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Fast charging in Norway – Evidence from a full scale laboratory

Presented at EVS32 Lyon, 20-22 May 2019

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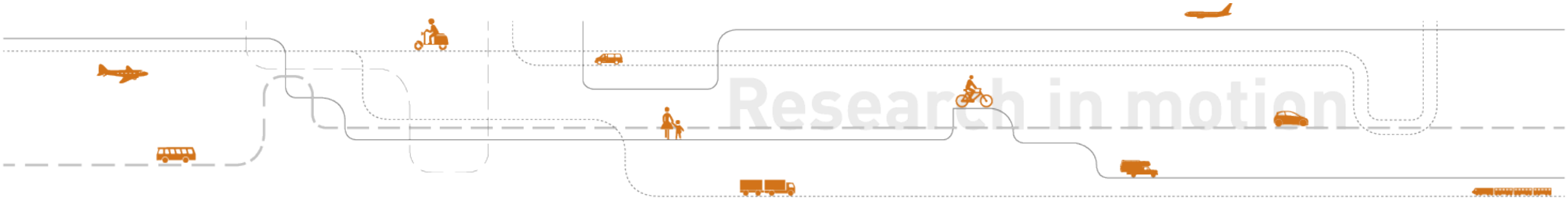


Norway quick facts

200 000 BEVs (01.01.2019):

- 194 000 Battery Electric vehicles (7.1% of fleet)
- 5 300 Battery Electric Vans (1.1% of all vans)

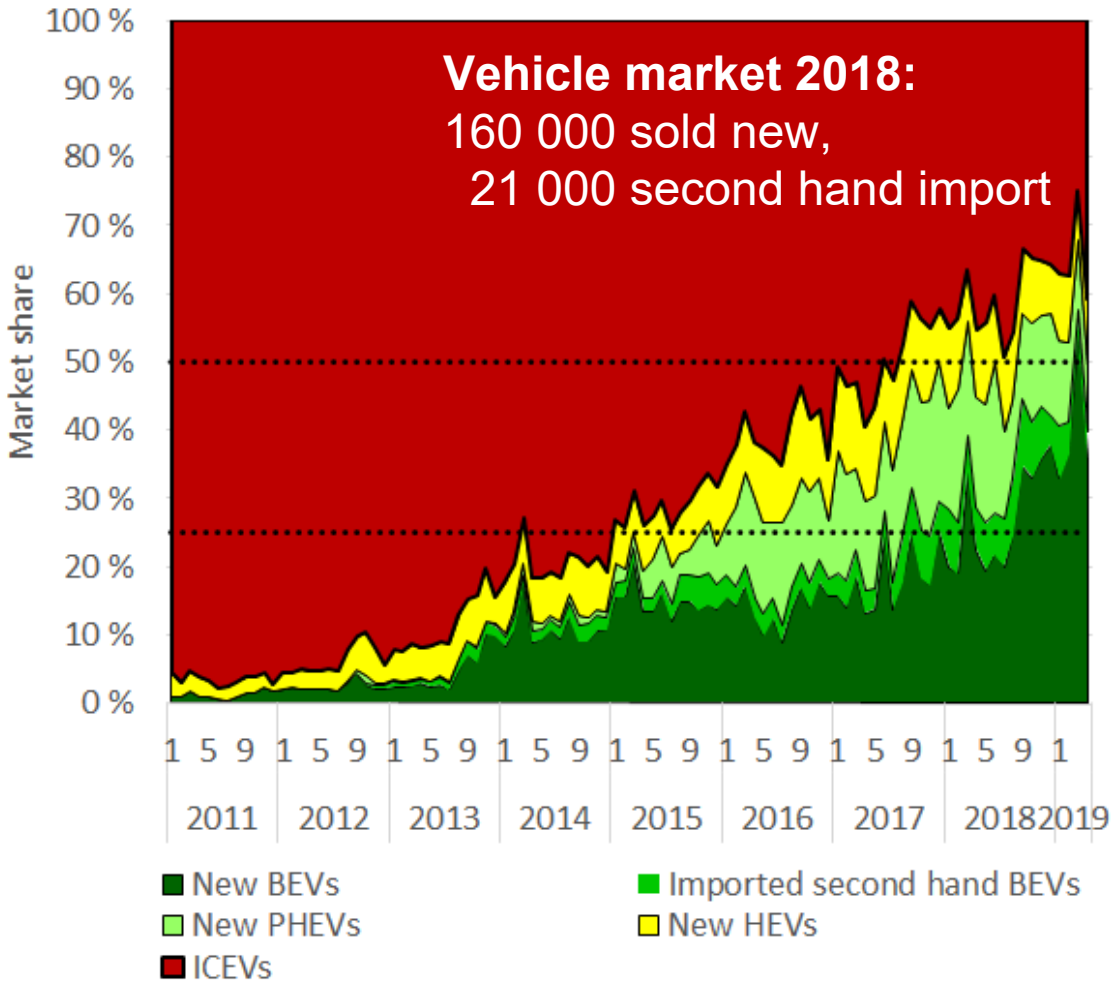
Fast charger infrastructure (status 01.01.2019)

- 1 100 CCS/Chademo 50 kW chargers, 500 locations
- Ultrafast 150-350 kW – being introduced

Travel speeds:

Main-road 

Motor-way 



Sources:
Vehicle register (status 01.01.2019) and Statistics Norway, E. Figenbaum 2018. Electromobility Status in Norway. TOI report 1627/2018. New un-published estimates from 2018 TOI BEV user survey

