Modelling smart charging in Dutch neighbourhoods

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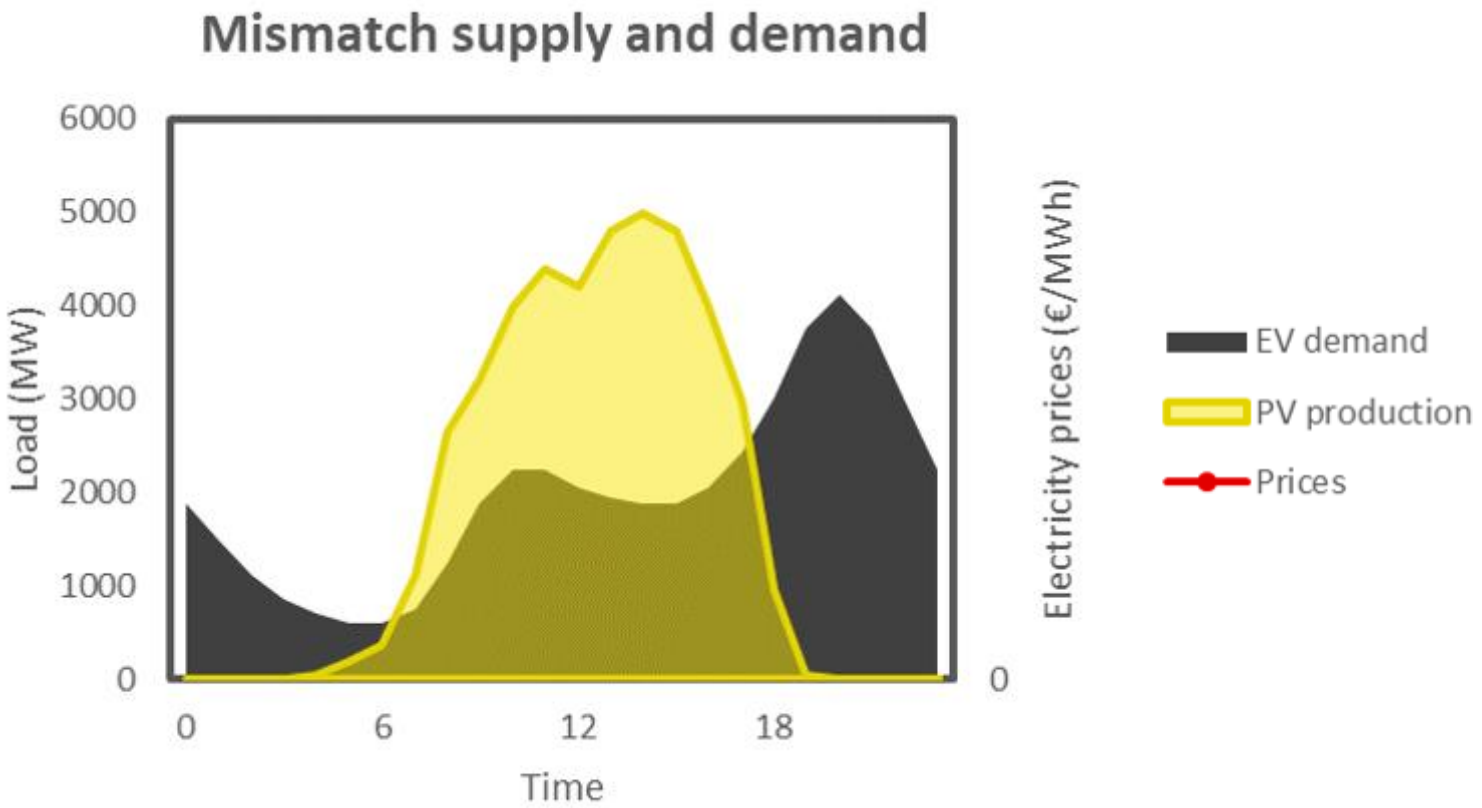
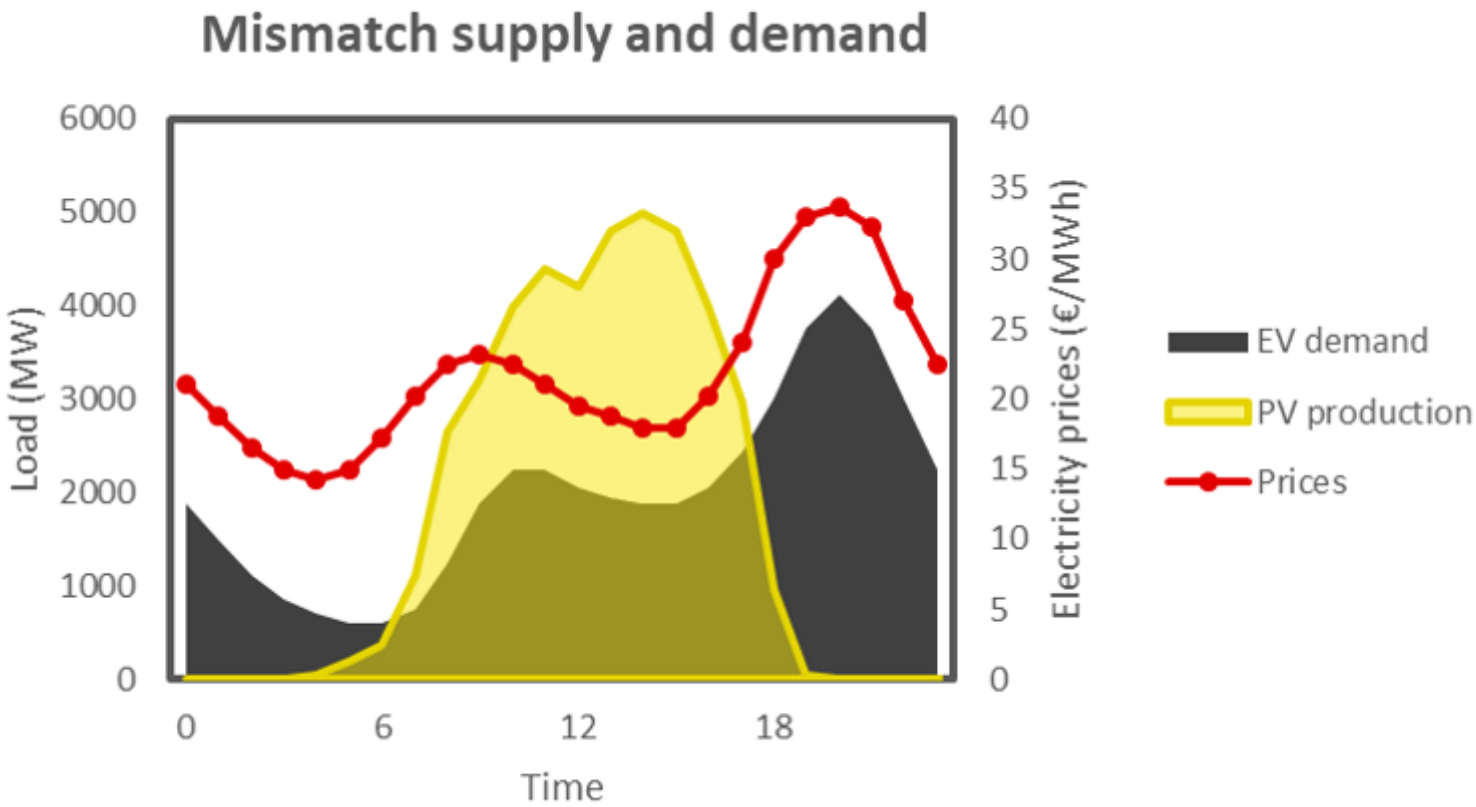
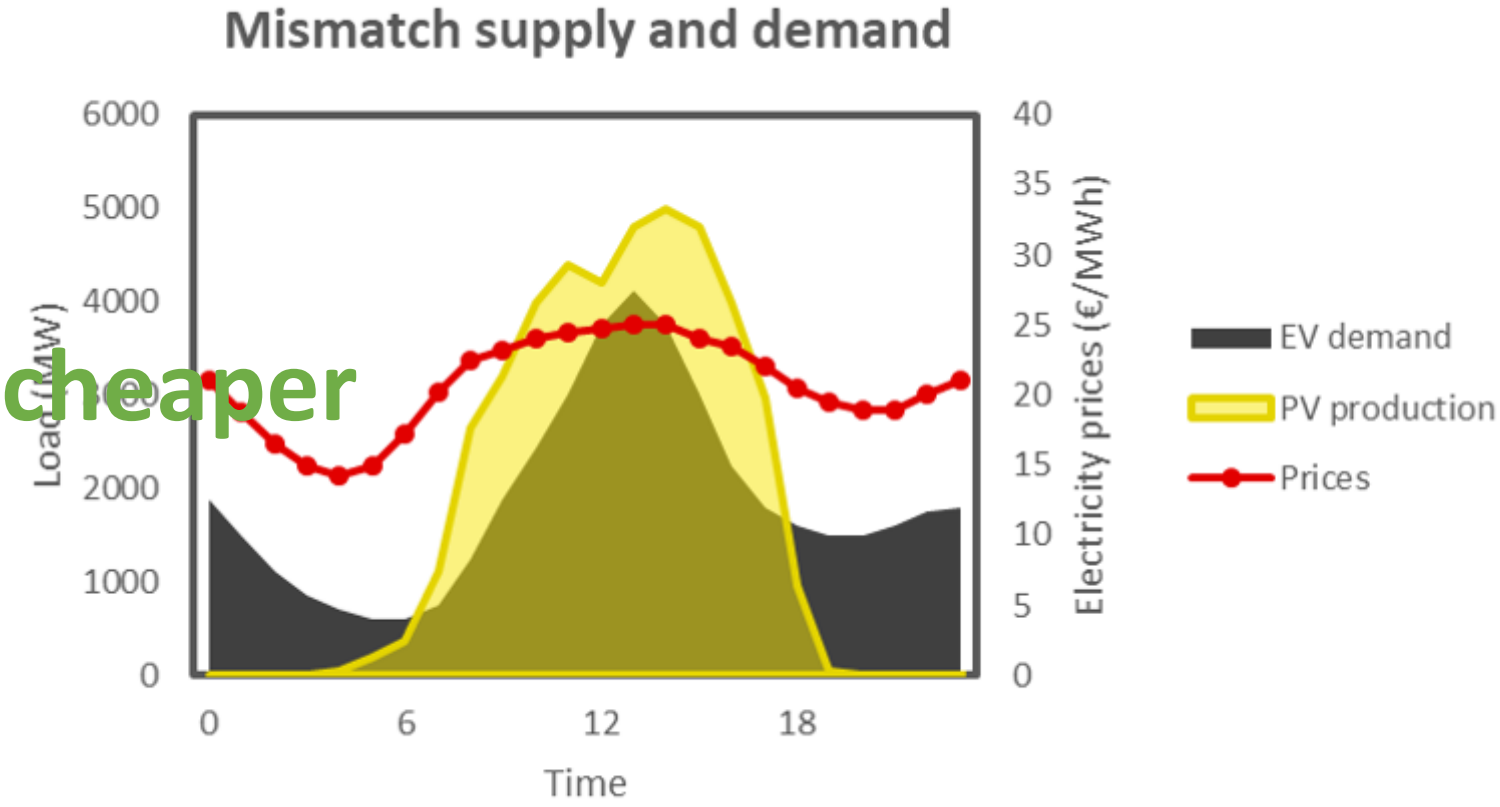

