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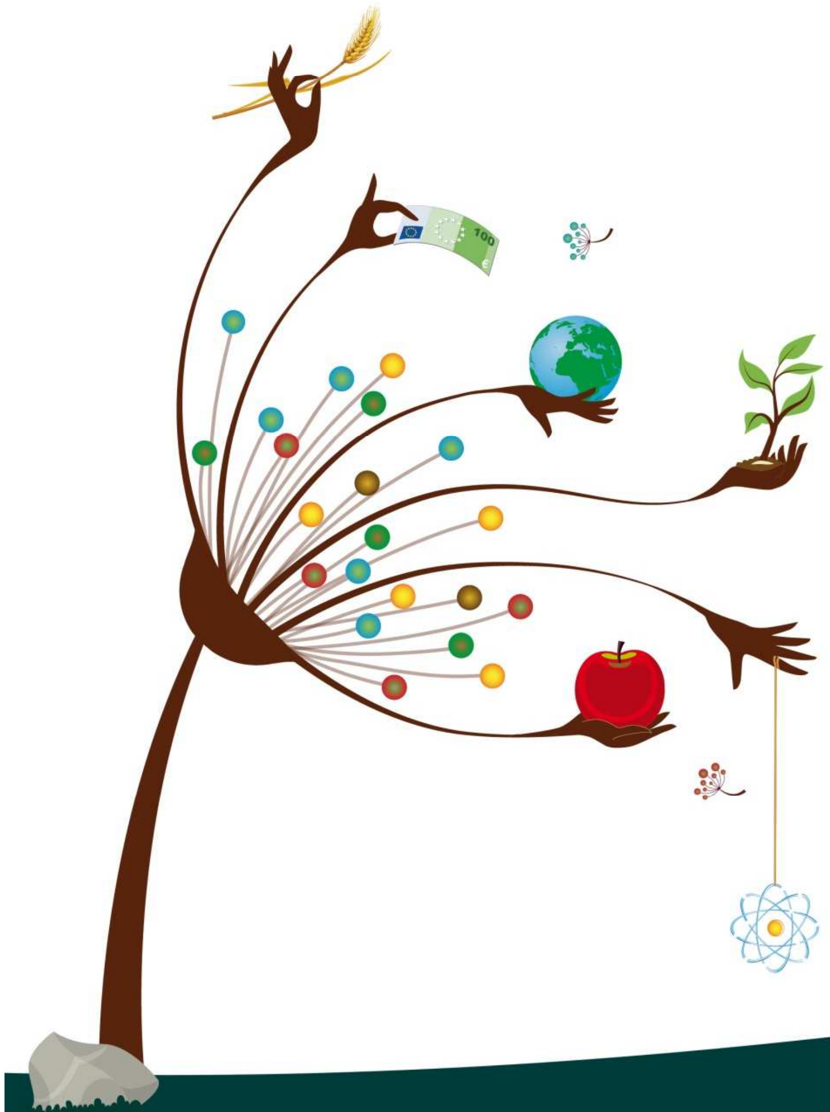

Using big data to relieve energy distribution stresses

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ESS Big Data Workshop 2016
Ljubljana, Slovenia

European Commission

JRC's Mission and Role

... is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

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JRC is the European Commission's in-house science service and the only DG executing direct research; providing science advice to EU policy.

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€ 386 million budget annually,
plus € 62 million earned income

JRC

5 countries
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125
instances of support
to the EU policy-maker
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3023
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Over 1,400
scientific publications per year

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Locations: Petten (NL), Ispra (IT) and Seville (ES)

Seven scientific units:

- Energy Storage
- Energy Efficiency & Renewables
- **Energy Security, Distribution and Markets**
- Sustainable Transport
- Air & Climate
- Economics of Climate Change, Energy & Transport
- Knowledge for Energy Union

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Using big data to relieve energy distribution stresses

The problem

- Hybrid and electric vehicles will increase, and stress electricity distribution networks.