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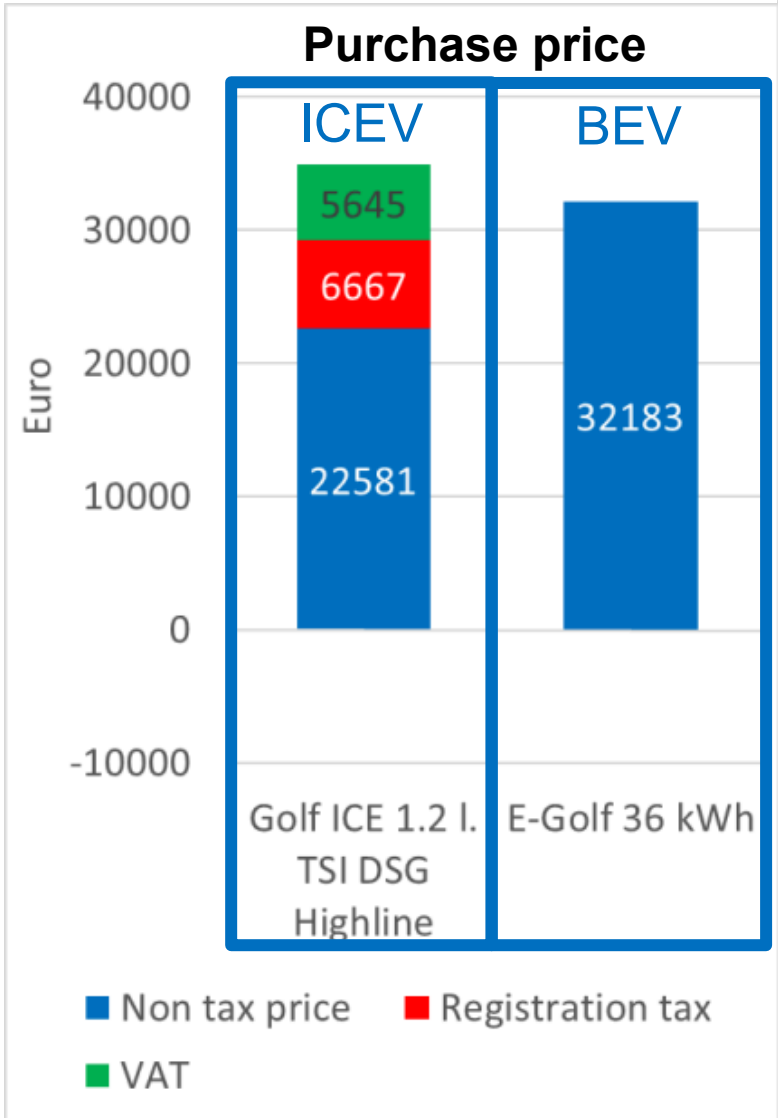
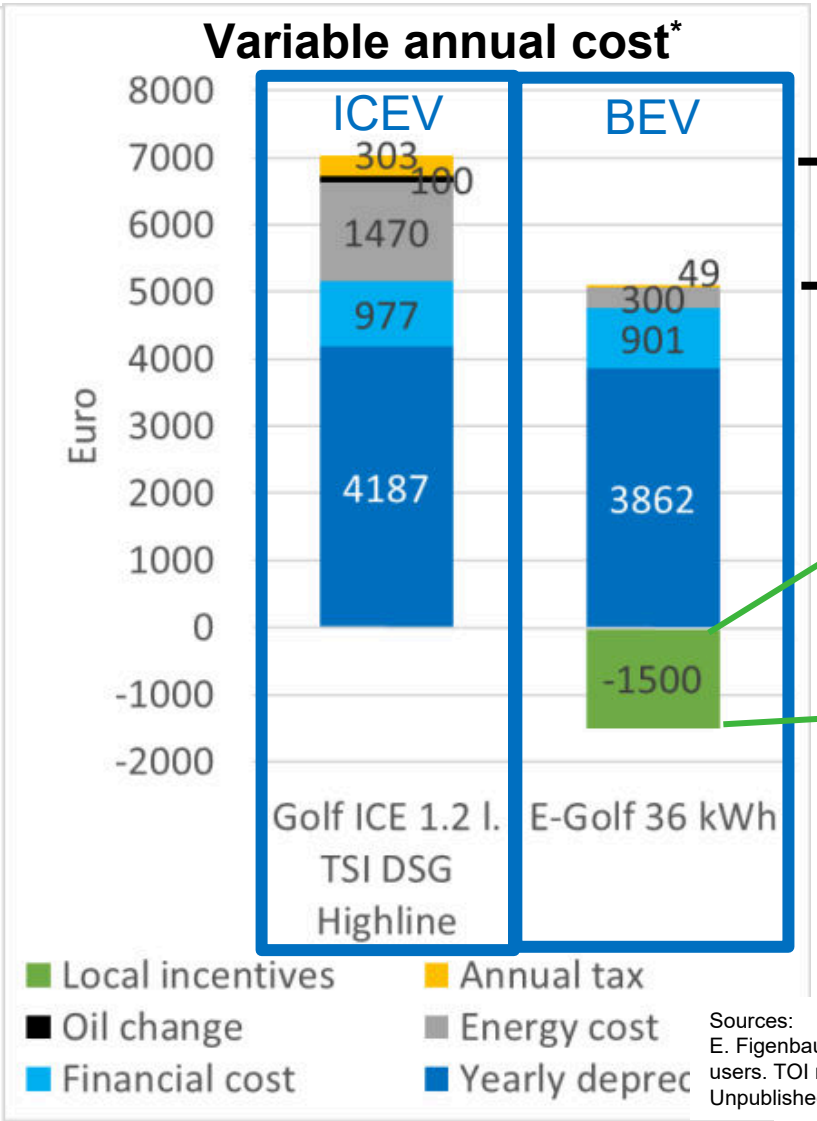
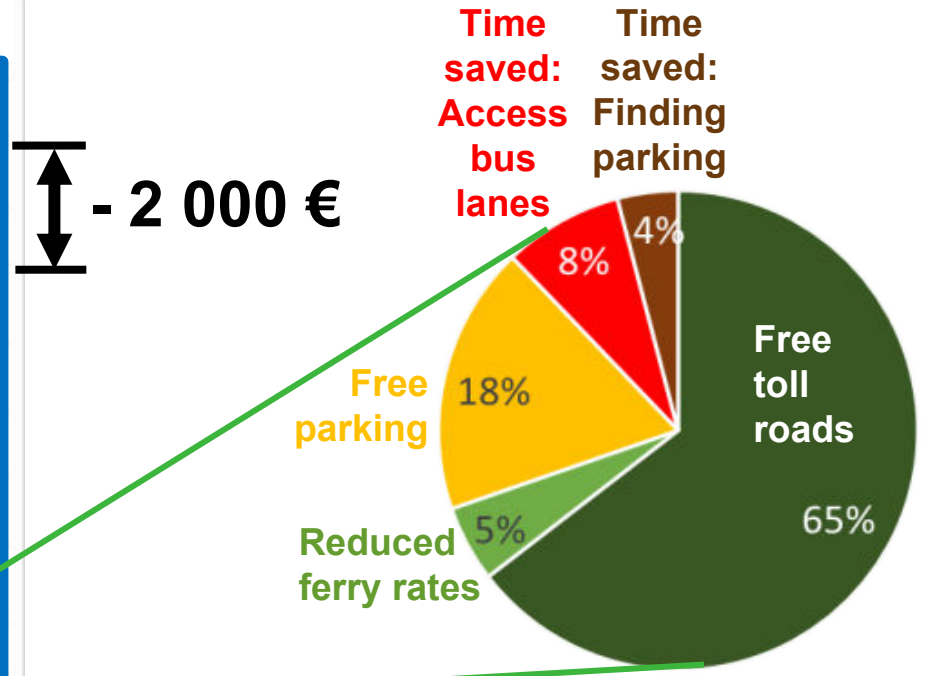
BEV economics in Norway – VW Golf - Electric vs gasoline

BEV purchase incentives: Exemption from VAT (25%) and registration tax, reduced annual tax
BEV local incentives: Free toll roads, free parking, access to bus lanes, reduced ferry rates







BEV advantage: 3 500 €/Year

*Insurance, tyre wear and other costs that do not vary is not included

Sources:
E. Figenbaum, M. Kolbenstvedt 2016. Learning from Norwegian Battery Electric and Plug-in Hybrid Vehicle users. TOI report 1492/2016. E. Figenbaum 2018. Electromobility Status in Norway. TOI report 1627/2018 Unpublished data from ELAN user survey 2018.

Datasets – Fast charging in Norway

Covers 50 kW Chademo/CCS charging: 2016Q1-2018Q1

- Dataset 1: Charger transaction data from Operator 1 - Q1 2016-Q1 2018
  - *Individual sessions, anonymous user ID allowed tracking of activity per user*
- Dataset 2: Charger usage data from Operator 2 - Jan 2016-Jan 2018
  - *Utilization rate of plug/charger, i.e. minutes in use per hour per plug/charger*
- Dataset 3: Survey of 3600 BEV users – June 2018
  - *Total use of fast chargers, opinions about fast chargers, reasons for fast charging*
- Statistics: BEV fleet composition
  - *Fleet battery size, theoretical fast charge capability*

Tesla network not included in the data, …but Tesla vehicles can occationally charge from Chademo chargers using an adapter

