<td>Daimler</td>
<td>10%</td>
</tr>
<tr>
<td>Renault-Nissan</td>
<td>10%</td>
</tr>
</tbody>
</table>

Source: CleanTechnica; available online at https://cleantechnica.com/2022/01/30/29-of-cars-sold-in-europe-were-plugin-electric-vehicles-in-december/
THE DECLINE OF VEHICLE SALES IN EUROPE

Source: European Automobile Manufacturers' Association as reported in Bloomberg Hyperdrive, April 20, 2022.
MONTHLY US EV SALES: DECEMBER 2010 – MARCH 2021

Source: Bureau of Transportation Statistics; available at https://www.bts.gov/data-spotlight/electric-vehicle-use-grows

thousands of EVs

01/2011 01/2013 01/2015 01/2017 01/2019 01/2021
TOTAL US PLUG-IN VEHICLES SOLD: DECEMBER 2010 – DECEMBER 2021

US plug-in vehicles sold in the current month

Total US plug-in vehicles sold through preceding month

Source: Argonne. Available at: https://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates

- **Plug-in vehicle share of total car sales**
- **Plug-in vehicle share of total light duty vehicle sales**
- **Plug-in light truck share of total light truck sales**


Share in %

2011 2013 2015 2017 2019 2022

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THE MONTHLY US ELECTRIC DRIVE VEHICLE SHARES AND GASOLINE PRICES

monthly HEV sales

monthly gasoline price

monthly plug-in electric vehicle sales

Q1 2022 CA GASOLINE PRICES

Source: Jae C. Hong, AP, via Chicago Tribune, March 12, 2022,
THE MONTHLY US ELECTRIC DRIVE VEHICLE SHARES AND GASOLINE PRICES

2,455,436 PHEVs and EVs have been sold since 2010

February 2022 sales: 59,554 plug-in vehicles – 44,148 EVs and 15,406 PHEVs – an increase of 68.9% from the sales in February 2021
PEVs captured 5.66% of total light-duty vehicle sales in February 2022


\begin{itemize}
  \item \textbf{FCEV:} 814 to 67,904
  \item \textbf{PHEV:} 3,218 to 173,804
  \item \textbf{BEV:} 250,893
  \item \textbf{HEV:} 473,426 to 959,397
  \item \textbf{alternative powertrains:} 491,334 to 810,945
  \item \textbf{total:} 959,397 to 1,609,908
\end{itemize}

SHARE OF TOTAL US ALTERNATIVE POWERTRAIN SALES: 2020 – 2021


<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCEV</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>PHEV</td>
<td>8.4%</td>
<td>60.6%</td>
</tr>
<tr>
<td>BEV</td>
<td>10.8%</td>
<td>59.6%</td>
</tr>
<tr>
<td>HEV</td>
<td>30.9%</td>
<td>29.4%</td>
</tr>
</tbody>
</table>
BEV AND PHEV SHARE OF TOTAL US EV SALES: 2020 – 2021


2020

PHEV

21.3%

26.9%

2021

BEV

78.7%

73.1%
TOTAL US BEV & PHEV SALES FROM 2011 TO 2021

**TOTAL SALES**
- **2011 – 2021**
  - **810,291**

**BEV**
- **65.3%**

**PHEV**
- **34.7%**

**Source:** IHS Markit / Auto Manufacturers Alliance, Advanced Technology Sales; chart by Loren McDonald / EVAdoption, LLC; available at https://evadoption.com/us-hybrid-and-phev-sales-growth-rate-outpaced-bevs-in-2021/
ANNUAL EV SHARE OF LIGHT DUTY VEHICLE SALES

Source: The Business Council for Sustainable Energy; https://bcse.org/factbook; p.33

California

US

Source: The Business Council for Sustainable Energy; https://bcse.org/factbook; p.33
President Biden on March 31, 2022, invoked the Defense Production Act – *DPA* – to spur domestic mining and processing of minerals used to make batteries for *EVs* and energy storage resources:

- This effort aims to strengthen *US* energy independence and to develop more domestic production of storage technology.
- The directive supports *lithium, graphite, cobalt, manganese* and *nickel* production/processing.
BIDEN INVOKES *DPA* ON MINERAL IMPORTS

- the directive supports *lithium, graphite, cobalt, manganese* and *nickel* production/processing
- Department of Defense is tasked to perform feasibility studies that adhere to "strong" environmental, labor, community and tribal consultation standards

- The directive, via the deployment of a Cold War relic, is timely since the minerals supply chain reliability is absolutely essential to the effective domestic manufacturing of batteries for *EVs*
BIDEN INVOKES *DPA* ON MINERAL IMPORTS

- While the Biden administration's action to invoke the *DPA* is "limited in scope" the action is very important since it sends a markets signal of its attempt to bolster domestic battery production.

