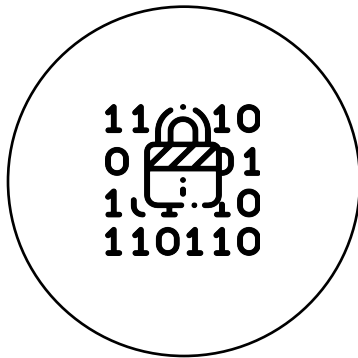


The value of charging intelligence

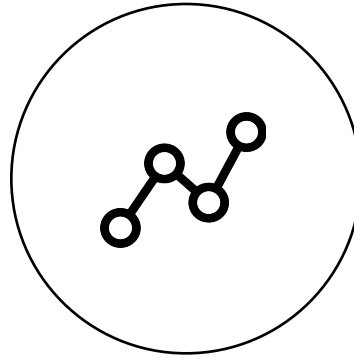
Using charging data to develop insights and algorithms

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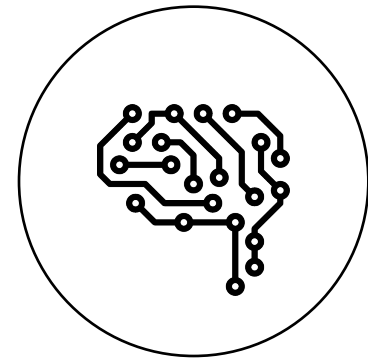
data