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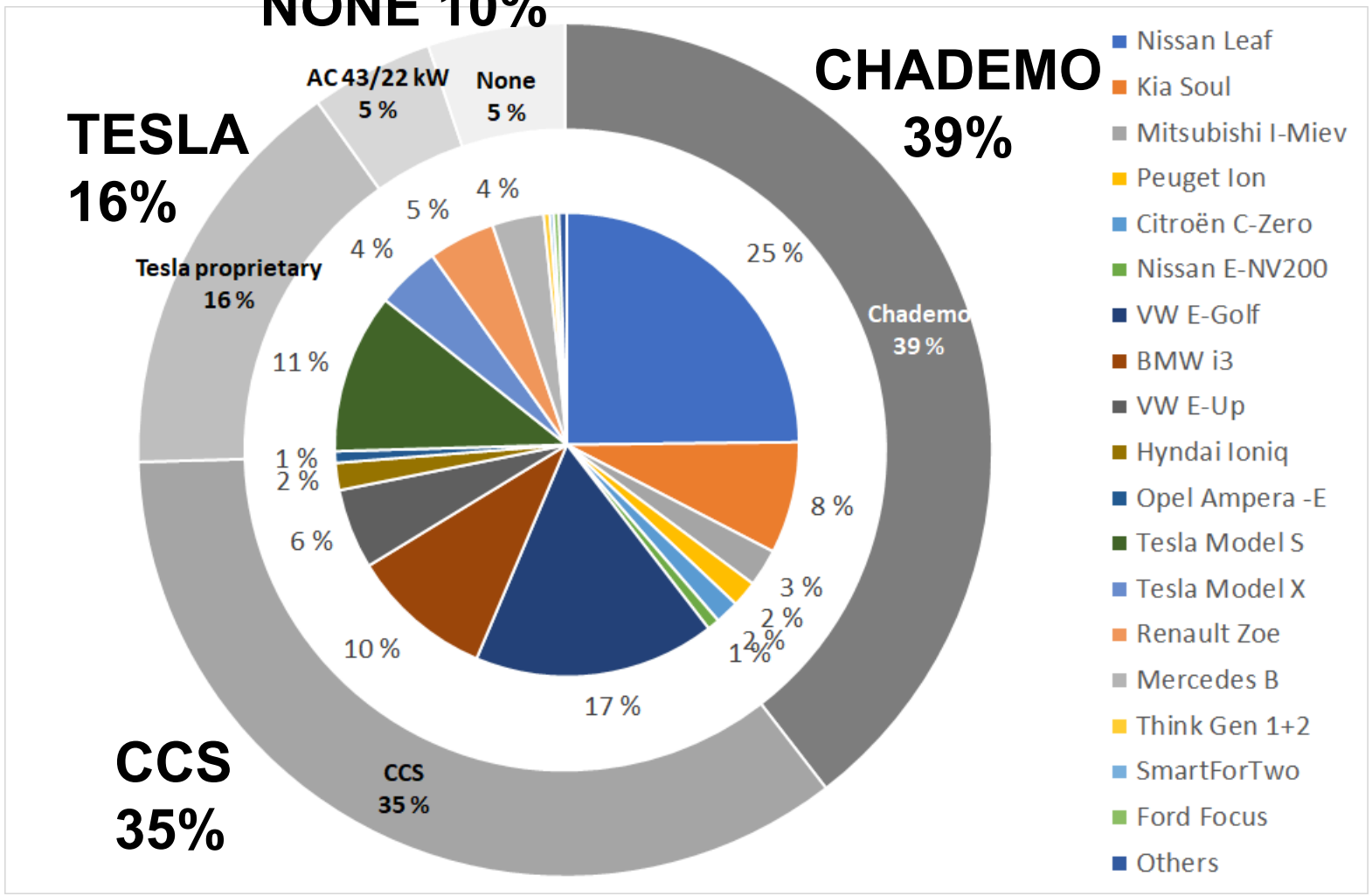
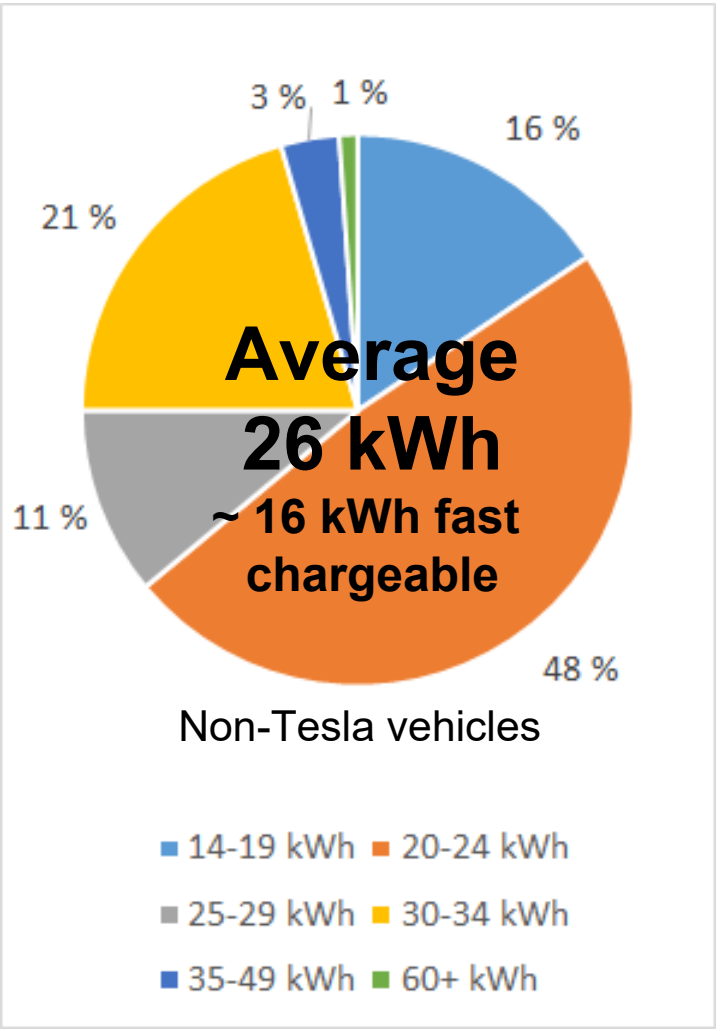
Models, charging system, battery sizes

Status 31.12.17





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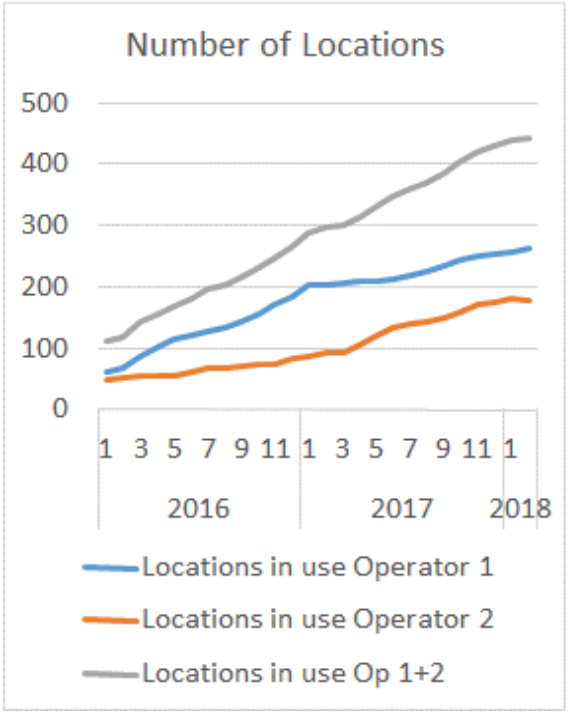
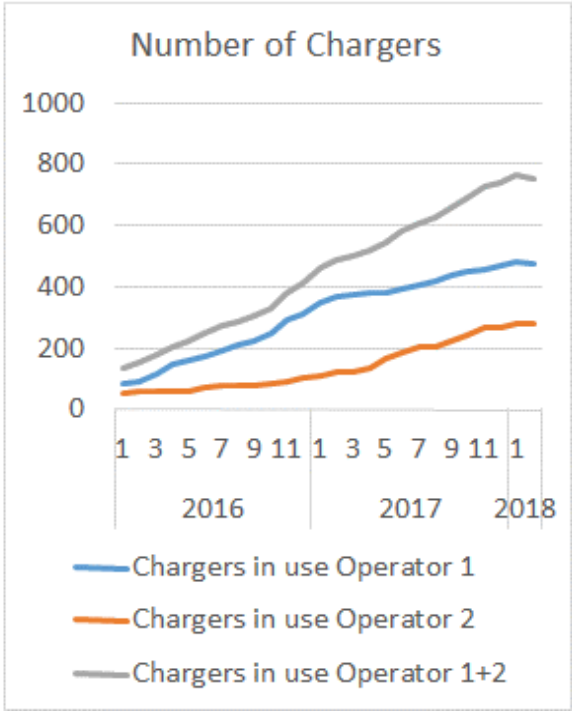
Fast chargers actively in use Jan 2016 - Jan/Mar 2018

2 nationwide operators, actual fleet size (linear interpolation within years)

