Norwegian EV Charging Infrastructure and User Experiences

The future of Electric Vehicle Infrastructure in the U.S. Webinar. 2 may 2019
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Institute of Transport Economics

- Multi-disciplinary Independent, non-profit research foundation.
- To develop and disseminate transportation knowledge with scientific quality and practical application.
Norway quick facts

- 5.3 million inhabitants

- 2.75 million passenger vehicles, of which:
  - 194,000 Battery Electric Vehicles (7.1%)
  - 96,000 Plug in Hybrid vehicles (3.5%)

- 0.48 million Light commercial vehicles, of which:
  - 5,300 Battery Electric Vans (1.1%)

- Charging infrastructure (status 01.01.2019)
  - ~1,100 50 kW CCS/Chademo fast chargers in ~500 locations
  - ~7,500 public normal chargers + domestic type sockets
  - ~90,000 Type 2 EVSE wallbox home chargers
  - Tesla Supercharger infrastructure

Sources:
Vehicle register (status 01.01.2019) and Statistics Norway
New un-published estimates from 2018 TOI BEV user survey
Monthly market shares

Source: www.OFVAS.no and the Norwegian Vehicle register (data from the Norwegian Public Roads Administration)
The first main reason for the high adoption of BEVs in Norway is especially suited for BEVs.

**Clean Electricity, strong grid**

- Electricity production 2017: 95.8%
  - Hydro power production: 1.9%
  - Wind power production: 2.3%
  - Thermal power production: 95.8%

**Private parking access**

- Norwegian households 2019:
  - Detached house: 2%
  - House with 2 dwellings: 3%
  - Row house, others with 3+ dwellings: 24%
  - Multi-dwelling building: 12%
  - Residence for communities: 9%
  - Other building: 49%

**Moderate road speeds**

- City: 31 mph (50 mph)
- Main-road: 50 mph (80 mph)
- Motorway: 62-68 mph (100-110 mph)

- Long distance trip average speed: 70-80 km/h

Source: Statistics Norway

Source: Statistics Norway
The second main reason for the high adoption of BEVs in Norway have introduced big incentives and kept them in place:

### National
- Exemption from VAT (25% on other vehicles)
- Exemption from registration tax
- Reduced annual (circulation) tax
- Reduced benefit taxation on company cars
- Exemption from tax on change of ownership (introduced 2018)

### Local
- Free toll roads
- Free parking
- Reduced ferry rates
- Access to bus lanes

New policy: Max 50% of ICEV rate, local decision
New policy: Need to have a passenger in rush hours some places
The second main reason for the high adoption of BEVs in Norway have introduced BIG incentives and kept them in place.

VW Golf in 3 versions:
1. BEV – E-Golf
2. PHEV - GTE
3. ICEV – Gasoline

Purchase prices and Annual cost of ownership:

Sources:
The second main reason for the high adoption of BEVs in Norway is that they have introduced BIG incentives and kept them in place. These incentives include free parking, reduced ferry rates, access to bus lanes, and free toll roads. The BEV total cost of ownership advantage is 3,200 Euro/year.

Sources:
Who owns BEVs in Norway?

85% are consumers
- Younger than average
- 79% are multi-vehicle owners
- Families, children <18y
- Large transportation need
- Live in cities or outskirts
- 94% can charge at home

Buying motivation
- Reduced user cost
- Vehicle matching needs
- Incentives
- Environment

Experience
- Few challenges
- Have alternatives when range short

Sources:
Home charging

Detached/small houses
- No public support available
- EVSE wallbox cost about 1200-1800 US$ to install

Flats with common parking
- Parking facility jointly owned
- Annual meeting decides
- High cost
- Insufficient grid power

Typical solution:
- Basic infrastructure jointly owned
- Load shedding equipment
- Common cost: 1000 US$/flat
- Wallbox chargers are bought by flat owners which is billed for the electricity
- Charger cost: 1500 US$/flat
- Public support for basic installation

Source: Unpublished results from a TOI BEV user survey in 2018
Public charging infrastructure (1)

Up to 2010
- A few hundred public chargers
- People also used available outdoor domestic plugs

2010-2011
- Public support program – Normal chargers, first come first serve
- Money left was used to install a few fast chargers in late 2011

2012-2014
- National support fast chargers – first come first serve, 40%
- Municipalities installed free to use public «normal chargers»

Photo: Elbilforeningen.no
Public charging infrastructure (2)

2015-2017

- Supply a fast charger network along major roads
  - 2 fast + 2 semi-fast/50 km, 8000 km road network
  - Tenders for service – up to 100% support
  - Lowest bidder
  - Teamed up with McDonalds, fuel stations etc.

- Free to use public normal chargers in cities

2018

- Full fast charger coverage along all major roads
- Normal public charging infrastructure lags fleet
- Municipalities subcontract operation to operators
Public charging infrastructure - 2019 and beyond

Cities – Fast charging
- Fully commercial market, no support
- Challenge: Land to put chargers on

Cities – Normal charging
- Main challenge: On-street parkers
- From free to use to paid service

Fast charging between cities
- Economic viability, with variability workday, weekend, vacation?
- Expanding to super fast (150 - 350 kW)

Destinations
- Resorts
- Private cabins and holiday homes
Not that fast….

Average fast charge session:
- 30 kW power from 50 kW chargers
- 20 minutes duration
- 10 kWh energy charged
- ~13-19 fast charge events per user per year

Main reasons for low power:
- Primitive battery thermal management systems
- Cold winters

Result:
- Costs transfer from vehicle manufacturer to fast charge operator

Advice:
- Type approval test of charge speed versus ambient temperature

## 2017 fast charger usage by users that charged in 2016

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<th>Average</th>
<th>10-perc</th>
<th>20-perc</th>
<th>Median</th>
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</table>

Four fast charger user types, separated markets

**Users**
- **Occasional user (30%)**: likely use fast charger when they have a rare range problem
- **Frequent user (10%)**: likely people without home charging or professional users
- **Long distance trip user (rare)**: fast charges to get to far-away destinations
- **Local user (common)**: fast charges regularly to solve their everyday needs

**Markets**
- **South-East and Innlandet**: Users often charge in other provinces
- **Other provinces**: Most charge within province

Everyday money saver...long distance time waster...

Total cost of energy and charge/pause time over a year, average long distance driving pattern

More information:

efi@toi.no

https://www.toi.no/ansatte/figenbaum-erik-article31074-202.html
Back-up slides
The third main reason for the high adoption of BEVs
Three decades of complex interactions between niche markets, regimes (automobility as we know it) and landscape (long term trends)

1. Niche market experimentation
2. Weak ICEV regime
3. BEV industrialization efforts
4. Strong governance with large incentives
5. Enabling landscape (Li-Ion tech, vehicles)
6. ICEV regime grabbed BEV opportunity
7. Interested, wealthy and able consumers
Public normal charging

- On street:
  - Very challenging due to cost, permit, practicality, time
  - Makes road use less flexible
  - Installation in parking houses much easier

- Have been a free service:
  - Some use it to get free parking
  - Use data unreliable
  - Has blocked private initiatives

- More important as adoption increases among users without parking
The second main reason for the high adoption of BEVs in Norway is the introduction of big incentives and keeping them in place. 

...to be able to get people out of these... 

...and into these...
The second main reason for the high adoption of BEVs in Norway is that they have introduced BIG incentives and kept them in place. ...but now, getting people out of these... ...and into these equal substitutes is much easier!