charging session
on public charging
infrastructure



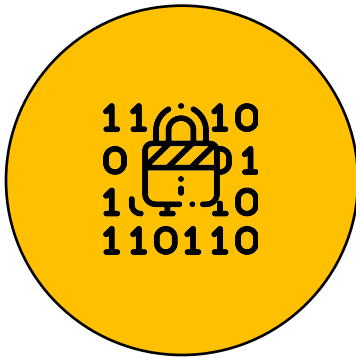
insights

public charging
infrastructure
utilization



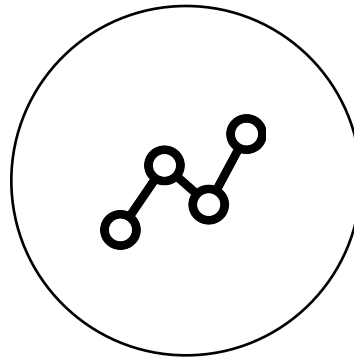
algorithms

optimization and
smart charging
algorithms



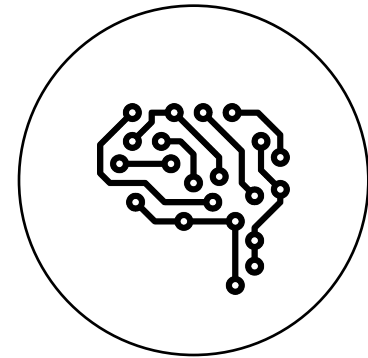
data

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insights

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infrastructure
utilization



algorithms

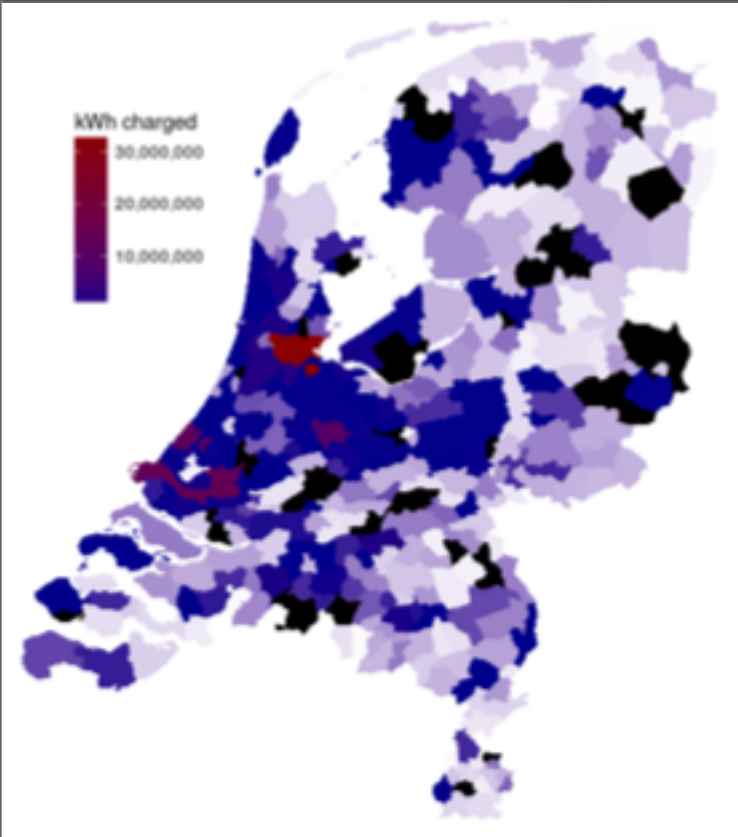
optimization and
smart charging
algorithms

Data from public charging infrastructure is provided by different partners.

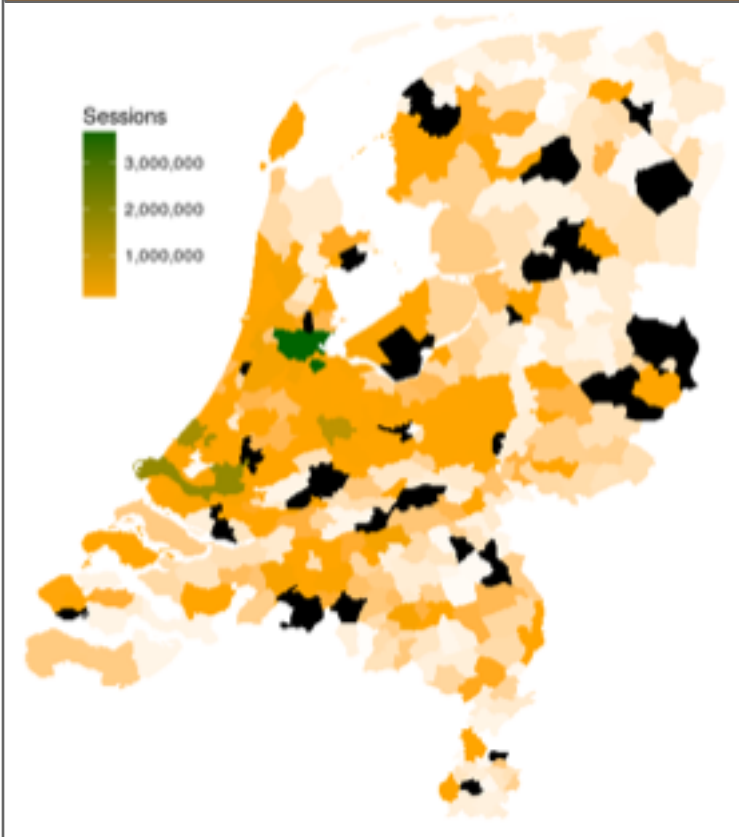


Data of all the partners covers a significant part of the Netherlands.

