Electric Vehicles and the Energy Transition

Fuel Choices and Smart Mobility Summit 2017

Albert Cheung
Head of Analysis, BNEF
acheung89@bloomberg.net
@albertwycheung

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Global EV sales by region

Source: Bloomberg New Energy Finance
Note: includes highway-capable passenger vehicles only. Excludes low speed EVs, buses or other commercial vehicles.
Transport fuel displaced by EVs on the road today

If all BEVs and PHEVs currently on the road were bought instead of an average gasoline or diesel car ….

Thousand barrels per day

On track to displace an equivalent of 28.4 thousand barrels of oil per day by the end of 2017

….then EVs on the road today, are displacing an equivalent of 28 thousand barrels of oil per day

~0.03% of oil production
On track to consume 5.7 TWh of electricity by the end of 2017

Based on EV models’ fuel consumption values, BNEF estimates that EVs on the road in 2017 will use 5.7 TWh of electricity. This is approximately 0.14% of U.S. power generation in 2016.
2040 Electric Vehicles Outlook

Annual global light duty vehicle sales

million cars per year

- 2015: 65 million cars (1% EV sales)
- 2020: 90 million cars (3% EV sales)
- 2025: 115 million cars (8% EV sales)
- 2030: 140 million cars (24% EV sales)
- 2035: 165 million cars (43% EV sales)
- 2040: 190 million cars (54% EV sales)

ICE sales vs. EV sales
Global fuel demand displacement from EV sales

Bloomberg New Energy Finance Note: we calculate the number of barrels displaced by multiplying the cumulative number of EVs on the road in a given year by the average vehicle miles travelled by the EV, divided by the average miles per gallon of an internal combustion engine vehicle on the road. This is then divided by 365 days/year, and divided again by 42, which is the number of gallons in one barrel. Our figures likely understate actual crude oil displacement given that one barrel of crude oil produces around 19.5 gallons of gasoline and 12 gallons of diesel. Our calculation treats a barrel displaced as entirely made of finished transportation fuel.
Yearly electricity consumption from EVs

- ~10% of power generation in 2040 in high-adoption markets
Remember this?
How people used to think about charging infrastructure

Electric cars: it's a chicken and egg issue

DC Fast Charging: A Chicken-and-Egg Problem

Electric Vehicles and their Infrastructure: The Chicken/Egg Dilemma

Improving electric vehicle sales may require solving unique chicken and egg problem

“The installation of public EV charging infrastructure is often described as a classic chicken and egg problem. Which will come first – a significant penetration of EVs, or a widely deployed charging network?”
Public EV charging infrastructure

Cumulative installations in selected countries

Thousand units installed

+248%  +40%  +10%  +49%  +61%


China
US
Japan
Netherlands
UK
Norway
France
Germany
Other

Note: Other includes: Belgium, Denmark, Italy, and Sweden. Public and semi-public chargers only. China values assume 2 outlets for every 1 charging pole reported by the China National Energy Administration. China 2015 number is an estimate as the official numbers have not yet been reported.

Source: Bloomberg New Energy Finance, China National Energy Administration, Danish EV Alliance, data.gouv.fr, BDEW, NOBIL, National Charge Point Registry, AFDC
Charging speeds of public EV charging infrastructure globally, 2016

By charging level:
- Standard: 3kW (8%)
- Mid-accelerated: 5-7kW (14%)
- Accelerated: 22-43kW (49%)
- Fast: 43-120kW (29%)

Total: 363,000 charging points
Ratio of publicly available EVSE to the number of petrol filling stations, 2016

<table>
<thead>
<tr>
<th>Country</th>
<th>Ratio</th>
</tr>
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<tbody>
<tr>
<td>US</td>
<td>0.38</td>
</tr>
<tr>
<td>Germany</td>
<td>0.45</td>
</tr>
<tr>
<td>France</td>
<td>0.95</td>
</tr>
<tr>
<td>Japan</td>
<td>1.03</td>
</tr>
<tr>
<td>UK</td>
<td>1.38</td>
</tr>
<tr>
<td>China</td>
<td>1.64</td>
</tr>
<tr>
<td>Norway</td>
<td>4.37</td>
</tr>
<tr>
<td>Netherlands</td>
<td>5.65</td>
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</tbody>
</table>
Charging speeds of public EV charging infrastructure globally, 2016

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</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>74%</td>
<td>8%</td>
<td>9%</td>
<td>26%</td>
</tr>
<tr>
<td>China</td>
<td>54%</td>
<td>40%</td>
<td>42%</td>
<td>14%</td>
</tr>
<tr>
<td>US</td>
<td>40%</td>
<td>40%</td>
<td>18%</td>
<td>11%</td>
</tr>
<tr>
<td>UK</td>
<td>31%</td>
<td>31%</td>
<td>18%</td>
<td>18%</td>
</tr>
<tr>
<td>Germany</td>
<td>56%</td>
<td>17%</td>
<td>10%</td>
<td>11%</td>
</tr>
<tr>
<td>France</td>
<td>43%</td>
<td>37%</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>38%</td>
<td>37%</td>
<td>10%</td>
<td>13%</td>
</tr>
<tr>
<td>Norway</td>
<td>73%</td>
<td>74%</td>
<td>11%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Bloomberg New Energy Finance, ChargeMap, Avere, National charge Point Registry, MIIT, BDEW, Nobil, Alternative Fuels Data Centre
Who will own the infrastructure – and the customer relationship?