- While the Biden administration's action to invoke the *DPA* is "limited in scope" the action is very important since it sends a markets signal in its attempt to bolster domestic battery production.
US IMPORTS OF THE MINERALS USED IN EV BATTERIES

the imports’ share of the 2020 US mineral consumption

The status of global public charging

- As EV sales increase at a pace much faster than the number of public charging ports, the criticality of the EVCI development is becoming a more pressing issue globally.
- The BNEF 2022 public charging report indicates that the global number of EVs on the road per public charging port rose to 9.2 at the end of 2021 from 7.4 at the end of 2020.
THE STATUS OF GLOBAL PUBLIC CHARGING

- The public charging facility developments in 2021 failed to keep pace with that year’s global $EV$ sales of 6.6 million cars, with the singular exception of China, whose ratio of the number of $EV$s to that of charging ports remained basically unchanged since 2018.

- China’s push to expand its $EVCI$ has resulted in the fact that more than half the world's public
charging ports are in China

- The rapid increase in the deployment of EVs in the US was not accompanied by a larger number of public chargers and, therefore, there are fewer chargers per EV or there are more EVs per charging port than in earlier years

- The situation is even more acute in Europe, where,
THE STATUS OF GLOBAL PUBLIC CHARGING

EV sales surged since 2019, e.g., Germany’s ratio of the number of EVs per public charging point grew from 8 in 2019 to 20 in 2021 and in Norway – the most mature EV market in the world – the ratio is in the range of 30 to 40 EVs on the road per public charging port
THE STATUS OF GLOBAL PUBLIC CHARGING

- A very similar situation exists for DCFCs in the respective regions – China has 16 EVs for every ultra-fast charger and the US ratio is about 100.

- The number of 350-kW stations that are capable to add 100 km of range to an EV in just a few minutes is growing globally – a timely development as the trend to electrify trucks and pickups gets into a higher gear.
THE STATUS OF GLOBAL PUBLIC CHARGING

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- The number of 350-kW stations that are capable to add 100 km of range to an EV in just a few minutes is growing globally - a timely development as the trend to electrify trucks and pickups gets into a higher gear
ANNUAL GLOBAL RATIO OF EVs PER PUBLIC CHARGING POINT: 2014 – 2021

A public charging point is the number of individual charging connectors.

Source: BNEF data in Bloomberg Hyperdrive issue of April, 12, 2022.
RATIO OF EVs PER PUBLIC CHARGING POINT BY COUNTRIES: 2014 – 2021

Source: BNEF data in Bloomberg Hyperdrive issue of April 12, 2022
RATIO OF *EVs* PER FAST/ULTRA-FAST PUBLIC CHARGING POINT: 2017 – 2021

Source: BNEF data in Bloomberg Hyperdrive issue of April 12, 2022
## Mean Number of Charging Connectors per Charging Station by Operators

<table>
<thead>
<tr>
<th>Operator</th>
<th>Average Number of Ultra-Fast Charging Points per Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesla</td>
<td>10</td>
</tr>
<tr>
<td>BKK</td>
<td>3.8</td>
</tr>
<tr>
<td>Fastned</td>
<td>3.6</td>
</tr>
<tr>
<td>Ionity</td>
<td>3.5</td>
</tr>
<tr>
<td>Statkraft</td>
<td>2.9</td>
</tr>
<tr>
<td>BP</td>
<td>2.4</td>
</tr>
<tr>
<td>Shell</td>
<td>2.0</td>
</tr>
<tr>
<td>Allego</td>
<td>2.0</td>
</tr>
<tr>
<td>EnBW</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Source: BNEF data in Bloomberg Hyperdrive issue of April 12, 2022
THE 10 LARGEST US CHARGING NETWORKS

Source: evadoption; available at https://evadoption.com/ev-charging-stations-statistics/us-charging-network-rankings/

- **Total ports**
- **Total locations**
- **Level 2 ports**
- **Level 2 locations**
- **DCFC ports**
- **DCFC locations**

**ChargePoint network**
- **Tesla**
- **Non-networked**
- **SemaConnect network**
- **Blink network**
- **Electrify America**
- **EV Connect**
- **Greenlots**
- **Volta**
- **EVgo network**
- **Others**
LARGEST *US* DCFC NETWORKS