Total kWh charged
Over the years 2015, 2016 en 2017



Total number of charging sessions
Over the years 2015, 2016 en 2017



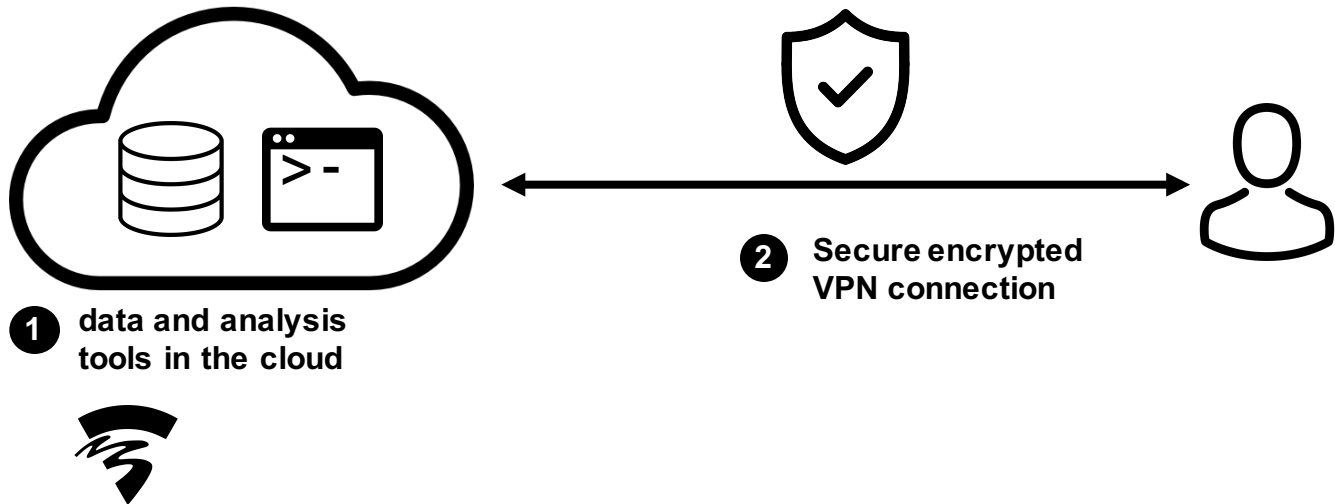
Data is stored on servers. The servers contain analysis tools as well.