Mismatch supply and demand
6000
5000
4000
3000
2000
1000
0
Load (MW)
0
6
12
18
Time
0
Electricity prices (€/MWh)
EV demand
PV production
Prices


Mismatch supply and demand
6000
5000
4000
3000
2000
1000
0
Load (MW)
40
35
30
25
20
15
10
5
0
Electricity prices (€/MWh)
0
6
12
18
Time
EV demand
PV production
Prices

1. Drive more sustainable

2. Charge cheaper



3. Cost effective electricity network

Who am I?

1. MSc Energy Science

2. Smart charging SparkCity model

3. Demand response & energy markets

SparkCity model in

BARCELONA

Content

PART 1: *Example scenario analyses*

PART 2: *Modelling approach*

PART 3: *What's next*

PART 1:

Example scenarios

Stakeholder questions about smart charging

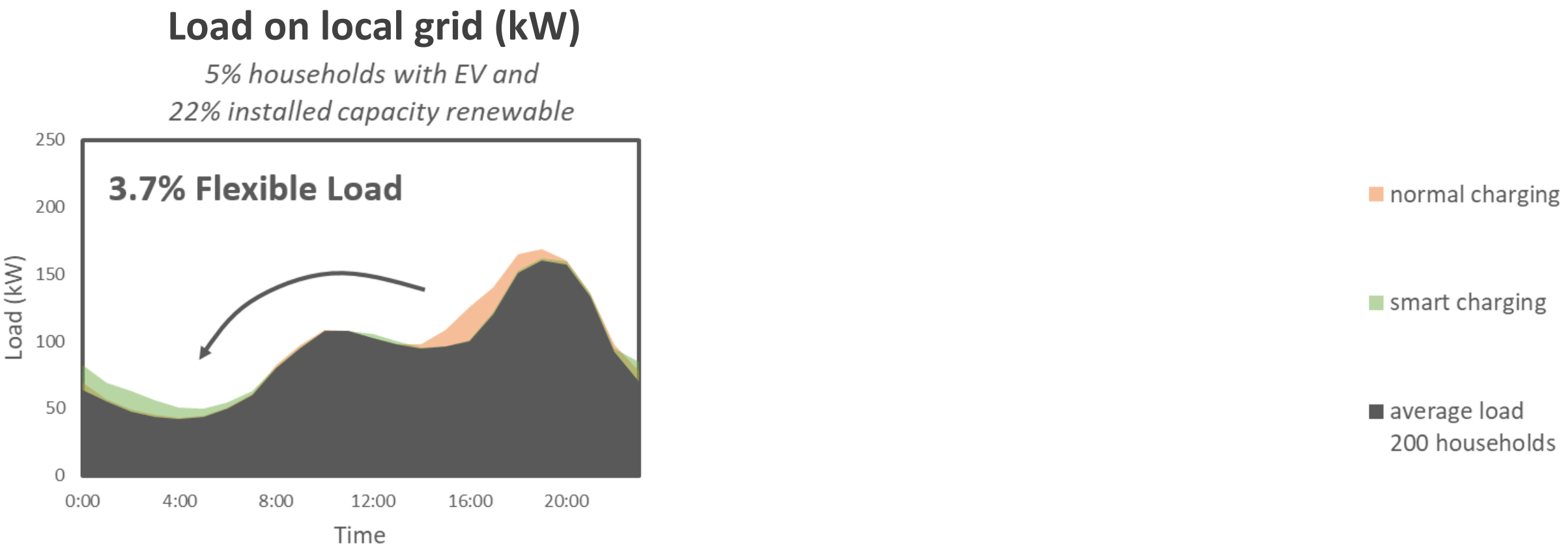
Energy supplier: What amount of load can be shifted?

Grid operator: What is the impact on the local grid load?

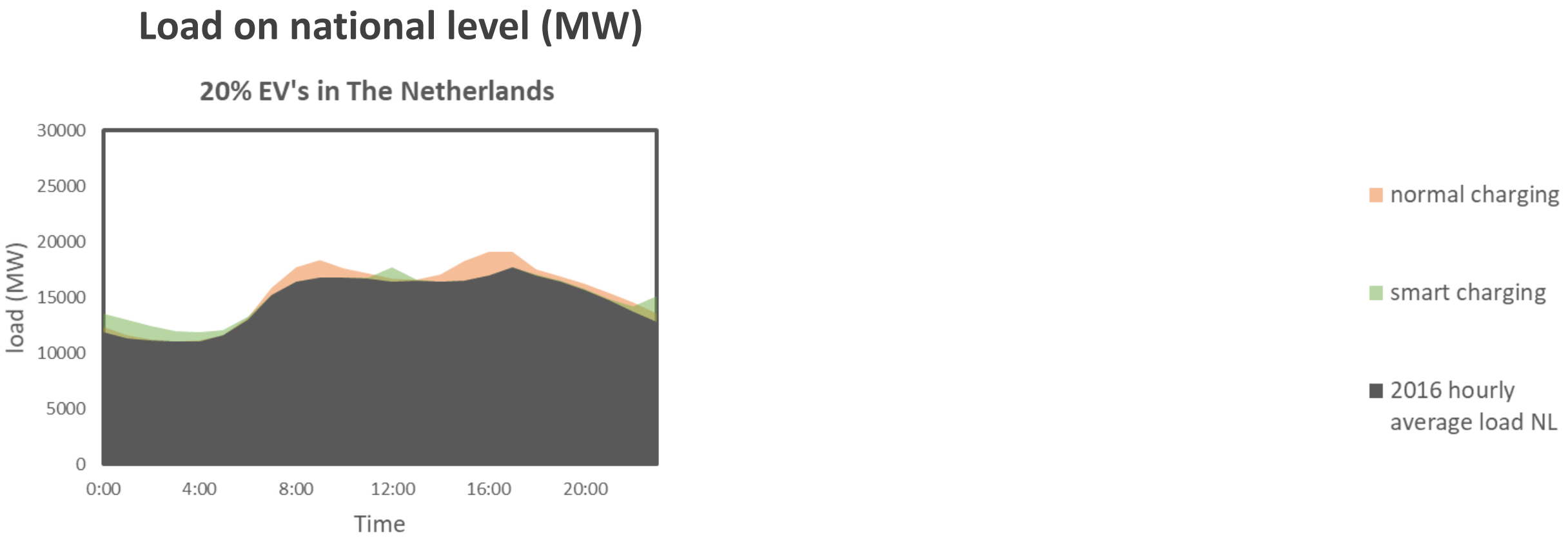
EV user: With what % can charging costs be reduced?

Government: What % renewable energy can be charged?