Registered vehicles (NL)	
2014	45.000
2015	87.700
2016:3	**96.700**

Targets (NL)	
2015	20.000
2020	200.000
2025	**1.000.000**

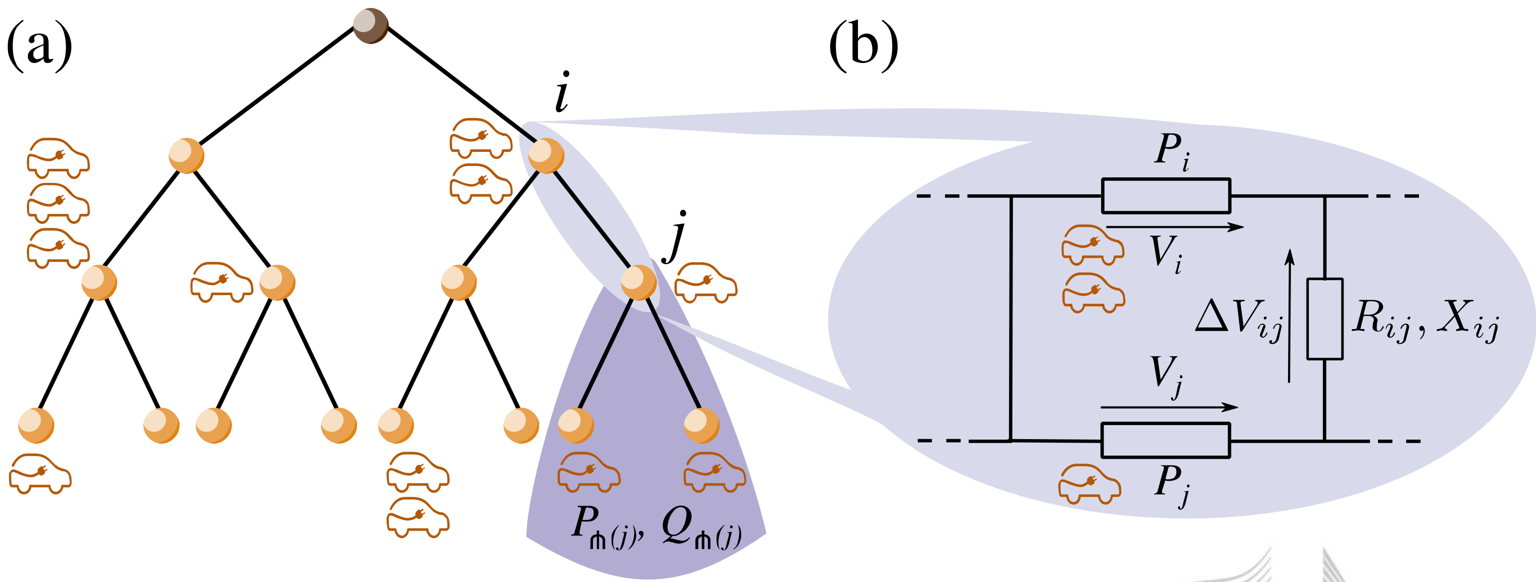
Source: Netherlands Enterprise Agency (RVO.nl)

Vehicle owners (Deloitte, 2010):

- prefer home charging,
- would consider day charging,
- are unwilling to accept a charging time of 8 hours

The problem

"if too many vehicles plug-in to the network,
charging takes too long,
more cars arrive than leave fully charged,
and the system undergoes a continuous phase transition to a
congested state"
Carvalho et al., 2015



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Our work

- To model **congestion management** for grids

Benefits:

- Less need for new infrastructure.
- Better services for consumers.
- Minimize electricity disruptions.

Data

Past
- Simulated data (Carvalho *et al.*, 2015)