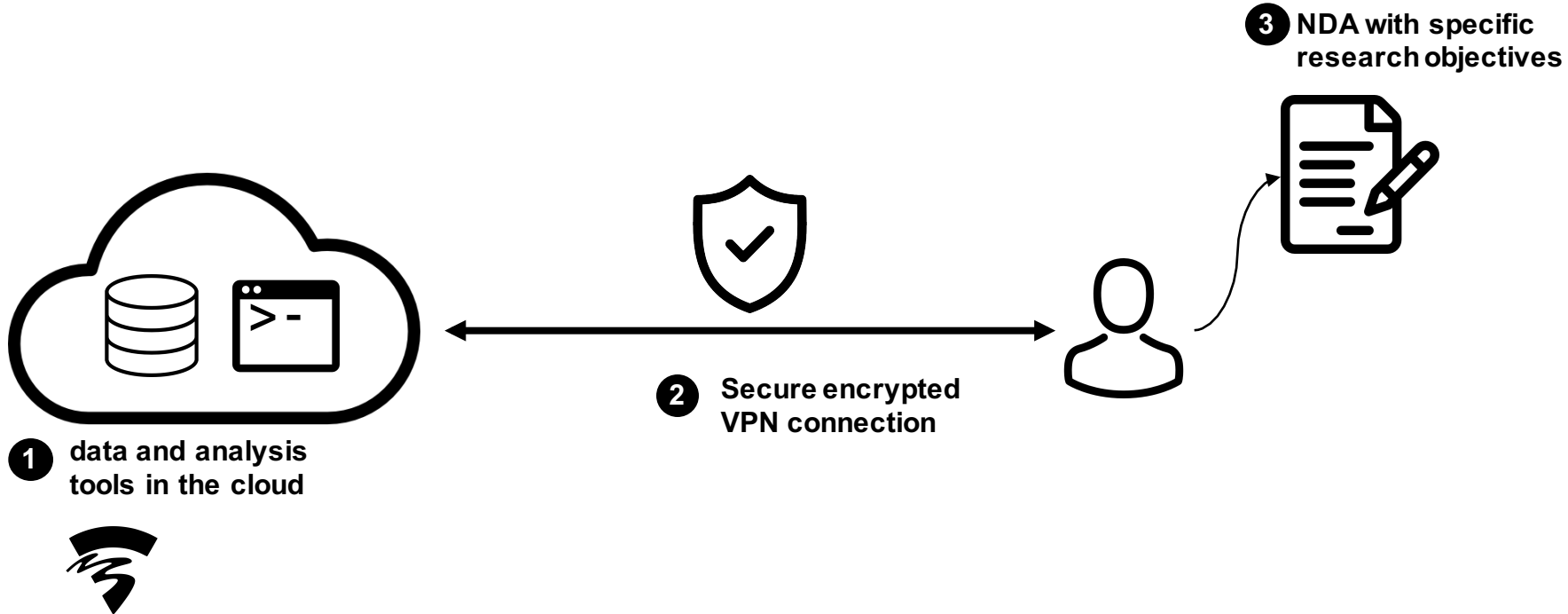
1 data and analysis
tools in the cloud



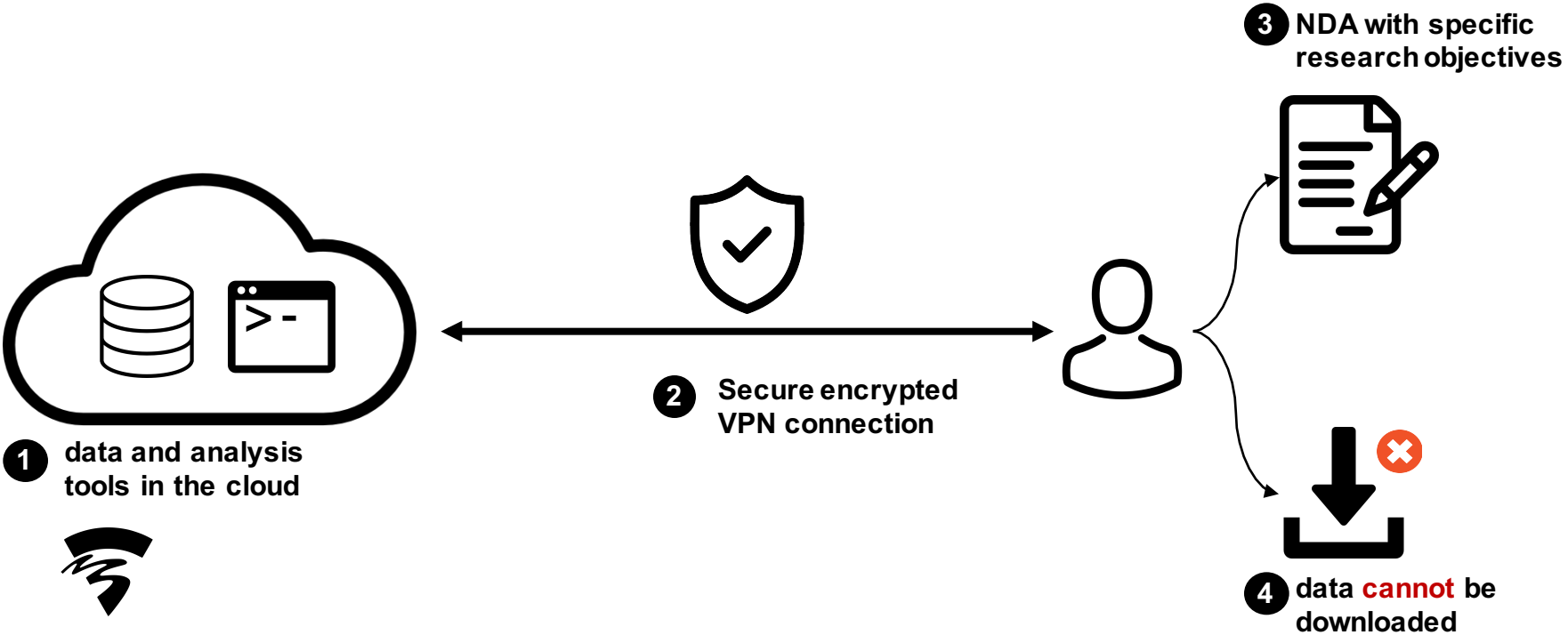
Data and analysis tools can only be accessed through VPN.