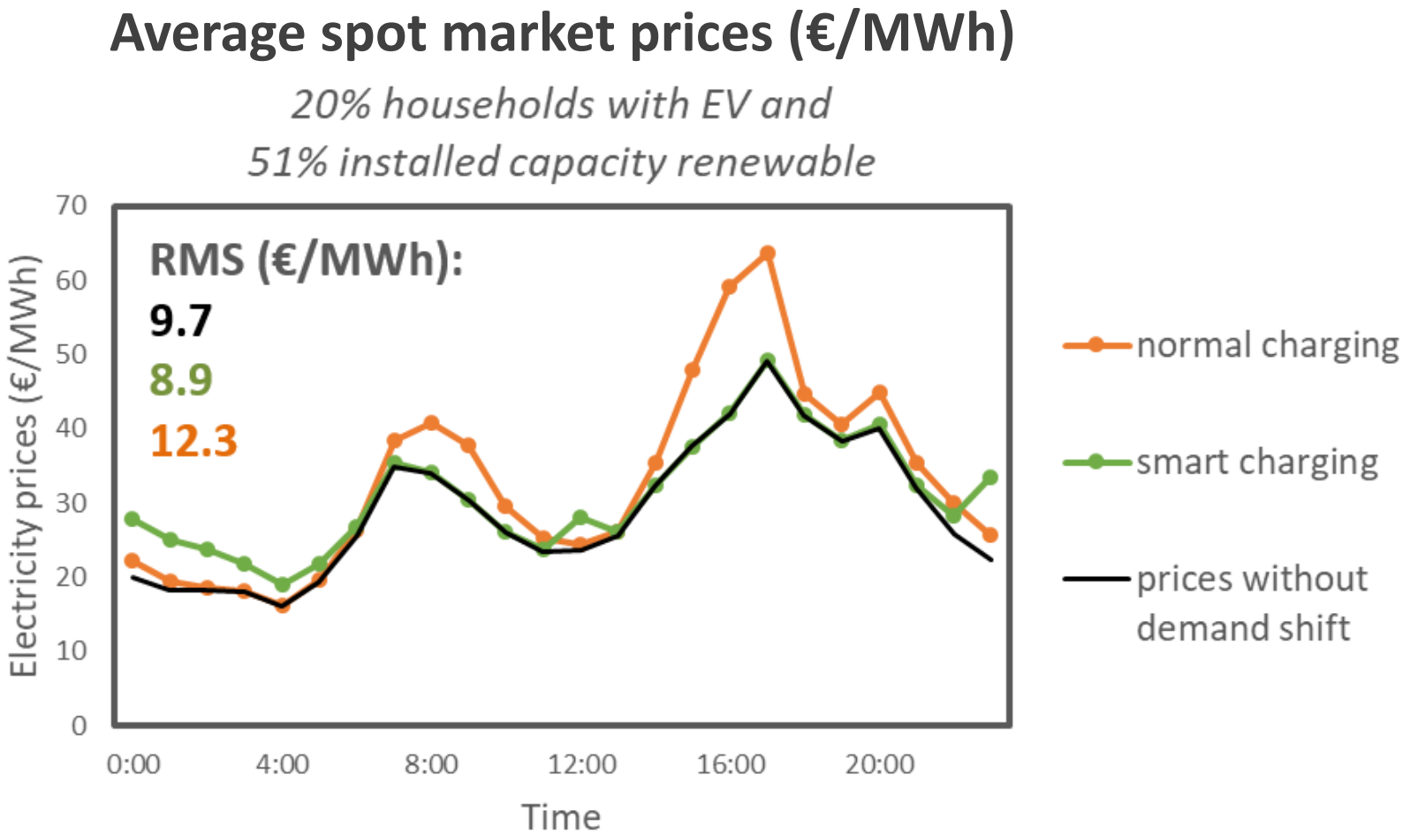
1. The flexibility in charging is enormous.
2. Smart charging decreases the afternoon load peak.



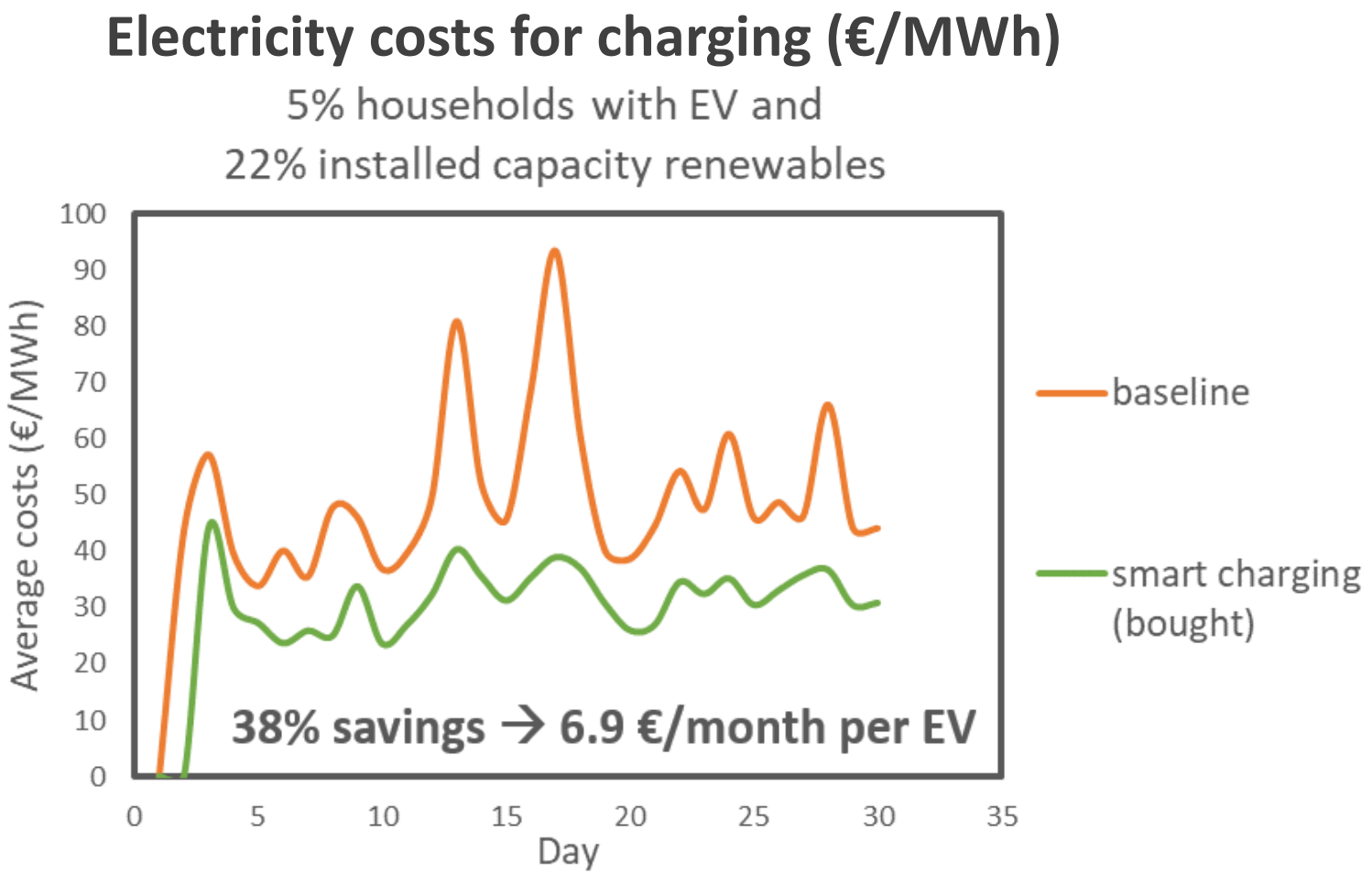
Smart charging can balance electricity supply and demand on national level.



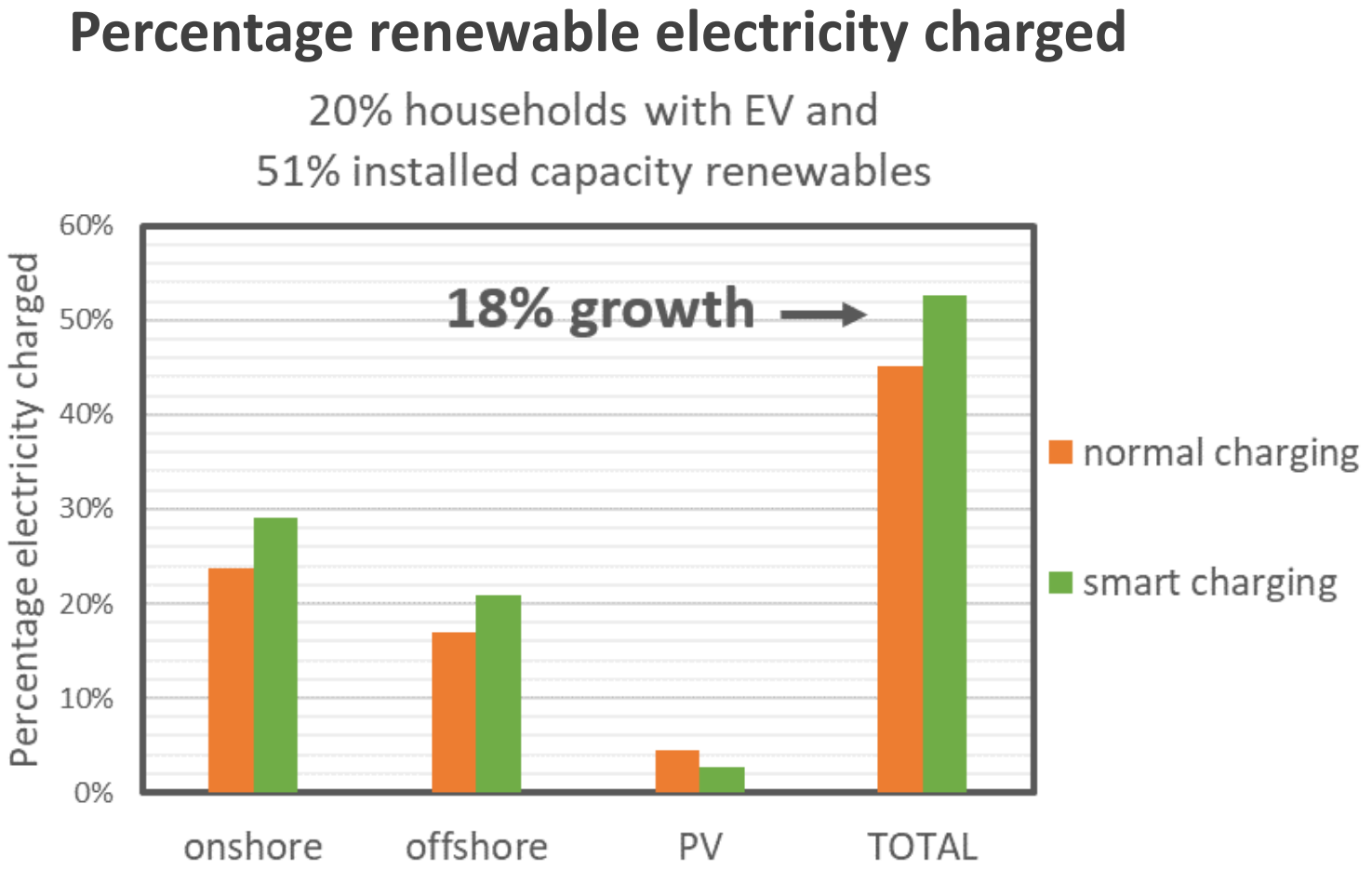
By balancing electricity supply and demand, volatility on spot markets decrease.



38% cost savings with smart charging.
This equals around 7€ per EV per month.