- 'Big oil'
  - Shell
  - 30,000 charge points
  - 100,000 members
  - NL, UK, DE, FR

- Auto
  - Ford
  - Daimler
  - BMW
  - Volkswagen
  - Alliance of 4 automakers
  - 400 rapid chargers planned across Europe
  - 350kW rapid charge

- Power
  - Enel
  - EnerNOC
  - EV charging-based demand response
  - Residential and commercial charge points

- Regulated utilities
  - SDGE
  - PG&E
  - Southern California Edison
  - California: public utility-led roll-outs with regulated returns
  - Public, commercial and residential charge points

- Independent
  - ChargePoint
  - Clever
  - Polar
  - Fastned
  - Various independent players
## EV-specific home charging tariffs in Europe

<table>
<thead>
<tr>
<th>Country</th>
<th>Utilities involved</th>
<th>Notes</th>
</tr>
</thead>
</table>
|          | OVO Energy         | • Flat rate of £83 per month  
|          |                    | • Access to UK Polar Network (50,000 EV chargepoints) |
|          | Good Energy        | • 15% per kWh cost reduction on variable EV tariff |
|          | Ecotricity         | • £40 a year discount for EV owners. |
|          | Endesa             | • 1,200 kWh of free electricity per year between 1:00am and 7:00am.  
|          |                    | • Free installation of a home charging point  
|          |                    | • Access to a public charging network that will be built in 2018. |
|          | EDP                | • 10% discount per kWh during night time charging.  
|          |                    | • All electricity is sourced from renewables.  
|          |                    | • The first 500 customers who sign up and have an EV from one of EDPs partner brands* get the first 15,000km of electricity for free, which is applied as a 40 euro per month bill reduction over 10 months. |

*EDP partner brands include: BMW, Mercedes, Audi, Mitsubishi, Nissan, Peugeot, Renault, Smart, Toyota, VW and Volvo*
U.S. states with utilities that offer EV-specific Time of Use rates

Data current as of September 1, 2017. Utilities in Hawaii and Alaska also have EV-specific TOU trial rates but are not shown. See Appendix for full list.
Selected EV-specific utility TOU charging rates in the U.S.

U.S. utility EV charging tariff hours and rates ($/kWh)

- **Southern California Edison**: $0.09/kWh (Off-peak), $0.17/kWh (On-peak), $0.09/kWh
- **Dakota Electric**: $0.07/kWh (Off-peak), $0.41/kWh (On-peak), $0.07/kWh
- **AEP Indiana Michigan Power**: $0.04/kWh (Off-peak), $0.14/kWh (On-peak), $0.04/kWh
- **Baltimore Gas and Electric**: $0.05/kWh (Off-peak), $0.15/kWh (On-peak), $0.05/kWh
- **Burbank Water and Power**: $0.08/kWh (Off-peak), $0.25/kWh (On-peak), $0.08/kWh
- **Consumers Energy**: $0.08/kWh (Off-peak), $0.15/kWh (On-peak), $0.08/kWh
- **National Grid**: $0.09/kWh (Off-peak), $0.2/kWh (On-peak), $0.09/kWh
- **NV Energy**: $0.05/kWh (Off-peak), $0.42/kWh (On-peak), $0.05/kWh
- **Otter Tail Power Company**: $0.03/kWh (Off-peak), $0.09/kWh (On-peak), $0.03/kWh
- **Salt River Project**: $0.06/kWh (Off-peak), $0.22/kWh (On-peak), $0.06/kWh
- **SMUD**: $0.08/kWh (Off-peak), $0.24/kWh (On-peak), $0.08/kWh
- **Xcel**: $0.03/kWh (Off-peak), $0.18/kWh (On-peak), $0.03/kWh

Source: Bloomberg New Energy Finance, rate filings and webpages of respective companies. Note: Data shown is for summer peak. Some rates include a monthly fee which is not included here. See subsequent slide for further notes.
Europe power generation forecast (BNEF NEO 2017)

49% wind and solar by 2040

Renewables share
Forecast grid-related emissions from the operation of battery electric vehicles

Growing renewables will make EVs cleaner and cleaner to 2040

Source: Bloomberg New Energy Finance, New Energy Outlook 2017. Note: The average ICE CO2 emissions are sales weighted across all six countries
Future EV charging patterns (UK)

Fixed EV charging

- Total power demand
- EV power demand
- Power demand excluding EVs

Fully flexible EV charging

If fully flexible, EVs should charge at night

By 2035, increased solar means that EVs charge at midday too
Realized power prices with different charging patterns (UK)

In 2040 it will make most sense to charge in the daytime (due to solar):

- Charging costs are **10% lower compared** to fixed night-time charging
- Daytime charging leads to a **42% improvement in solar realized prices**

**EVs can be a flexible load that supports renewable energy economics**

*Source: Bloomberg New Energy Finance  Note: Realised power prices are calculated as energy revenues divided by generation. They do not measure profitability.*
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Thank you!

Albert Cheung
Head of Analysis, BNEF
acheung89@bloomberg.net
@albertwycheung