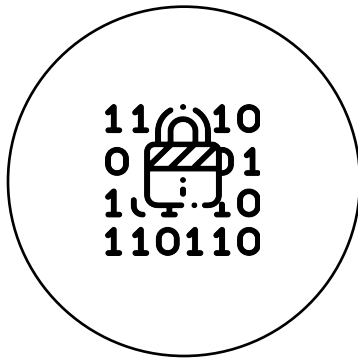


Researchers sign an NDA with clear research objectives to access the data.



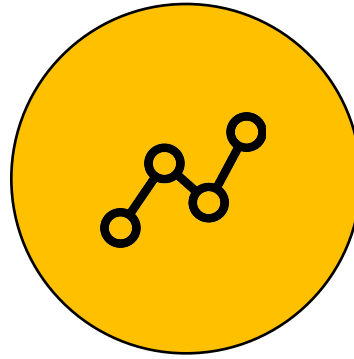
Data can not be downloaded to local disk.





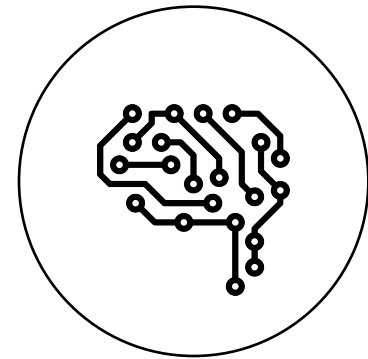
data

charging session
on public charging
infrastructure



insights

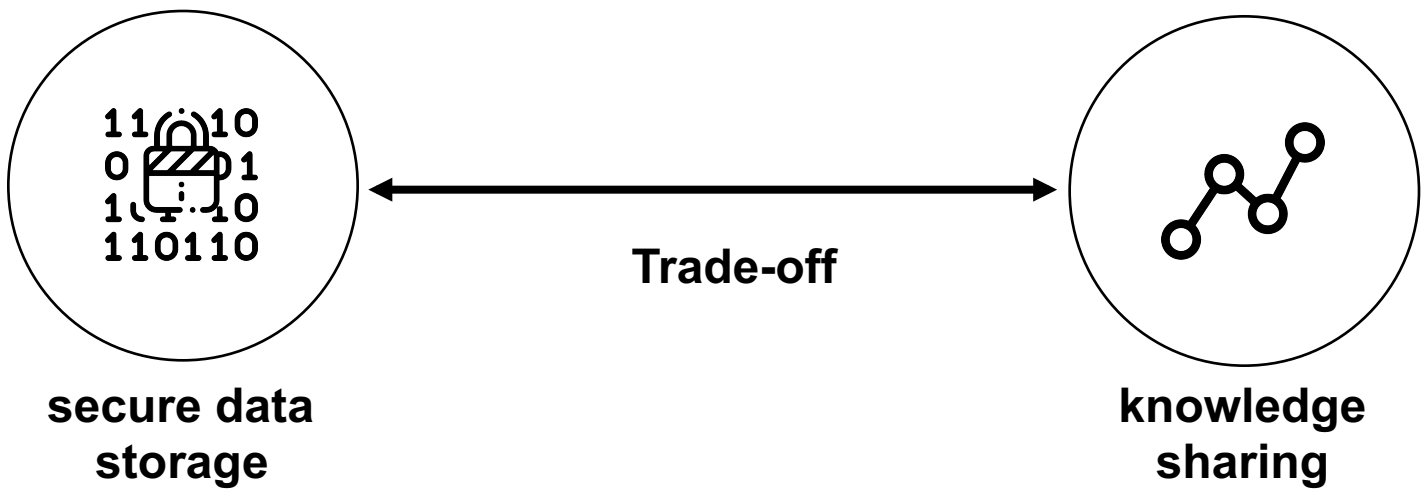
public charging
infrastructure
utilization