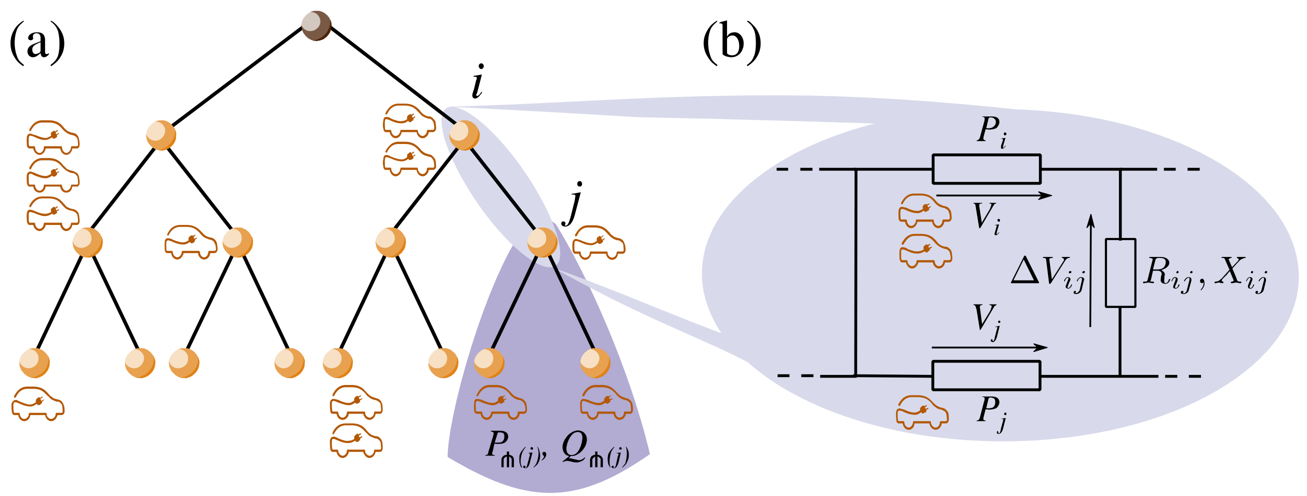
Present
- Real data for NL: charging stations

Future
- Real big data from smart metering

The model

Alternative congestion control mechanisms

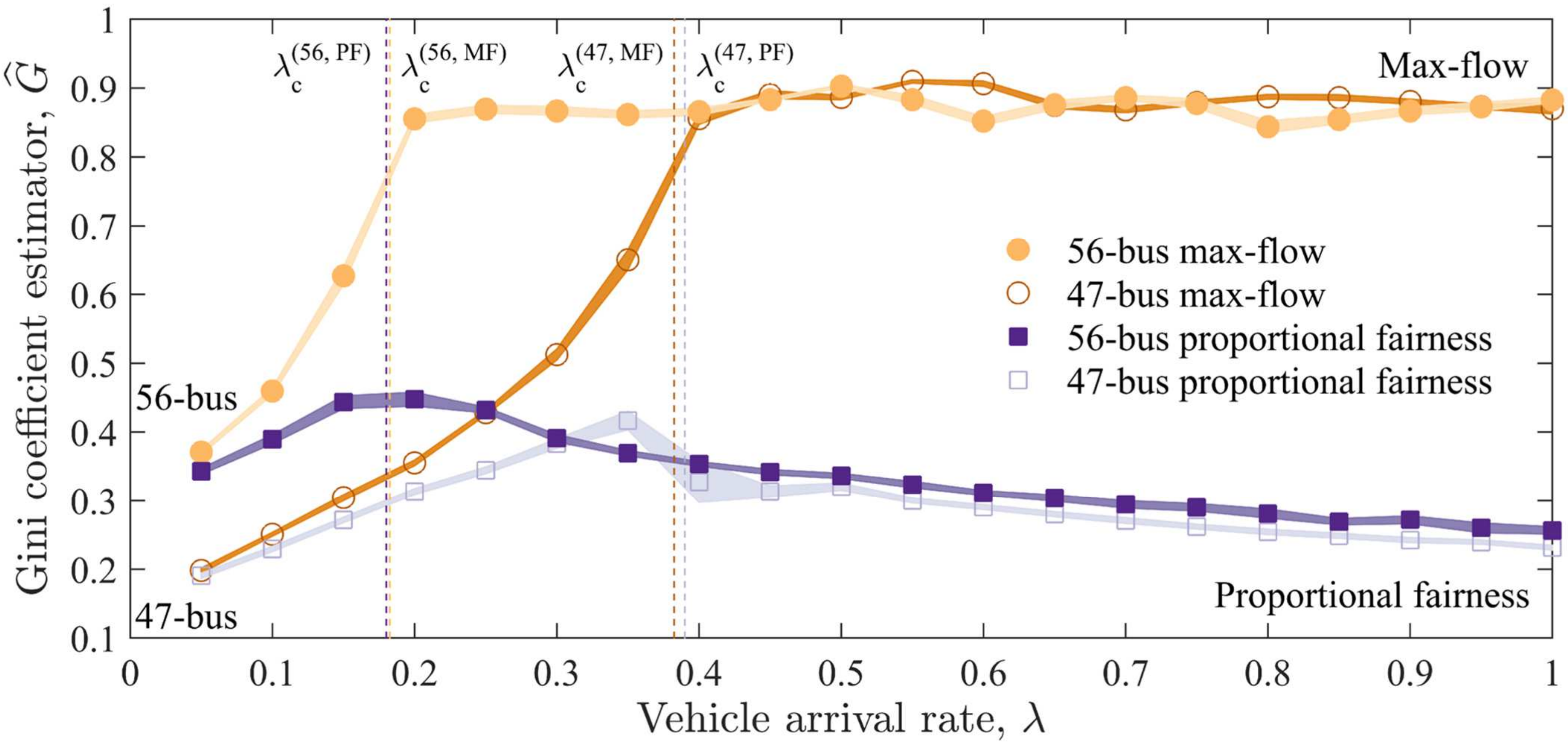
- Max-flow: the closer, the better
- Proportional fairness*: (more) equal treatment