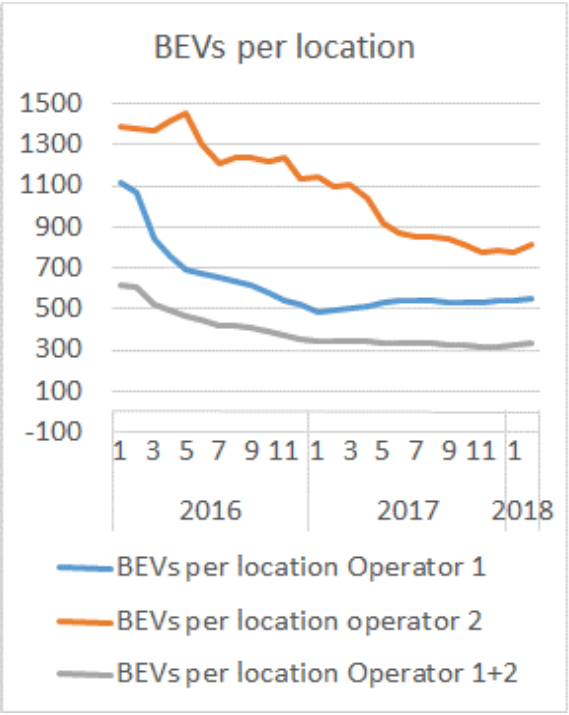
# of charger locations



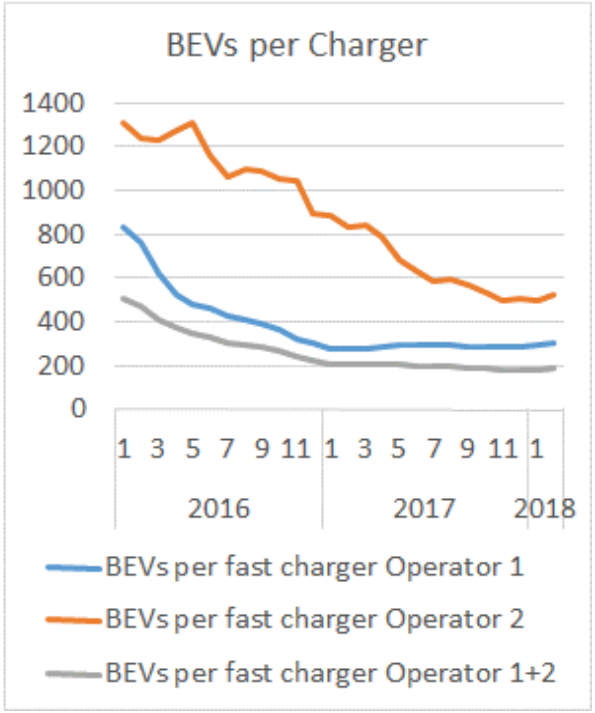
# of chargers



# of BEVs/location



# of BEVs/charger



End 2017: ~430 locations

~780 fast chargers

~300 BEVs/location

~200 BEVs/charger

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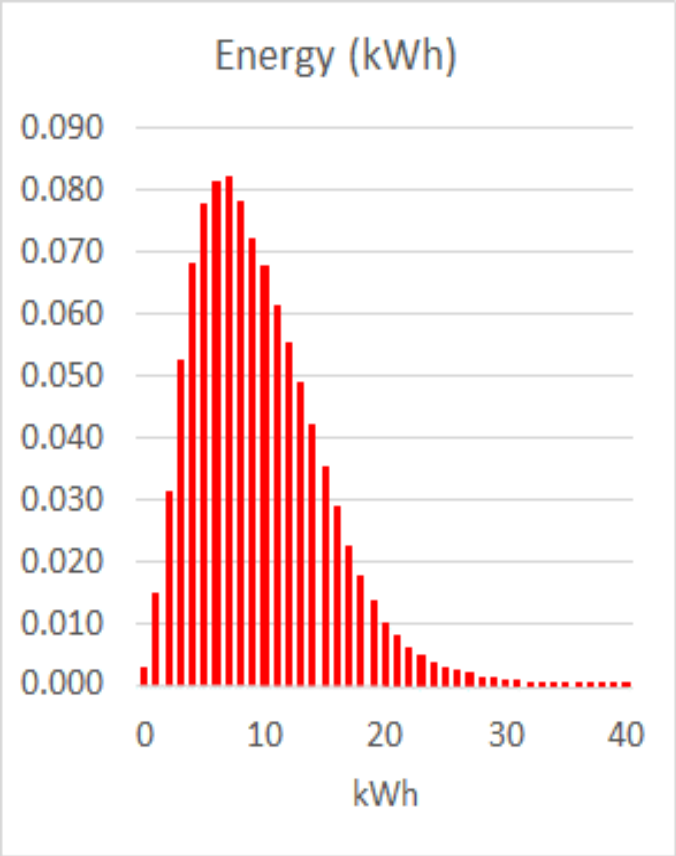
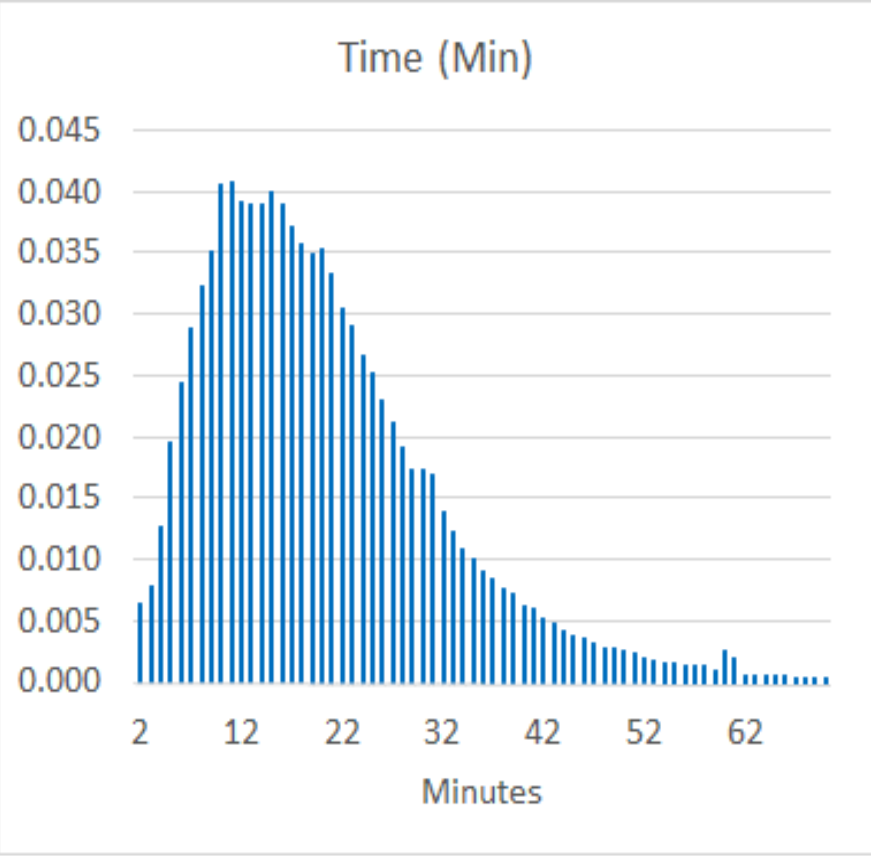
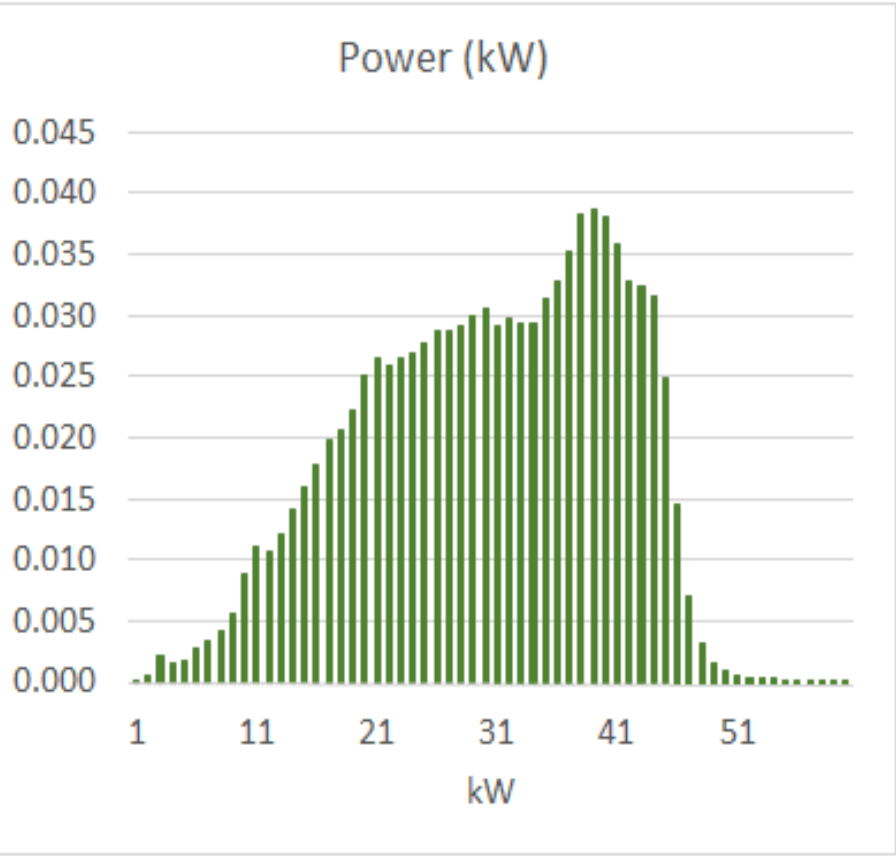
Main results: Average kWh, Minutes, kW, per charge event