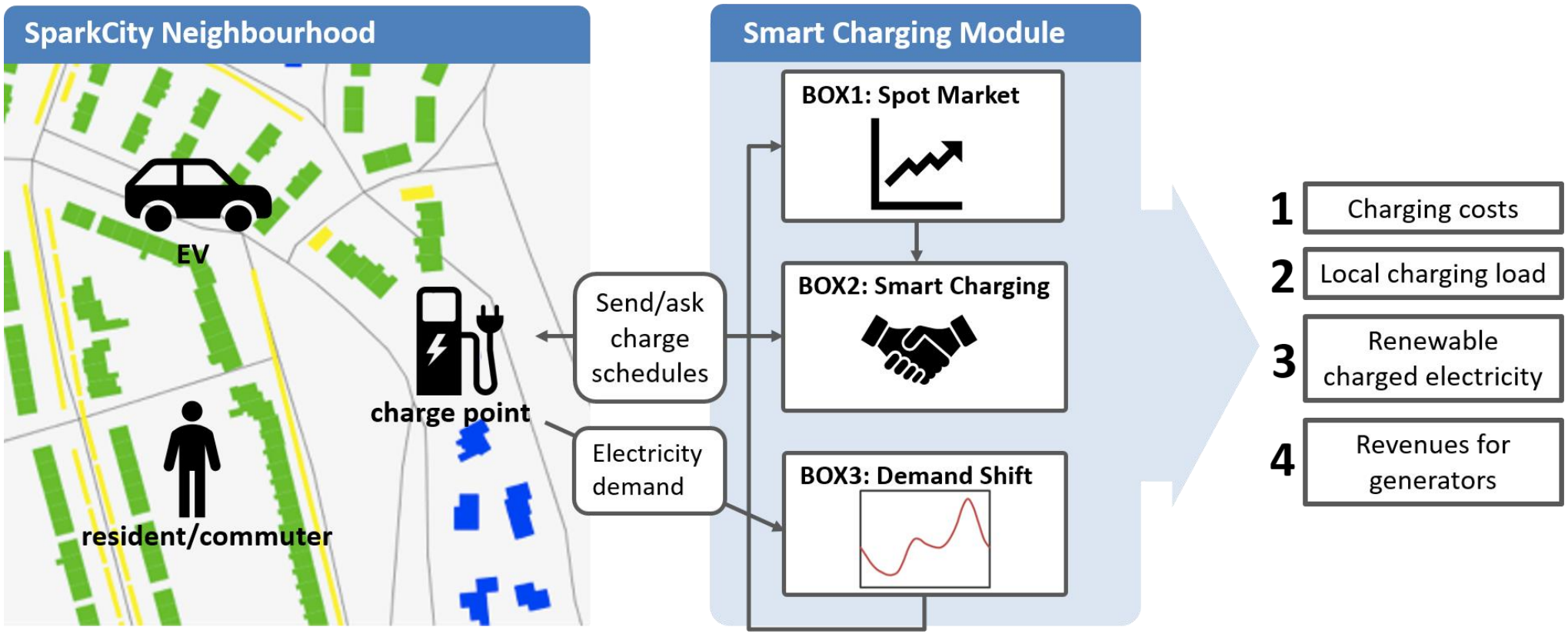


With smart charging at least 18% more renewable electricity is charged.

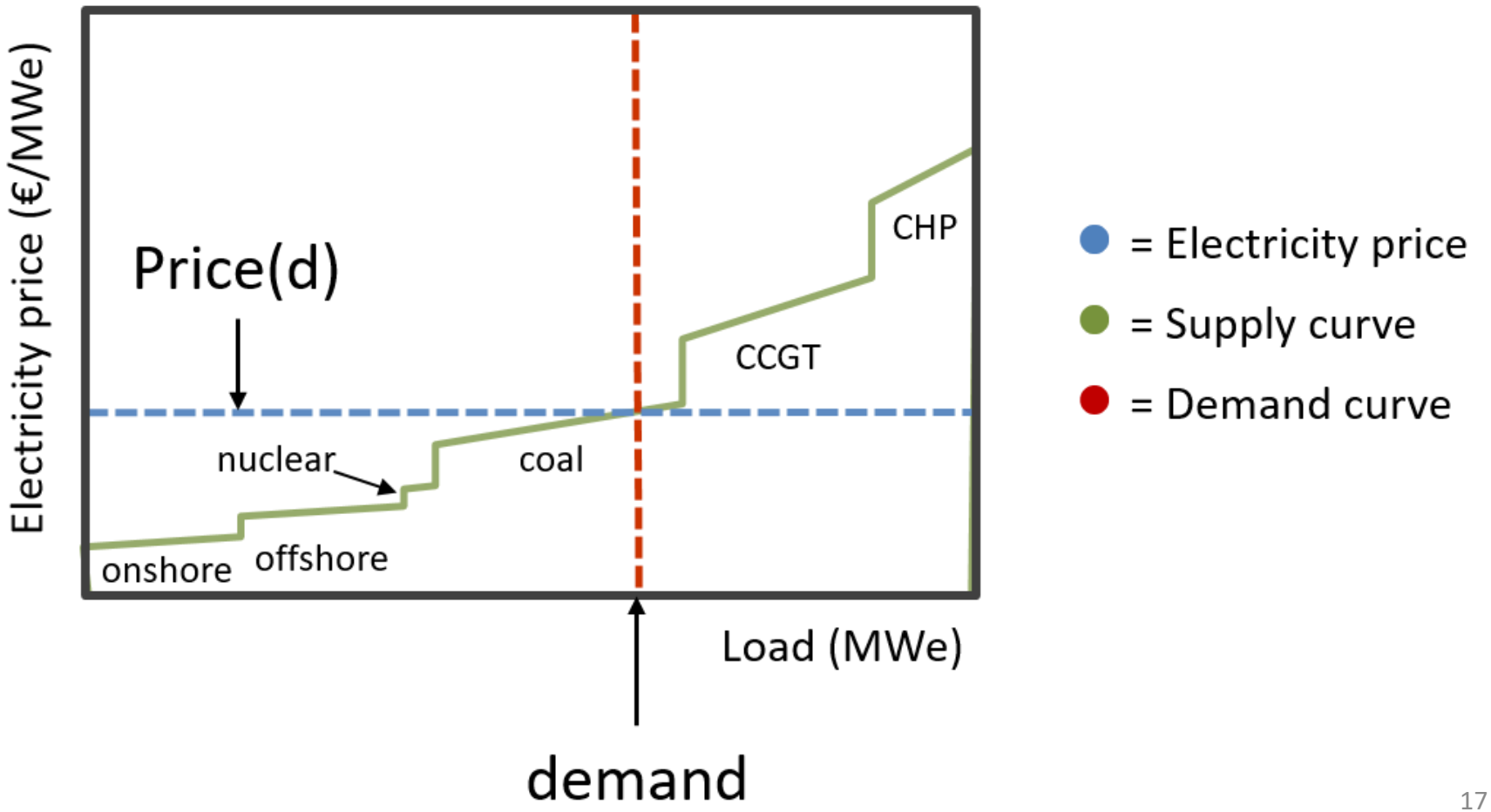


PART 2:

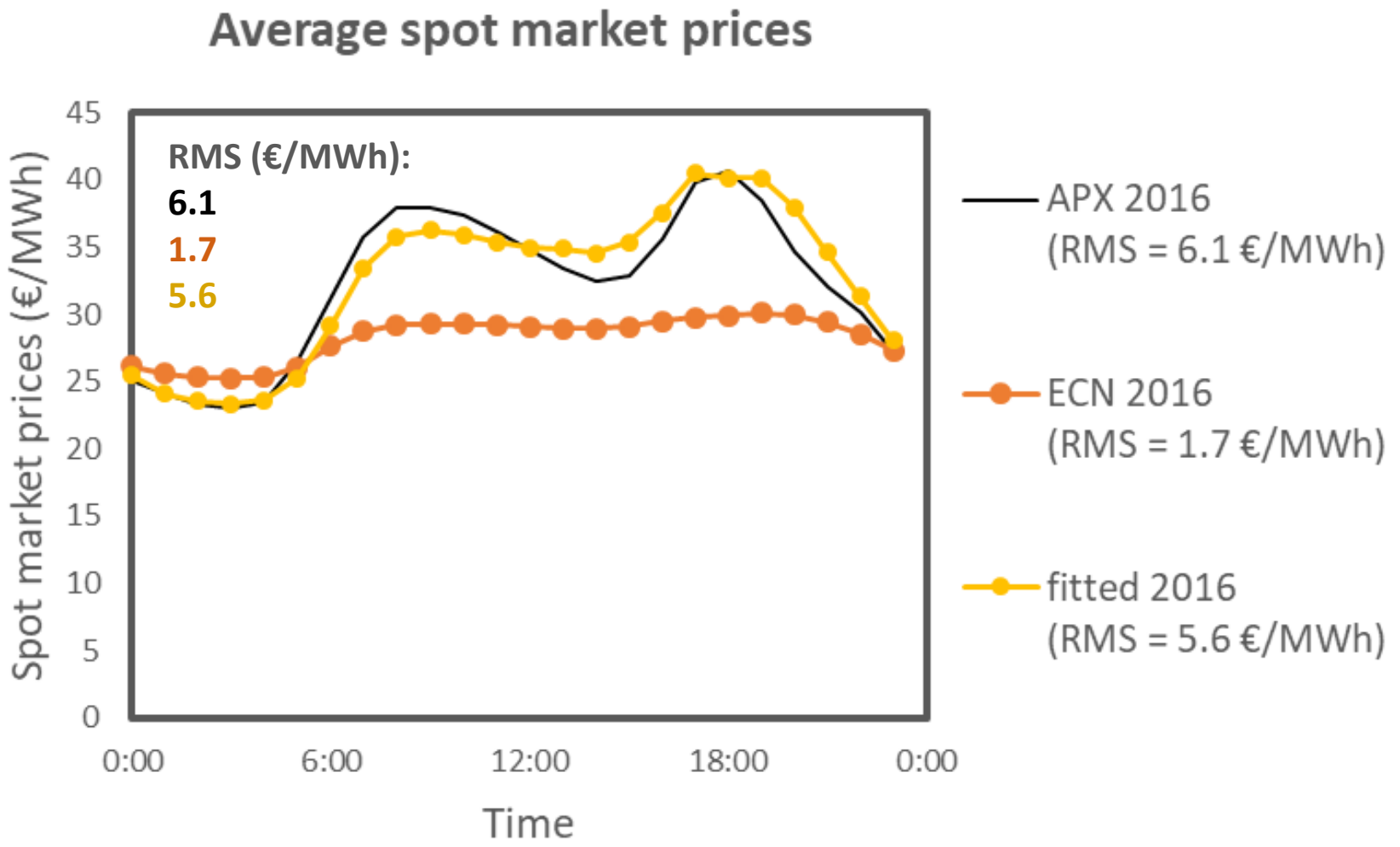
Modelling approach


SparkCity Neighbourhood
EV
charge point
resident/commuter
Send/ask charge schedules
Electricity demand
Smart Charging Module
BOX1: Spot Market
BOX2: Smart Charging
BOX3: Demand Shift
1 Charging costs
2 Local charging load
3 Renewable charged electricity
4 Revenues for generators