** see Kelly and Yudovina, 2014*

Results with simulated data

Gini coefficient (Carvalho *et al.*, 2015)



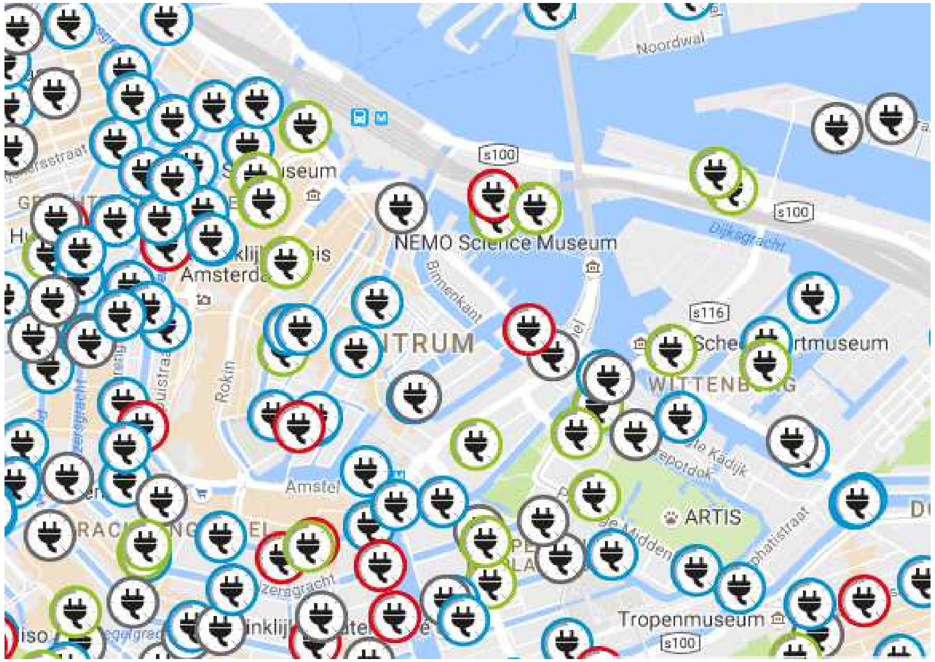
Sweden: G=0.26
US: G=0.41
Seychelles: G=0.66

Real data for NL

Charging stations in NL

Charging stations (NL)			
	Public	**Semi-public**	**Private (est.)**
2014	5.400	6.400	28.000
2015	7.400	10.400	55.000
2016:2	**8.800**	**15.200**	

Source: Netherlands Enterprise Agency (RVO.nl)



Source: https://www.oplaadpunten.nl/

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The data

Data from company with public charging stations

Main data:

- **~1.000.000 transactions**
- Jan 2012 - March 2016
- 1.747 charging points (~20% of total)
- 53.832 unique cards