Data from 1 operator, values rounded

Share of charge sessions







Average:	**9.6 kWh**	**Average:**	**20 min**
Median:	8.7 kWh	Median:	18 min
Lowest 10%:	< 3.5 kWh	Lowest 10%:	< 8 min
Highest 10%:	> 16.5 kWh	Highest 10%:	> 36 min

Average:	**30 kW**
Median:	31 kW
Lowest 10%:	< 16 kW
Highest 10%:	> 43 kW

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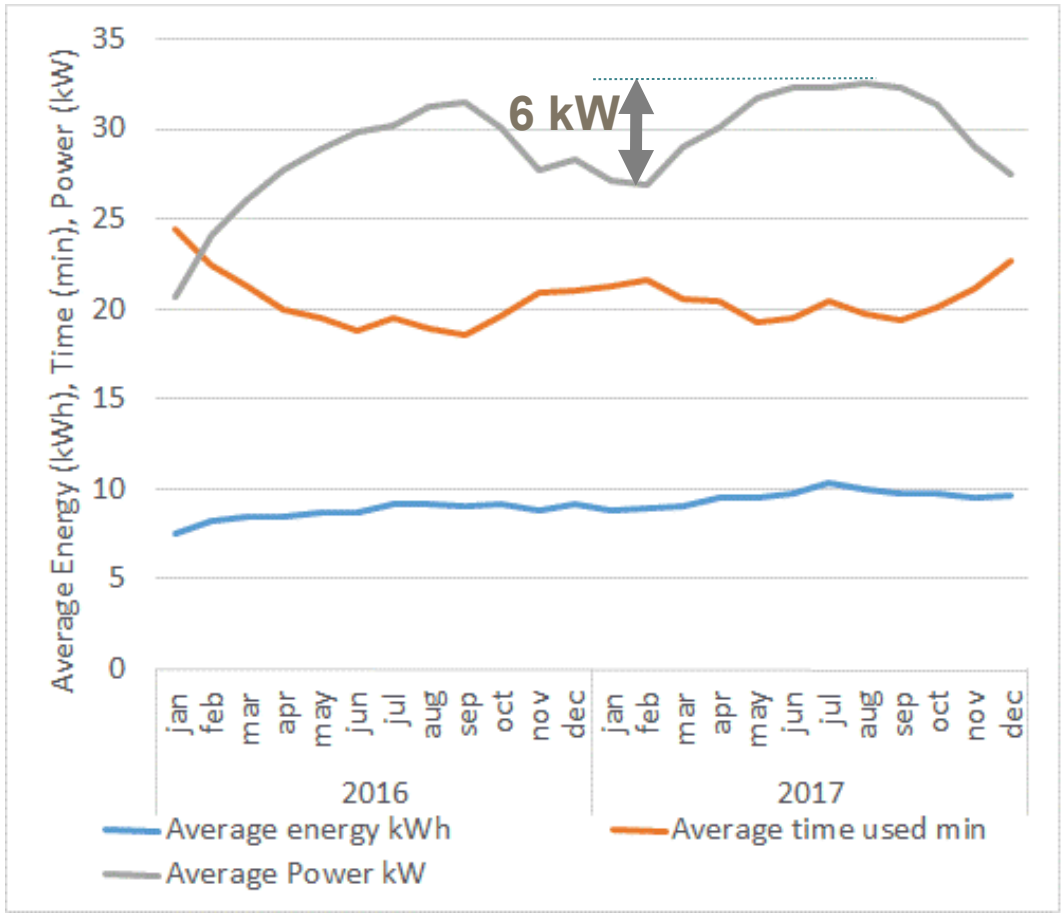
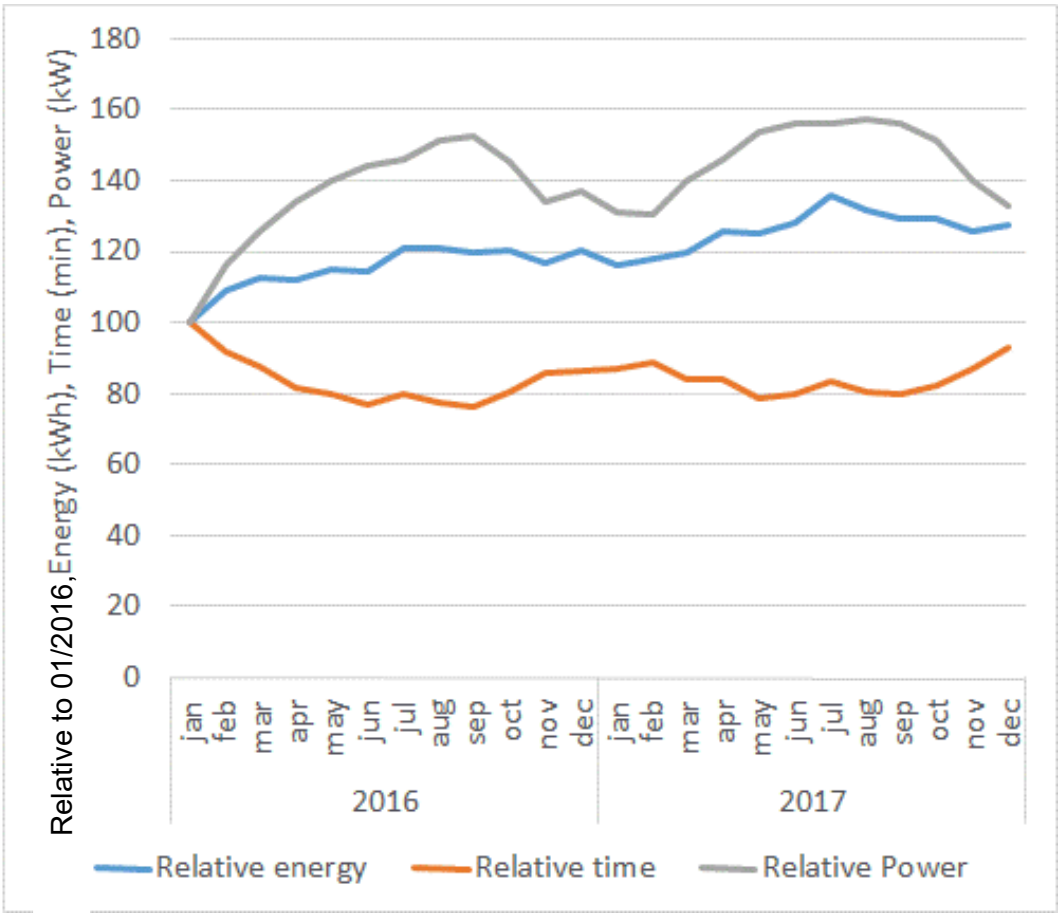
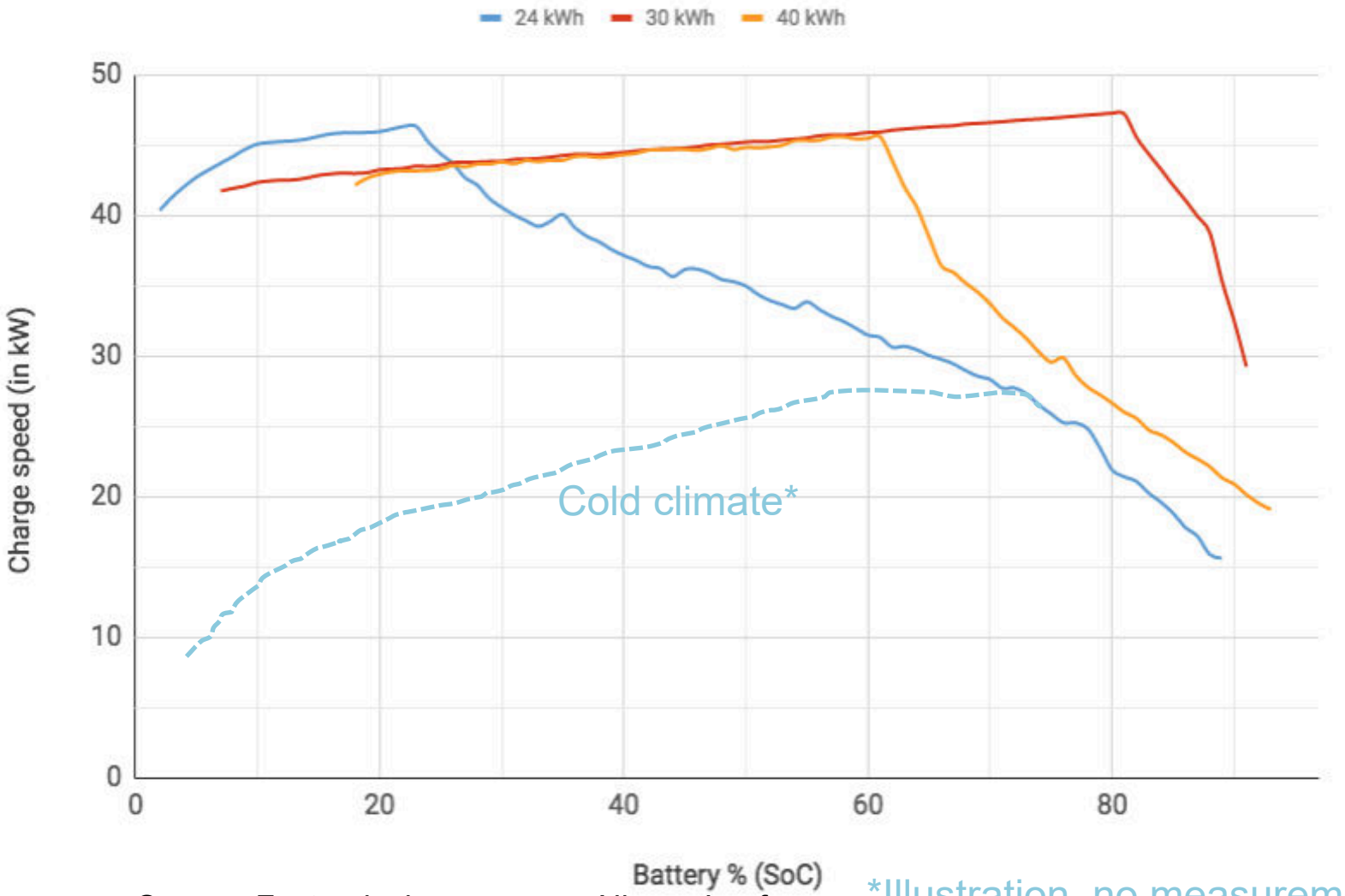
Charge power, energy, time - variability over the year