<table>
<thead>
<tr>
<th>Network</th>
<th>DCFC Ports</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesla</td>
<td>12,580</td>
<td>58.0</td>
</tr>
<tr>
<td>Electrify America</td>
<td>3,112</td>
<td>14.4</td>
</tr>
<tr>
<td>EVgo network</td>
<td>1,711</td>
<td>7.9</td>
</tr>
<tr>
<td>ChargePoint network</td>
<td>1,675</td>
<td>7.7</td>
</tr>
<tr>
<td>non-networked</td>
<td>909</td>
<td>4.2</td>
</tr>
<tr>
<td>Francis Energy</td>
<td>545</td>
<td>2.5</td>
</tr>
<tr>
<td>greenlots</td>
<td>477</td>
<td>2.2</td>
</tr>
<tr>
<td>others</td>
<td>667</td>
<td>2.9</td>
</tr>
</tbody>
</table>

*21,676 installed DCFC ports in the US*

Source: evadoption.com/ev-charging-stations/statistics/us-charging-network-rankings/

*The share in % of EVgo of the total DCFCs*

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TESLA SUPERCHARGER STATION

Source: Bloomberg
### LARGEST US LEVEL 2 NETWORKS

<table>
<thead>
<tr>
<th>Network</th>
<th>Ports</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChargePoint network</td>
<td>47,114</td>
<td>51.5</td>
</tr>
<tr>
<td>Tesla Destination</td>
<td>14,677</td>
<td>16.0</td>
</tr>
<tr>
<td>non-networked</td>
<td>10,519</td>
<td>11.5</td>
</tr>
<tr>
<td>SemaConnect network</td>
<td>5,802</td>
<td>6.3</td>
</tr>
<tr>
<td>Blink network</td>
<td>3,158</td>
<td>3.4</td>
</tr>
<tr>
<td>EV connect</td>
<td>2,774</td>
<td>3.0</td>
</tr>
<tr>
<td>Greenlots</td>
<td>2,309</td>
<td>2.5</td>
</tr>
<tr>
<td>Volta</td>
<td>2,199</td>
<td>2.4</td>
</tr>
<tr>
<td>others</td>
<td>2,987</td>
<td>3.4</td>
</tr>
</tbody>
</table>

*91,539 installed level 2 ports in the US*

*the share in % of Tesla Destination of the total level 2 ports*

The higher ratios of the number of EVs on the road to the number of charging stations is not necessarily a bad outcome since many charging stations are under-utilized at present; but, the high ratios imply more private investment in EVCI is needed and to achieve such an outcome, higher utilization per charger will be required to improve the economics of charging station operations.
THE HIGHER NUMBER OF EVS PER PUBLIC CHARGING STATION

Given the slow pace of development in EVCI, one may conclude that a successful business model is yet to be established for EVCI stations; such a situation is not surprising given the wide array of issues, such as EVSE and siting costs, charging speeds, electricity tariffs, fee and pricing structure, government regulation, support and permitting, that need to be considered.
THE HIGHER NUMBER OF EVS PER PUBLIC CHARGING STATION

- To illustrate the complexity and challenges in the EVCI business model, consider the determination of the appropriate number of station chargers—an issue requiring that competing objectives be kept in balance: charging station operators desire more charging sessions per day, but too many sessions imply that there are times when drivers must wait because of queues at occupied ports, resulting in undesirable customer experience; while operators aim for high utilization, it cannot be so high as to cause customer frustration.
PG&E’S BI-DIRECTIONAL EV RESIDENTIAL CHARGING PROGRAM

- PG&E entered into a partnership with GM to create a bi-directional EV program with the capability to supply homes and small businesses with the electricity stored in the EVs located on site; a pilot program in Summer 2022 is planned to test V2G and V2H – vehicle-to-home – systems.

- The key objective of the PG&E – GM pilot program is to determine the extent of the capability of the
PG&E’S BI-DIRECTIONAL EV RESIDENTIAL CHARGING PROGRAM

V2G and V2H systems to improve the PG&E distribution grid reliability

- CA Senate Bill 676 required the CPUC to formulate strategies and metrics to integrate EVs into the grid by 2030; the PG&E – GM pilot program is an initiative under the CPUC-approved framework for the integration of EVs into the grid to meet the Senate Bill 676 requirements
PG&E’S BI-DIRECTIONAL EV RESIDENTIAL CHARGING PROGRAM

- Testing tasks include the installation of EV chargers, including bi-directional hardware and communication software used to coordinate among the home/business network, EV and the PG&E distribution grid

- PG&E must develop a mechanism to specify the price signals to use the EV batteries to serve home/business demand and grid load with the full consideration in the rates for electricity supplied to the customer of the worth of a charged EV to provide mobility
PG&E’S BI-DIRECTIONAL EV RESIDENTIAL CHARGING PROGRAM

The creation of the tariff for the bi-directional EV charging program will require the modification of the two current time-of-use rate tariffs for EVs:

- home-charging EV-2A, under which the electricity to charge the EV is combined with that to serve the customer electricity needs;
- home-charging EV-2B, under which the electricity to charge the EV is separated from that for the customer needs and requires an additional meter to be installed.
PG&E AND FORD ASSESS THE F-150 EV FOR GRID SUPPORT

On the heels of PG&E’s announcement of a collaborative effort with GM to assess the ability of GM EVs to act as on-demand electricity sources for homes, the utility starts a joint effort with Ford to study the capability of F-150 Lightning EV trucks to provide reliability services in terms of backup energy for customers’ homes.