Secondary: intra-transaction metering

- ~30.000.000 data rows

Data fields

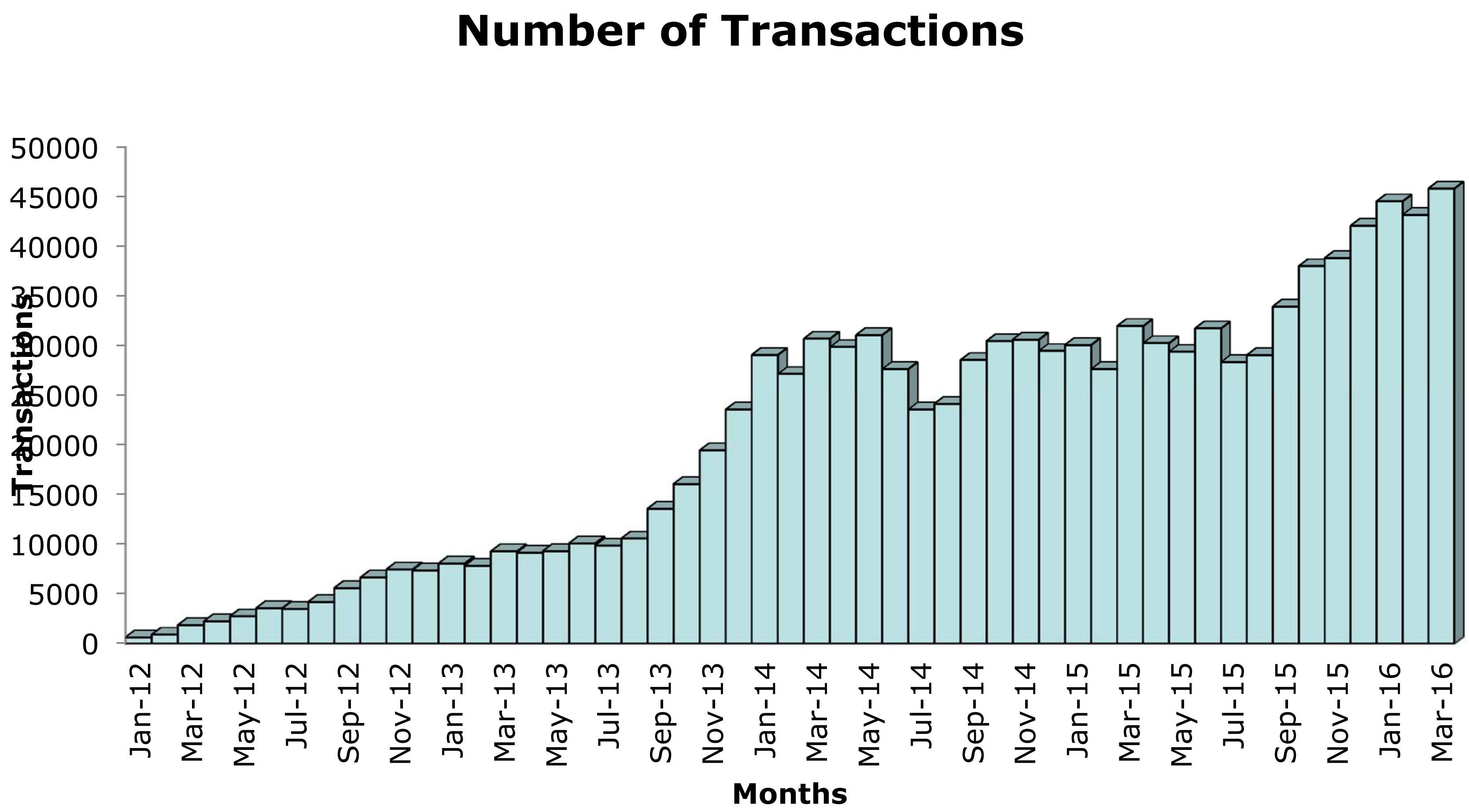
Main data (1 mil data rows):

- Transaction id
- Stop card
- Transaction start/stop
- Meter value start/end transaction
- Connected time
- Charge time
- Charge point location

Secondary data (30 mil data rows):