Charge power
– Average 30 kW from 50 kW chargers



Source: Fastned, charge curves Nissan Leaf

*Illustration, no measurements

Cheaper vehicles

↑

Primitive battery thermal management

↓

Inefficient charging

↓

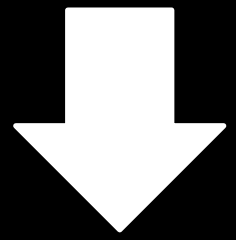
Increased infrastructure cost

↓ ↓

Increased end-user cost

Increased Government support cost

«Charge speed» is the new «range»



Type-approval test for cold and hot climate

Geographical/calendar spread of use of fast chargers

Operator 1: Fast charger usage in 2017 by users that also charged in 2016

	Average	20-perc	Median	80-perc	90-perc
# Charges per year	13.1	1	5	18	32
# Locations used	4.2	1	3	6	9
# Municipalities charged in	3.5	1	2	5	8
# Counties charged in	2.1	1	2	3	4
# Months charged in	4.3	1	3	7	10

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Four user types, markets separated by mountain chains

Users

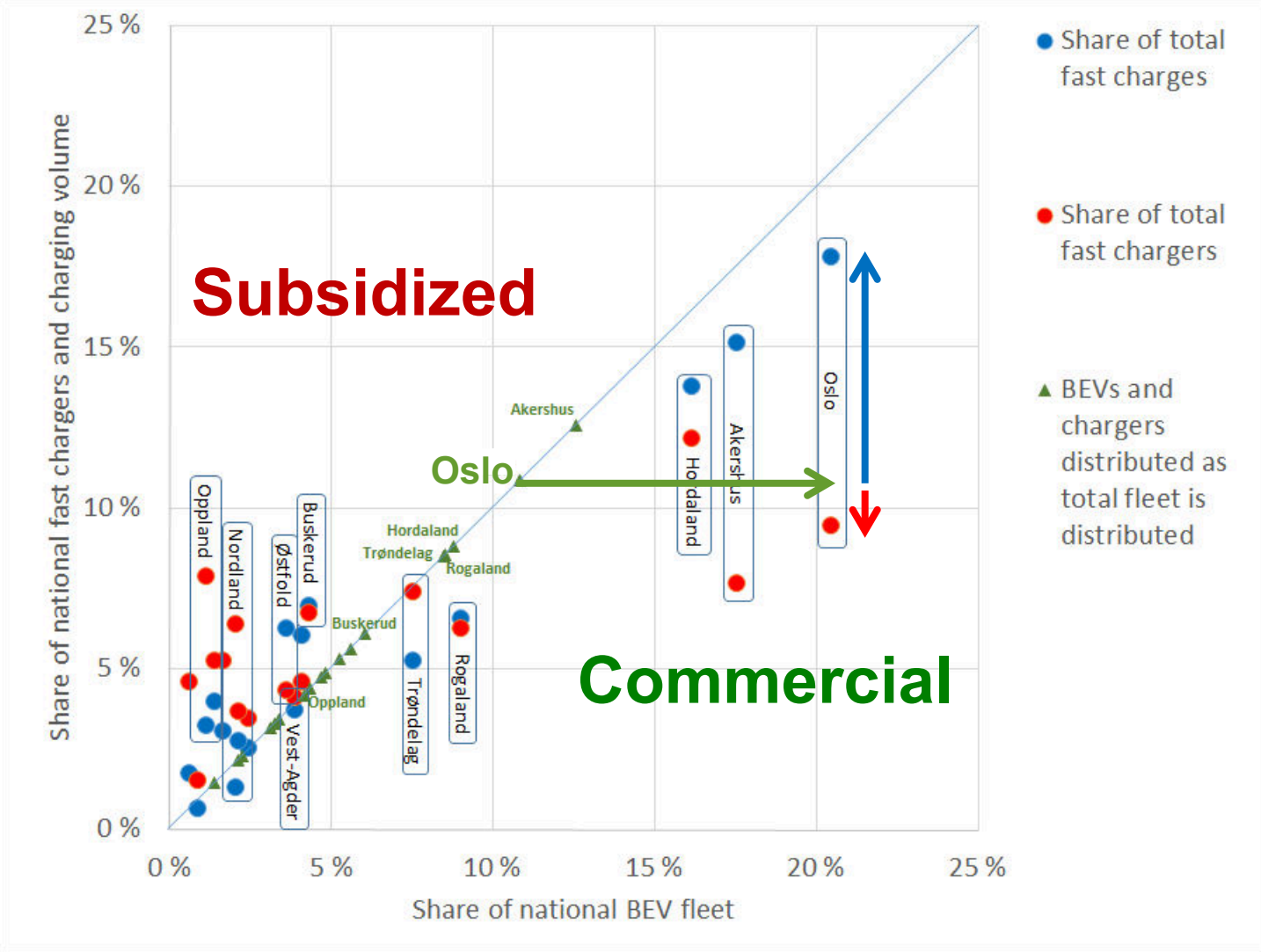
- Occasional (30%): Charge when range problem
- Frequent (10%): Professional or no home charging
- Long distance trip (rare): Get to far-away destinations
- Local/regional (common): Solve everyday needs