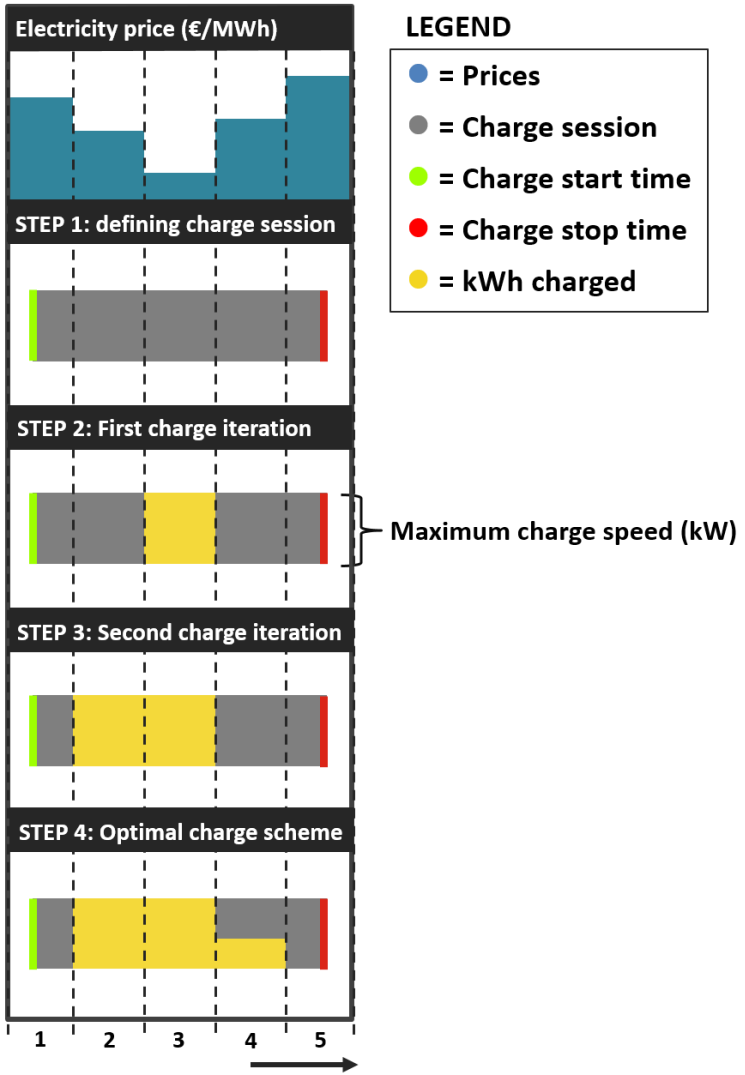
Merit order → spot market pricing



Validation of spot market pricing



Optimal charge schedule with “valley filling”



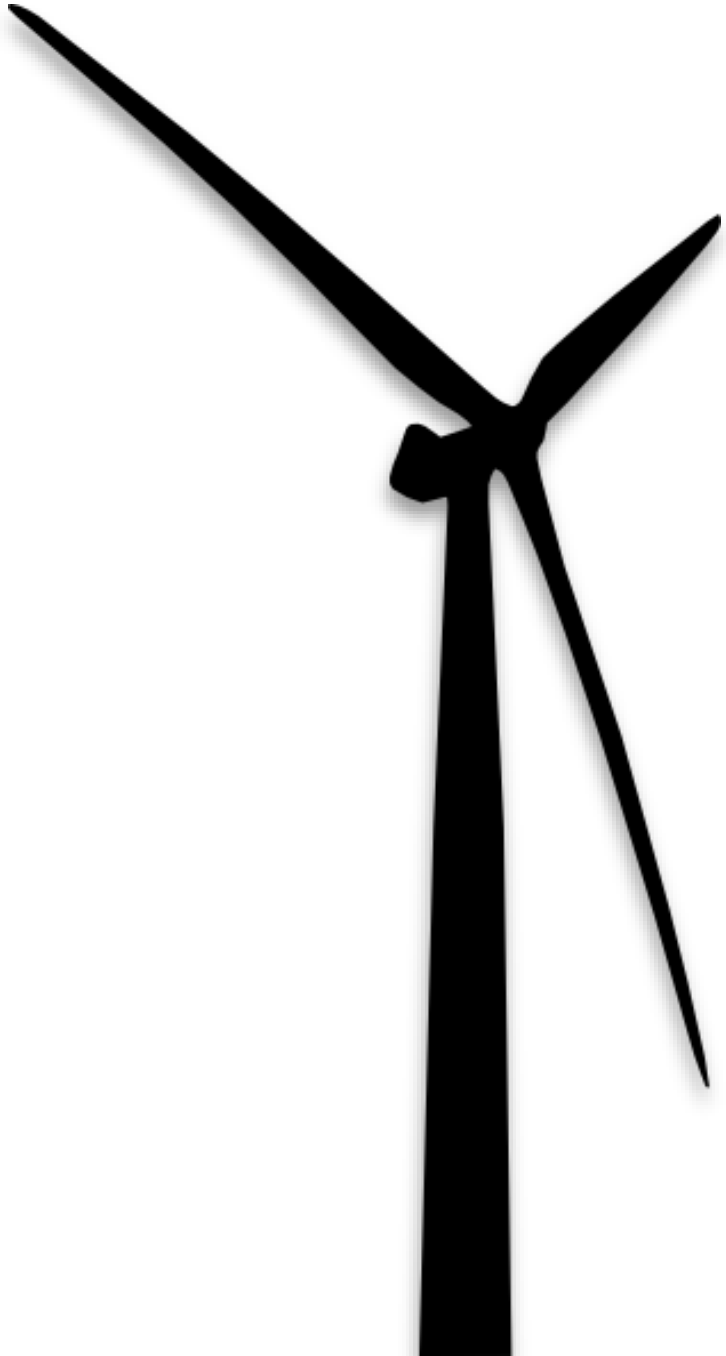
PART 3:

What's next…

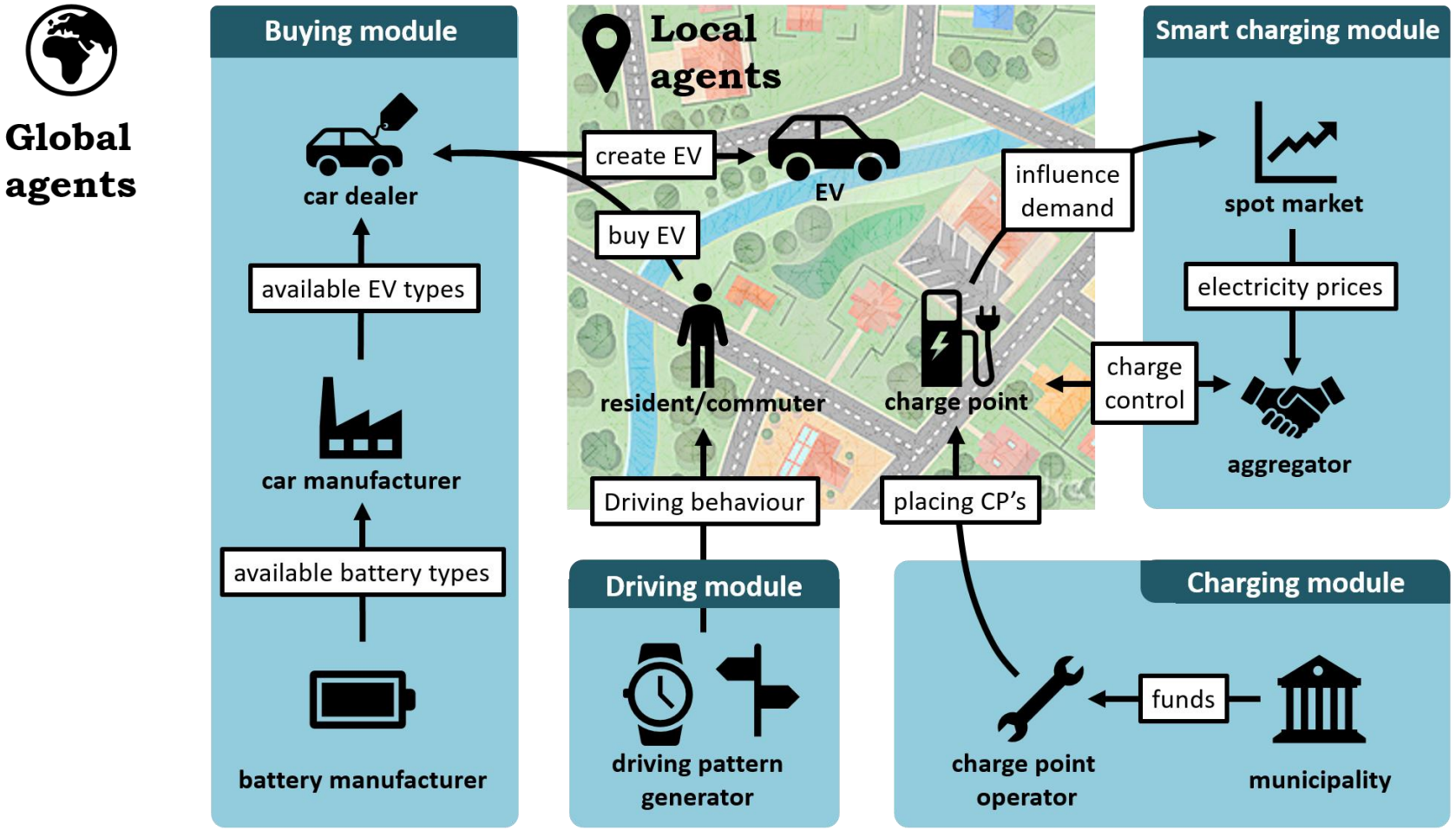
1. Including local grid constraints in optimisation