THE ELECTRIFICATION OF SCHOOL BUSES

School buses constitute the largest form of *US* public transportation, with nearly half a million children riding on them to school and back.

At present, fewer than 1% of the nation’s school buses are *fueled* by electricity.

The application of *EV* advances to school bus technology and the effective use of the federal government funding under the *Infrastructure Investment and Jobs Act* of 2021 are key drivers to
THE ELECTRIFICATION OF SCHOOL BUSES

make the adoption of *ESBs* – *electric school buses* – an increasingly viable option for school districts

- *ESBs* equipped with *V2G* technology can reduce GHG from both the transportation and power generation sectors – the two *US* economy sectors that contribute most of GHG emissions

- the replacement of the large number of school buses by *ESBs*, in itself, results in a sizeable
THE ELECTRIFICATION OF SCHOOL BUSES

- reduction of \(GHG\) emissions;
- the effective deployment of \(ESBs\)' batteries can further reduce utilization of polluting resources and wholesale electricity market prices to aid energy transition and encourage deeper renewable energy resource penetrations; and,
- in addition to these environmental benefits,
- the wider deployment of \(ESB\) fleets equipped
THE ELECTRIFICATION OF SCHOOL BUSES

with $V2G$ technology improve the health of the population in their locations

The wider deployment of $ESB$ fleets equipped with $V2G$ technology can benefit the grid and the electricity consumers with the services such fleets provide to the grid through the effective utilization of their aggregated batteries in terms of various demand response and demand
The wider deployment of ESB fleets equipped with V2G technology can benefit the grid and the electricity consumers with the services such fleets provide to the grid from the effective utilization of their aggregated batteries in terms of various demand response and demand.
THE ELECTRIFICATION OF SCHOOL BUSES

management applications such as peak clipping, valley filling and load shaping;

- emergency support to enhance the electricity reliability during peak demand periods; and

- reduction of the investment made by utilities due to the provision of these support services and thereby bring in new revenue streams to the school districts.
THE ELECTRIFICATION OF SCHOOL BUSES

- The realization of such benefits will require the formulation of supportive policies and their enactment into legislative initiatives at all levels of government – local, county, state and federal – together with the implementation of tariff modifications by regulatory agencies, and the cooperation of school districts.

- Specifically, the formulation of effective incentives will create a major push to the wider and more effective deployment of ESBs.
Con Edison reported its findings of a demonstration project with the objective to determine the technical and economic viability of using V2G-equipped school buses to support the grid at times when demand for power is high.

Con Edison worked with bus manufacturer Lion Electric, White Plains school bus contractor National Express and project developer First Priority Group.
Electrified (FPGe) and energy technology company Nuvve Holding Corp to undertake the three-year study that was performed with 5 ESBs that took elementary school students in White Plains, NY, to their classes each day.

- Three of the buses were retrofitted with power converters to allow them to perform V2G bi-directional charging.
The study showed that electrification of school buses can provide benefits to school districts, transportation providers and utility customers without deleterious impacts on the batteries:

- the utilization of the batteries for both transportation and grid support causes the batteries to degrade just as much as for transportation only
CON EDISON ESB DEMONSTRATION PROJECT

- bus availability and transportation performance of EBSs were almost the same as that of the diesel buses
- roughly 85% of the battery energy reached the grid – 15% losses were in line with the Con Edison criteria

- The project demonstrated the feasibility of the V2G-equipped EBSs to support the grid at
times when demand for power is high, which is usually on hot summer NY afternoons

- Overall, the results indicate the huge potential to deploy ESBs on a large scale to discharge power into the grid at times of peak loads and the associated benefits for school districts, transportation providers and utility customers that the electrification of school buses can provide
GM HUMMER EV

Source: BNEF data in Bloomberg Hyperdrive issue of April, 12, 2022

- 9,000 + lbs.
- range of 329 mi
- 100 mi charge in 12 m with an 800 V DC fast-charger
- $112,595 price tag
HYUNDAI IONIQ5 2022 EV

THE NEW NISSAN ARYA EV