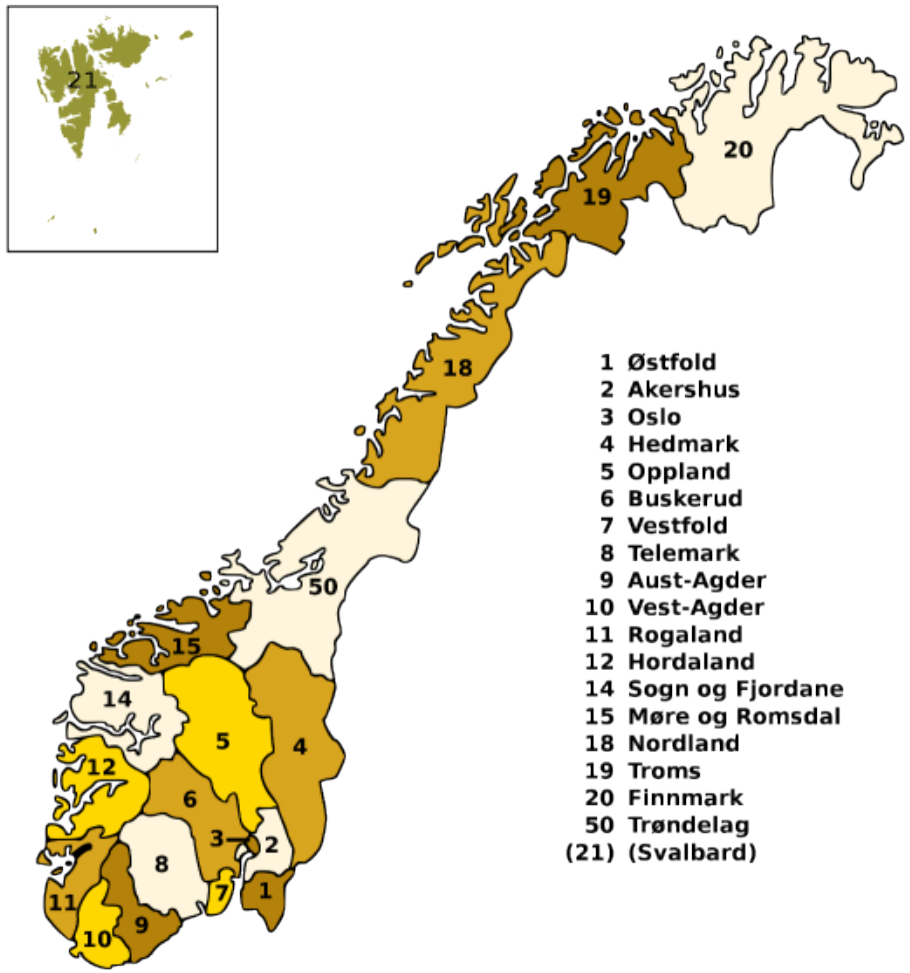
Markets

- South-East: Users often charge in other Counties
- Other areas: Majority charge in one County

Total national charging activity

Counties share of national charge events, chargers, BEV fleet (relative scale)





Based on actual data from 2 main nationwide operators and 1 large local operator (estimated values)

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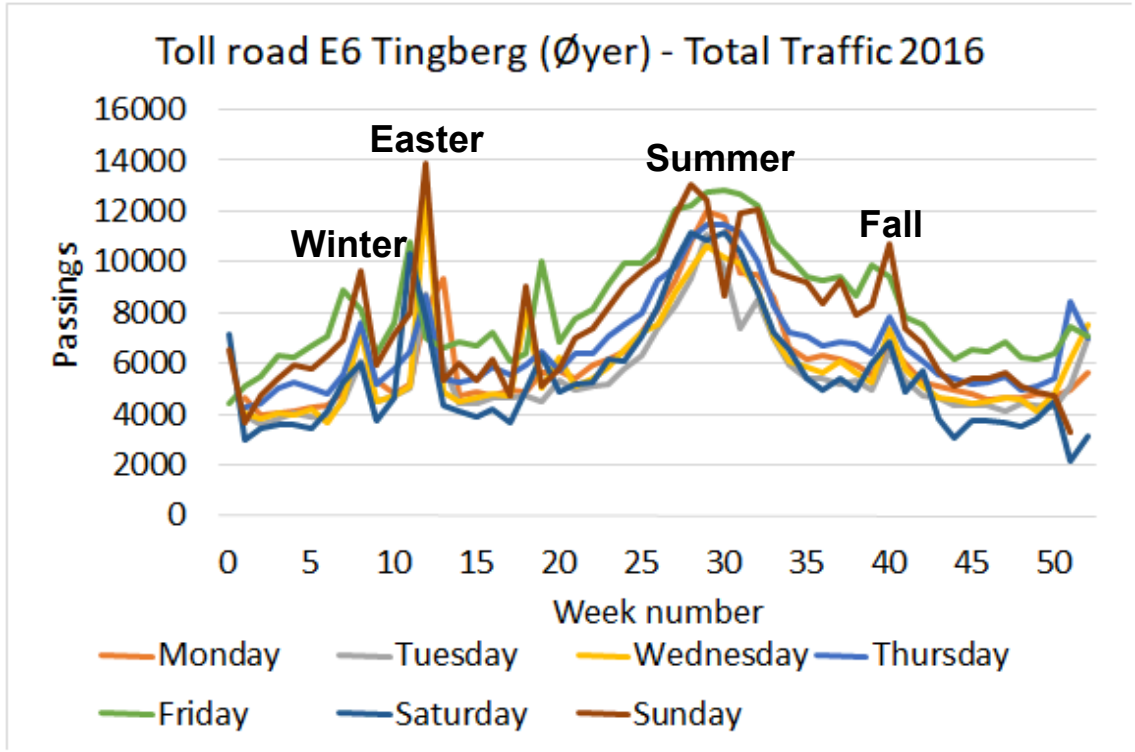
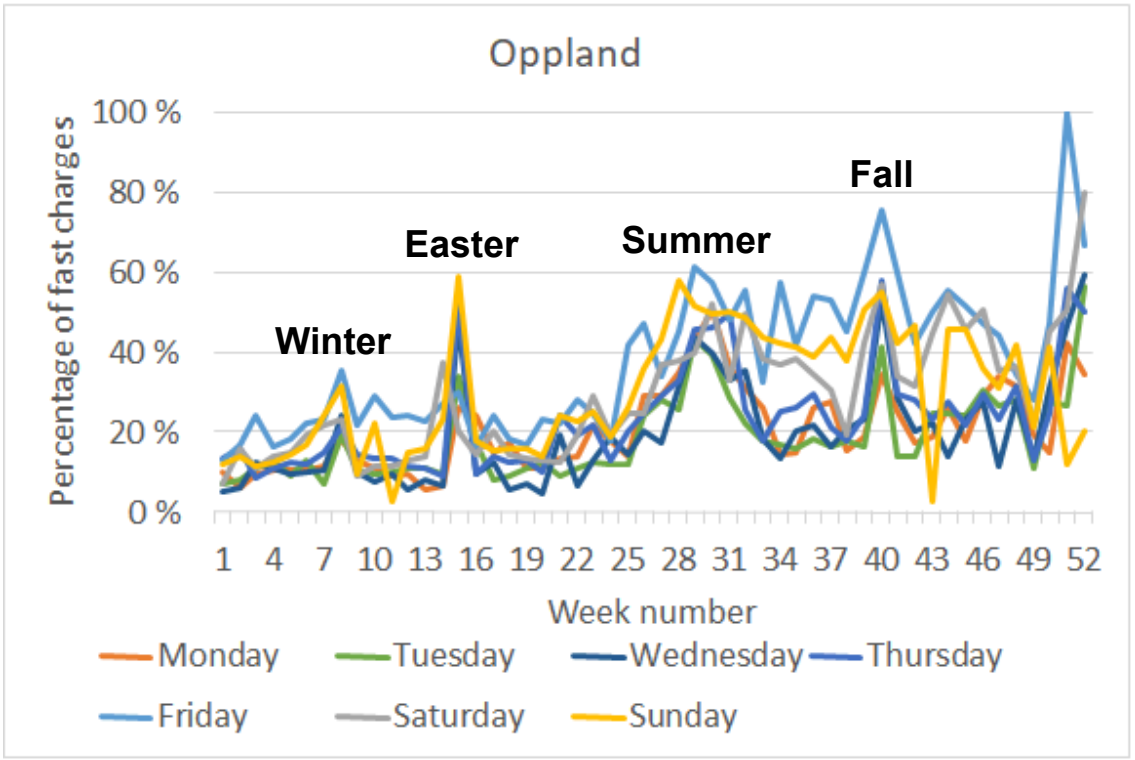
Huge variation in demand over the year due to variation in traffic flow

Transport corridors far from major cities – High risk of queues in main vacation periods