2. Improving pricing with better wind & PV data

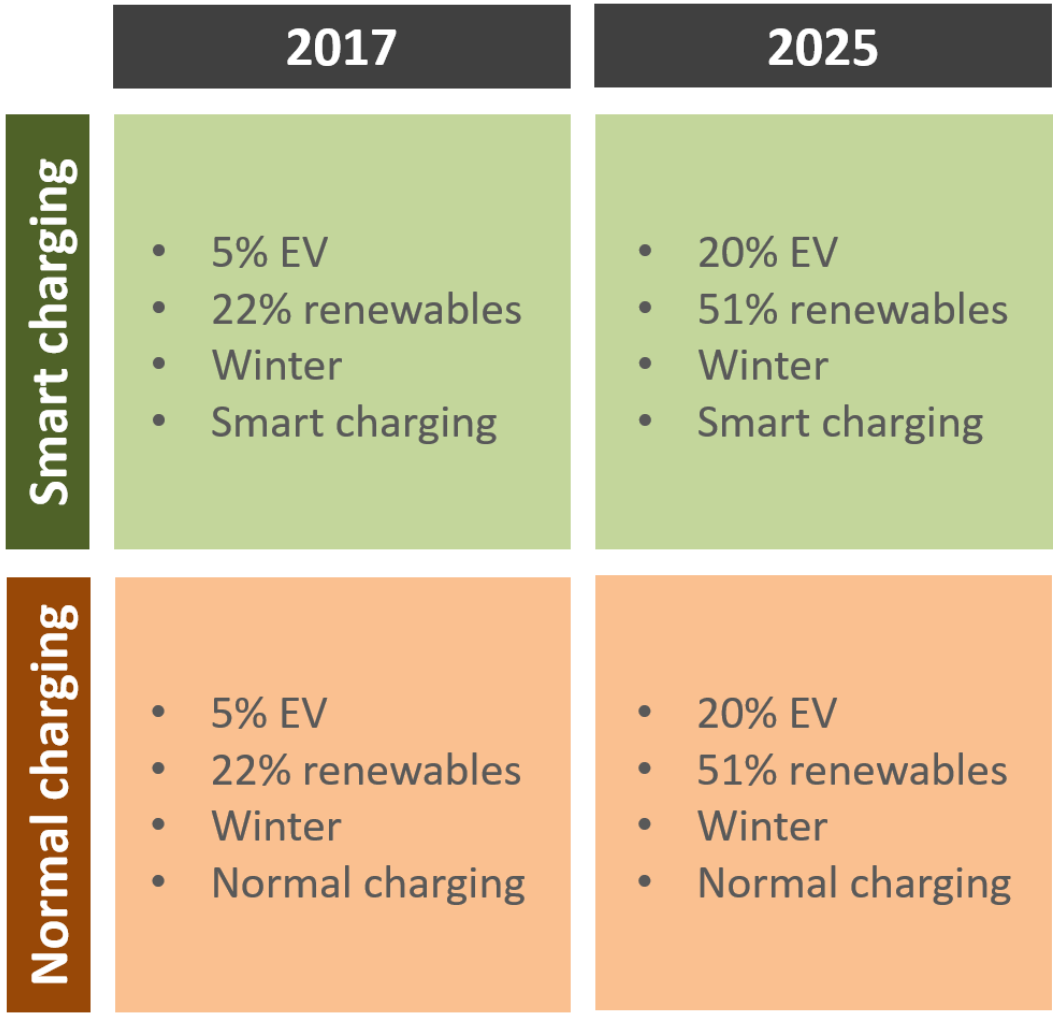
3. Improving driving behaviour



ABCD model


Global agents
Buying module
car dealer
available EV types
car manufacturer
available battery types
battery manufacturer
Local agents
create EV
EV
buy EV
resident/commuter
charge point
Driving behaviour
placing CP's
Driving module
driving pattern generator
influence demand
Smart charging module
spot market
electricity prices
charge control
aggregator
Charging module
funds
charge point operator
municipality

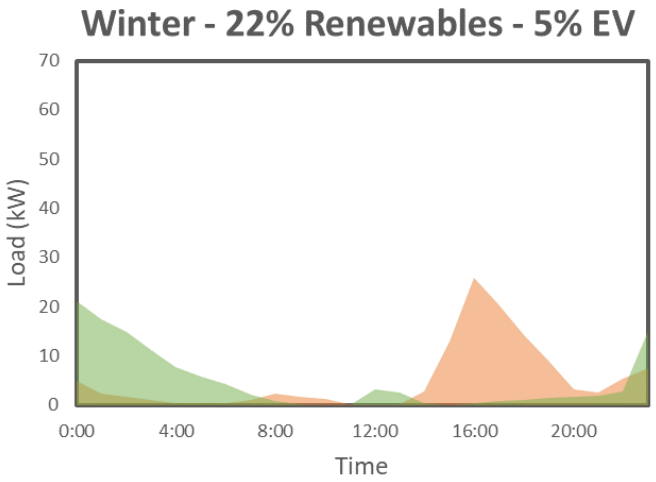
Scenario quadrants

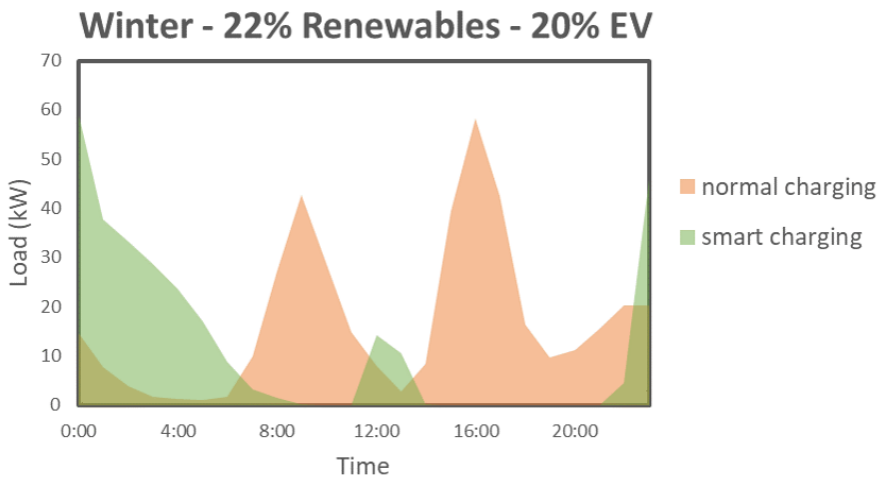


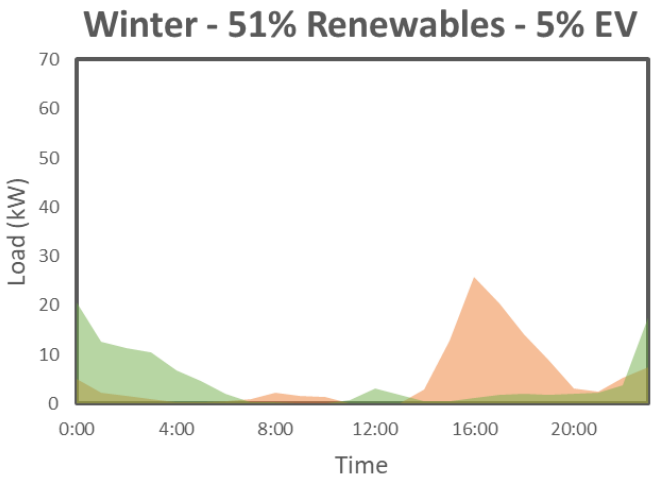
Scenarios for BOX 2 validation

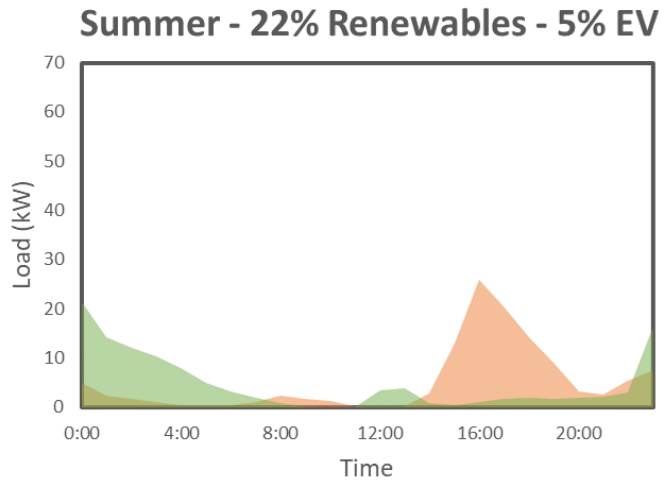
	Baseline	More EV	More renewables	Different season
Smart charging	• 5% EV • 22% renewables • Winter • Smart charging	• 20% EV • 22% renewables • Winter • Smart charging	• 5% EV • 51% renewables • Winter • Smart charging	• 5% EV • 22% renewables • Summer • Smart charging
Normal charging	• 5% EV • 22% renewables • Winter • Normal charging	• 20% EV • 22% renewables • Winter • Normal charging	• 5% EV • 51% renewables • Winter • Normal charging	• 5% EV • 22% renewables • Summer • Normal charging