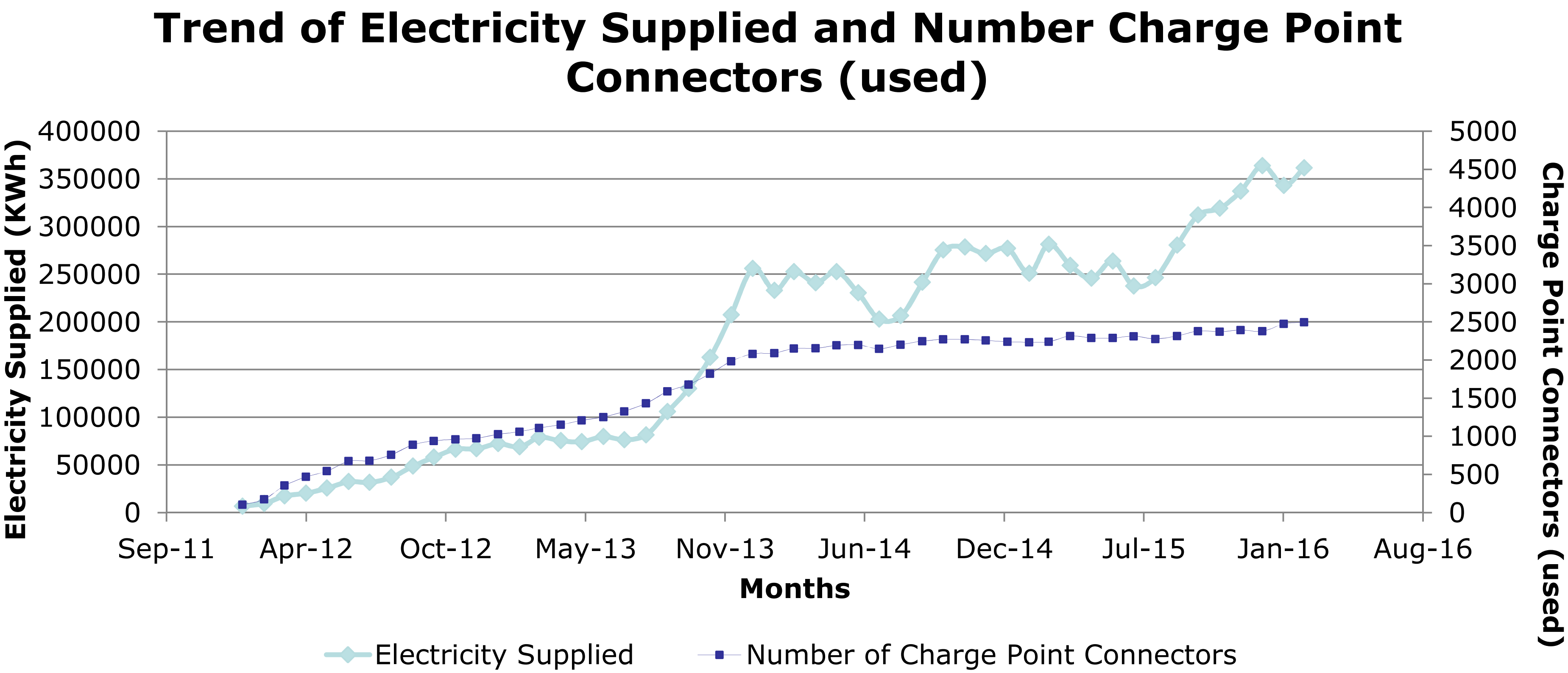
- Meter readings with 15 minutes intervals
- Average power

The data



Number of Transactions
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Transactions
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15
Sep-15
Nov-15
Jan-16
Mar-16
Months

The data



Trend of Electricity Supplied and Number Charge Point Connectors (used)
Electricity Supplied (KWh)
400000
350000
300000
250000
200000
150000
100000
50000
0
Charge Point Connectors (used)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Sep-11
Apr-12
Oct-12
May-13
Nov-13
Jun-14
Dec-14
Jul-15
Jan-16
Aug-16
Months
Electricity Supplied
Number of Charge Point Connectors

The data

- Average connected time: ~7h15
- Average charge time: ~2h30
- **Average idle time: ~4h40**

- Average Max Power: ~3.7 kWh

- Total energy: ~9 GWh
- **Average total energy: ~8.5 kWh**

Next steps: data analysis

Derive spatial and temporal behaviours:

- patterns of charging station usage
- flexibility of users to charge at different stations and times
- factors that influence the evolution of the utilisation of charging stations

User strategies for charging:

- vehicle arrival and departure times
- state of charge
- user charging habits
- trip duration or length

Future activities

- Complete the model runs
- Acquire data for more charging stations/countries
- **Acquire georeferenced data for smart meters (home and sub-stations) and the distribution network**

References

- Carvalho R., et al. (2015), Critical behaviour in charging of electric vehicles, *New Journal of Physics (17.9: 095001).*

- Deloitte (2010), *Gaining traction: a customer view of electric vehicle mass adoption in the US automotive market US Survey of Vehicle Owners Technical Report Deloitte Development LLC*

- Kelly F. and Yudovina E. (2014) *Stochastic Networks,* Cambridge: Cambridge University Press.

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