Traffic in toll road E6 (major road north-south) – Øyer (Oppland county) 2016



Demand for fast charging Operator 1 – Oppland county 2017



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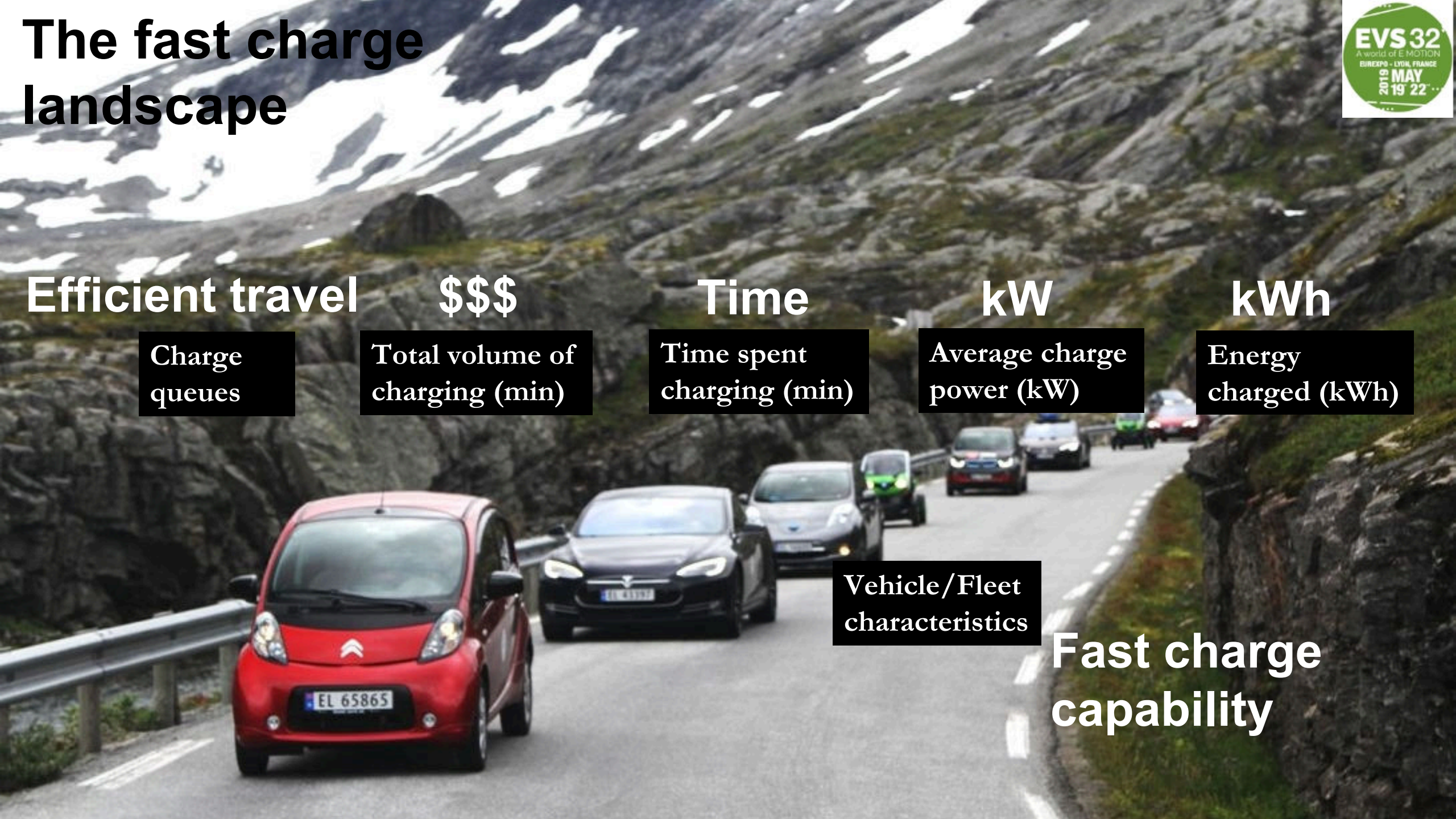
The fast charge landscape



Efficient travel

Charge queues

$$$

Total volume of charging (min)

Time

Time spent charging (min)

kW

Average charge power (kW)

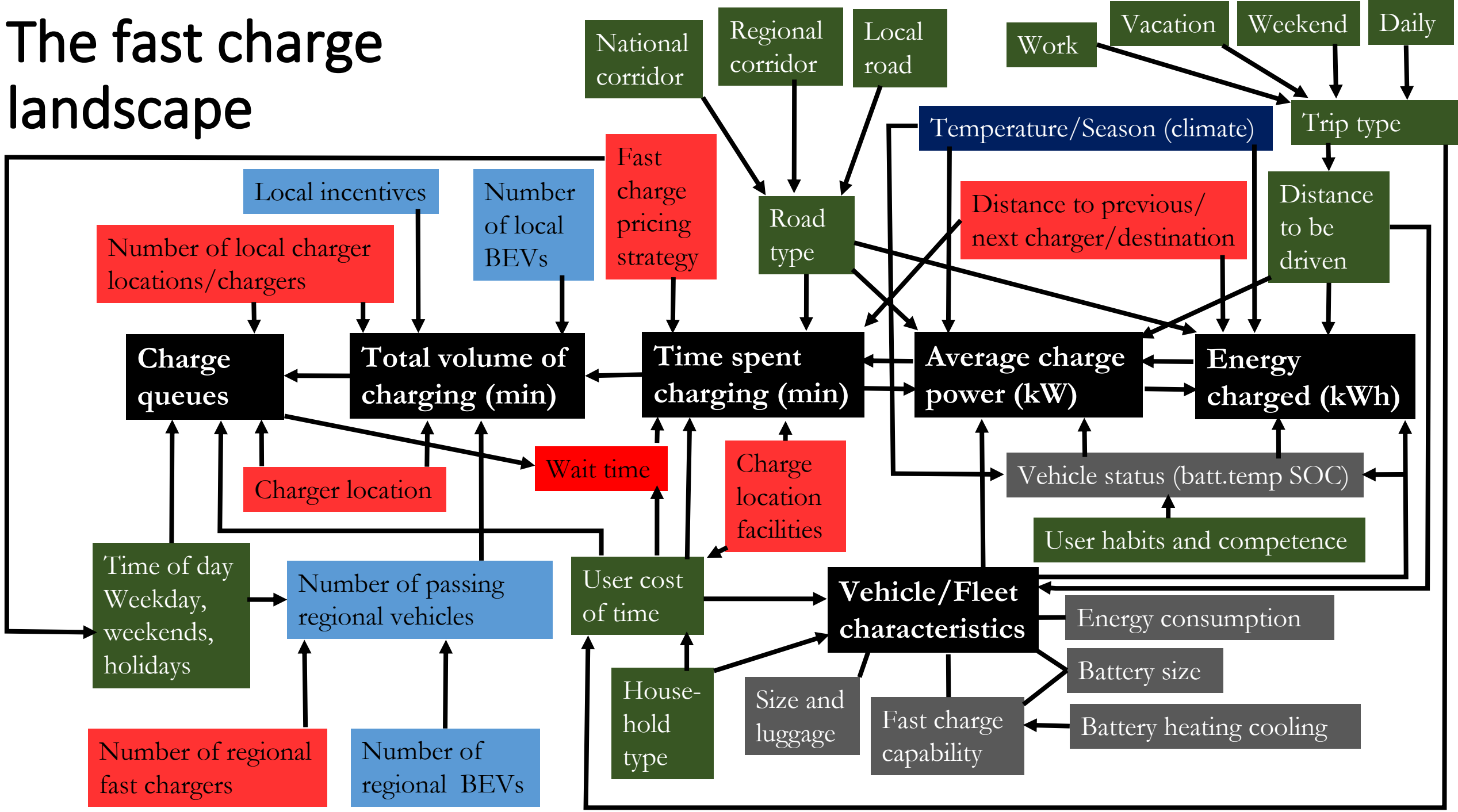
kWh

Energy charged (kWh)

Vehicle/Fleet characteristics

Fast charge capability

The fast charge landscape



Source: E. Figenbaum 2019. Charging into the future. Analysis of fast charger usage. TOI report 1682/2019. Institute of Transport Economics, Oslo, Norway

Recommendations

Charging network

- Denser charger networks for efficient charging
- Local daily use needed for profitability

Government

- Type approval test of fast charge speed
- Measures for unprofitable corridor chargers
- Balanced national BEV roll out

User information

- Efficient use of fast chargers
- Peak demand times

More information

efi@toi.no

https://www.toi.no/staff/figenbaum-erik-article31076-27.html