Average local charging load

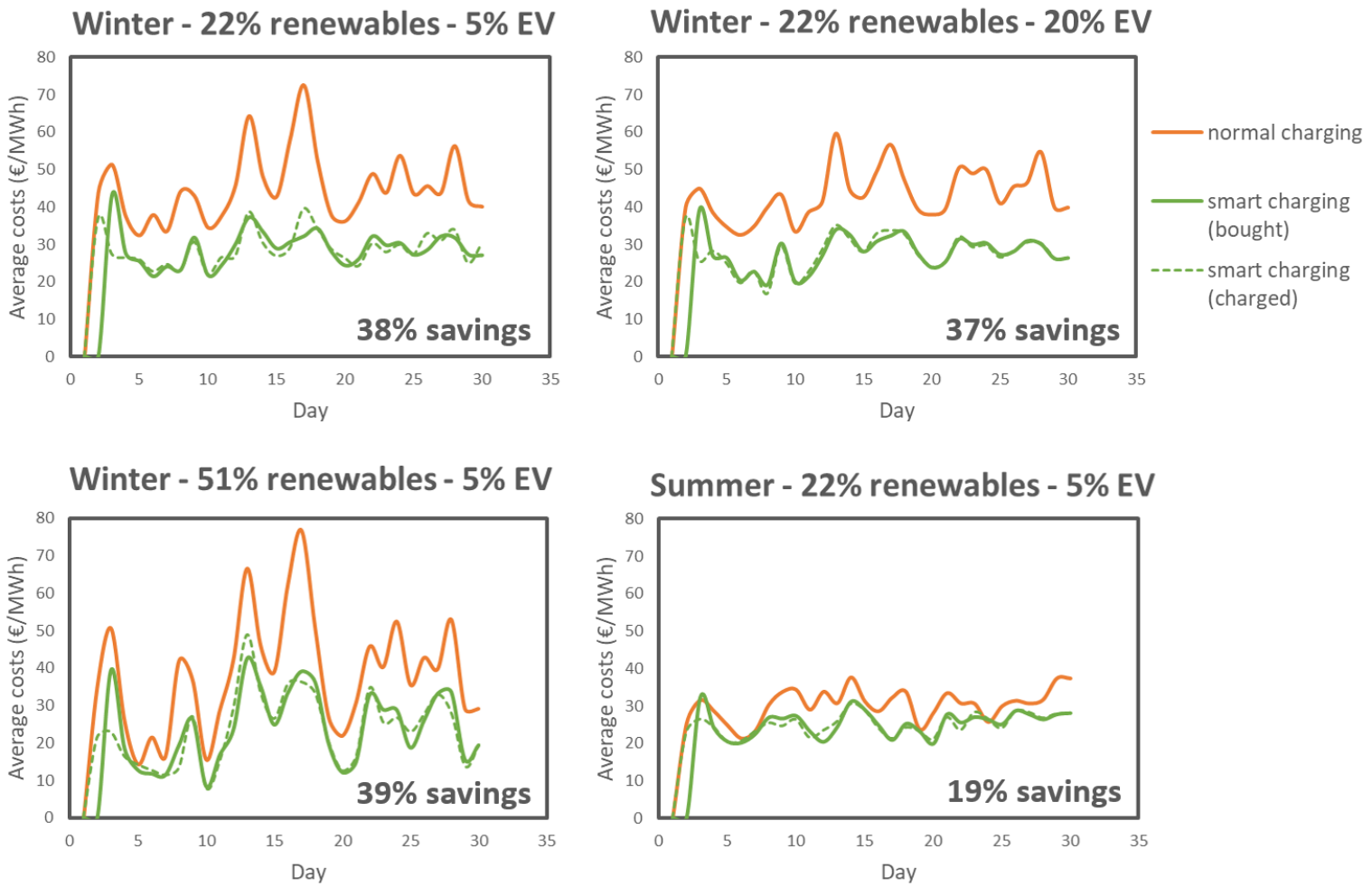




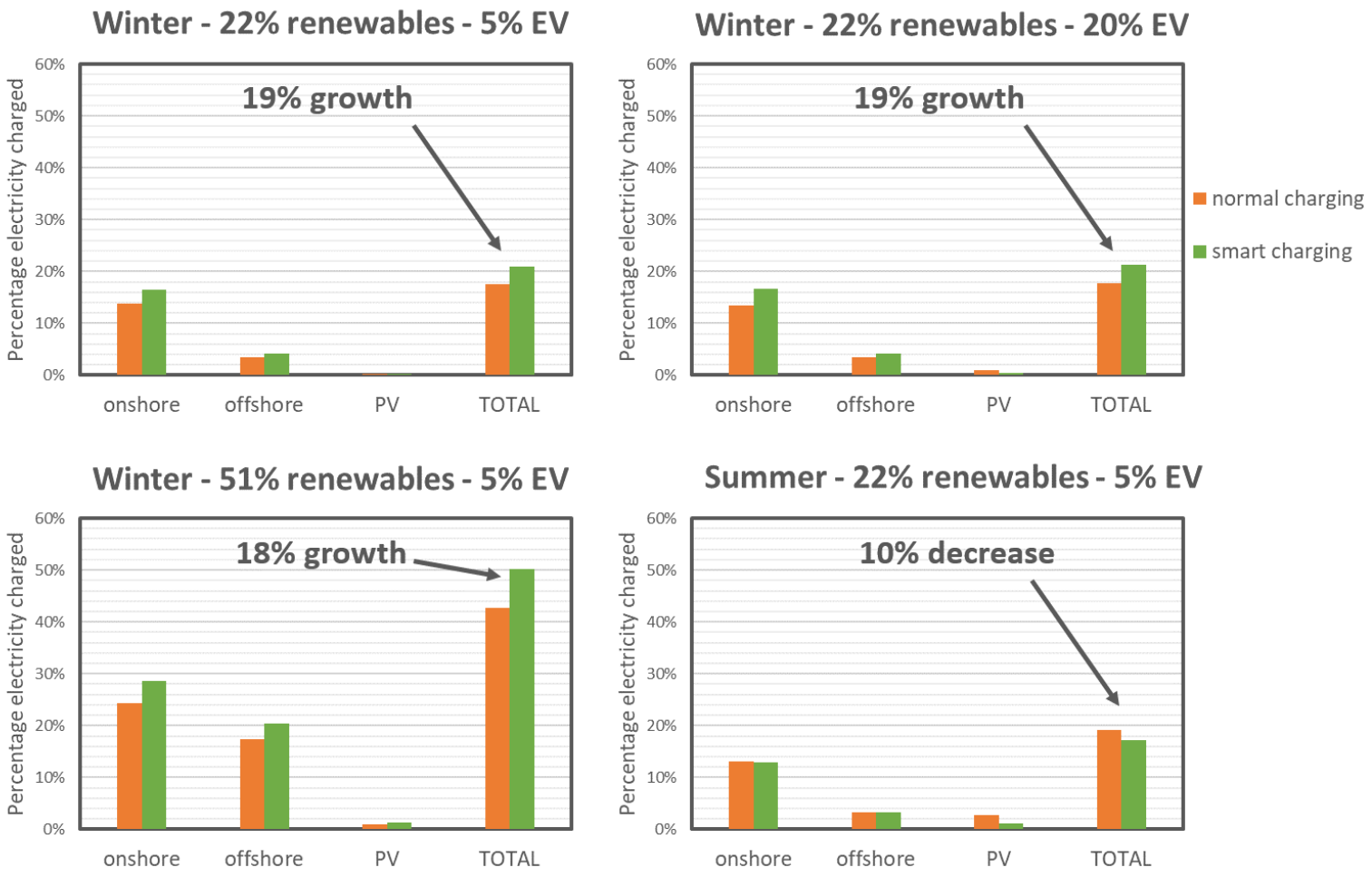




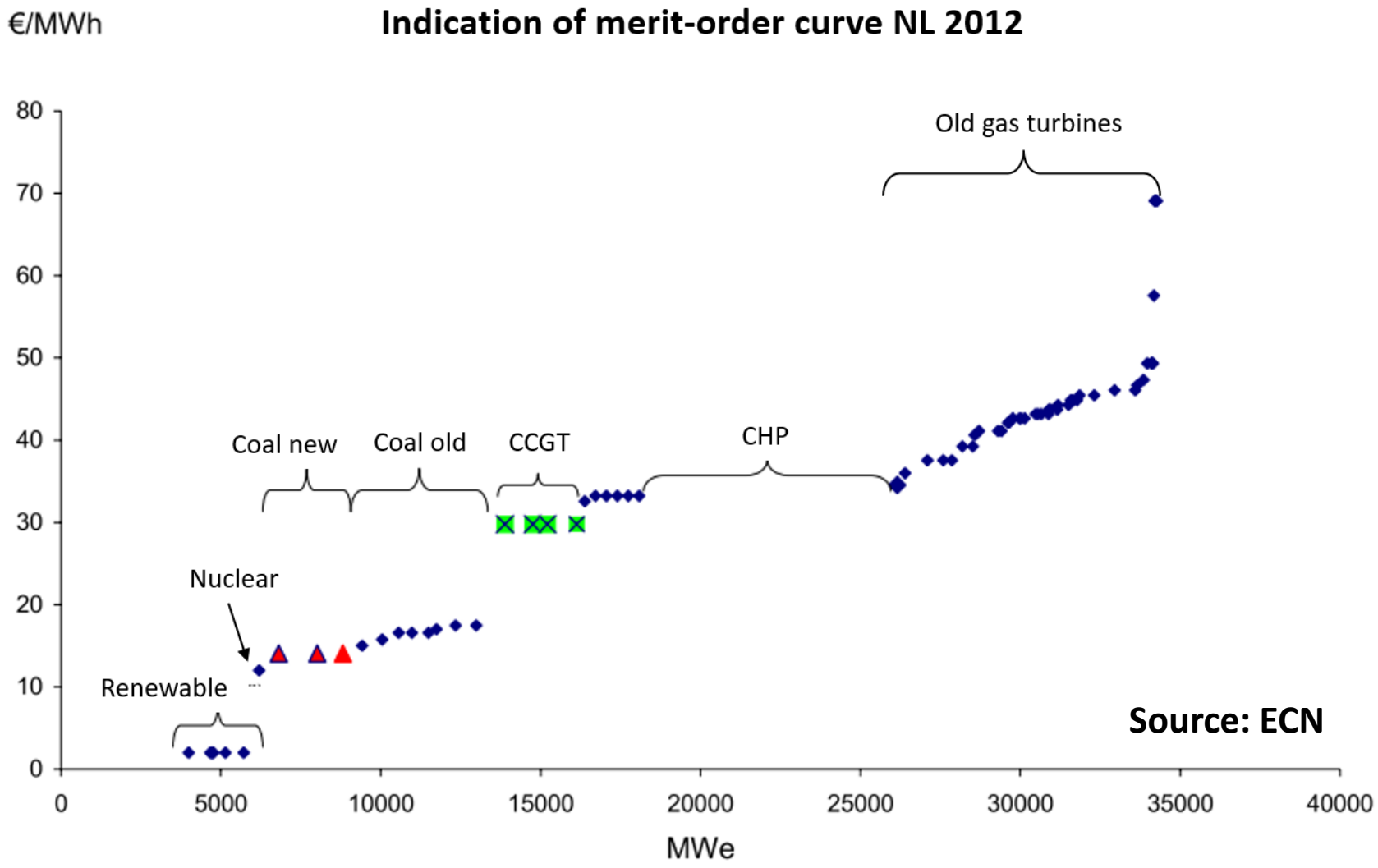
Cost of electricity used for charging



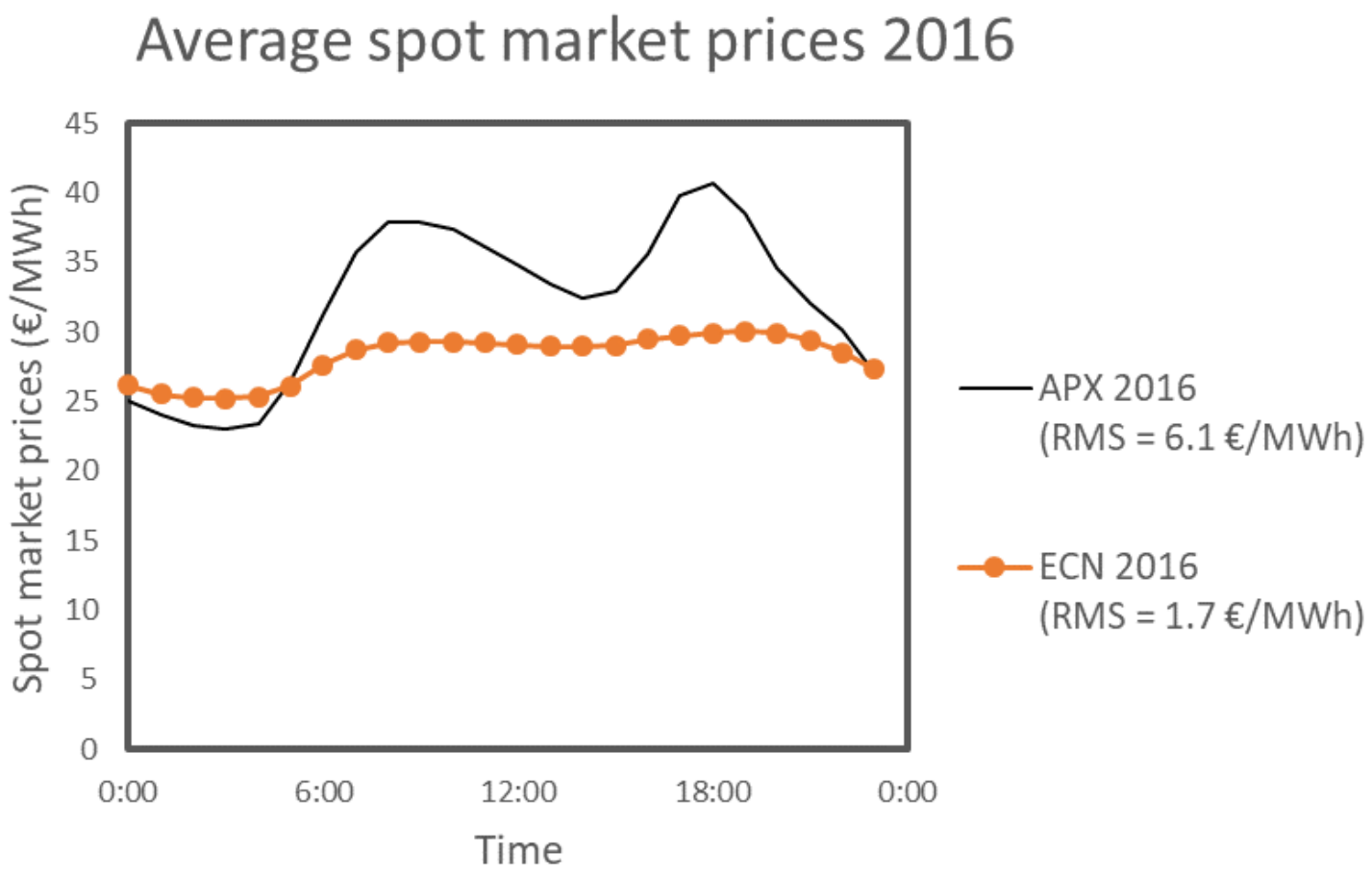
Renewable charged electricity



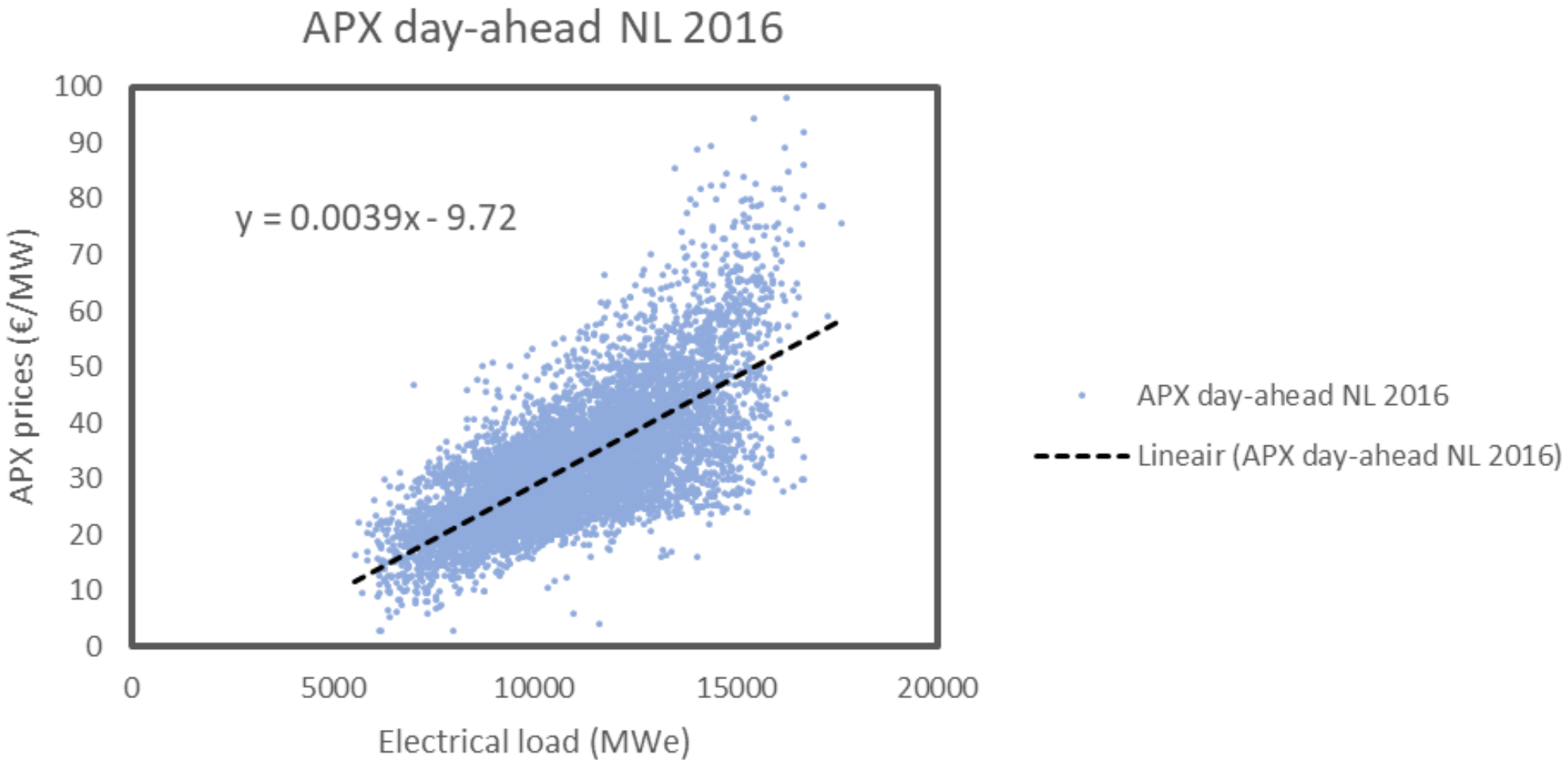
Use SRMC and supply capacities from literature



Comparing results with APX 2016 prices



METHOD 2:
Relate the market prices directly to the demand



My goal:

Enable smart charging based on price optimisation in the SparkCity model.