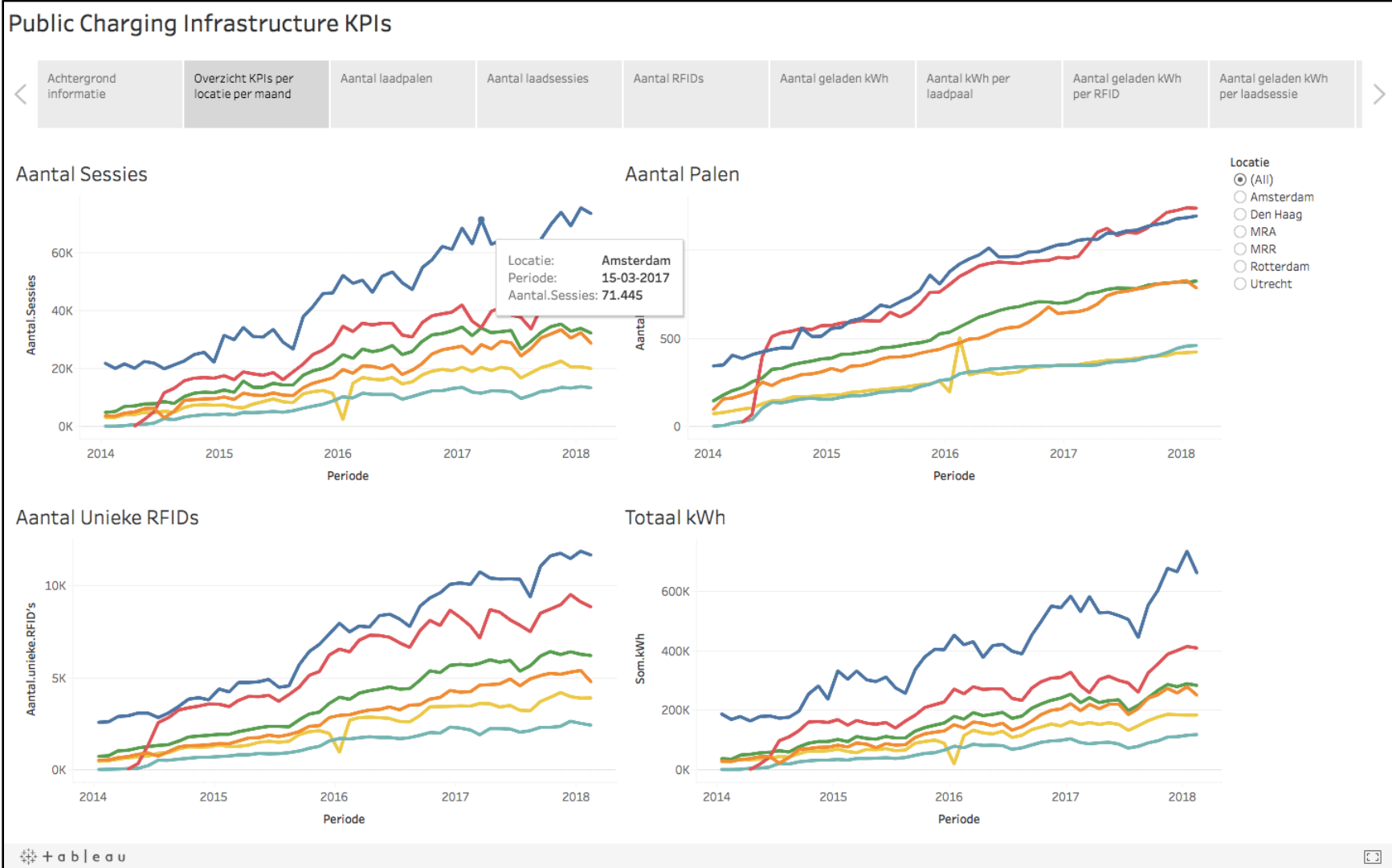
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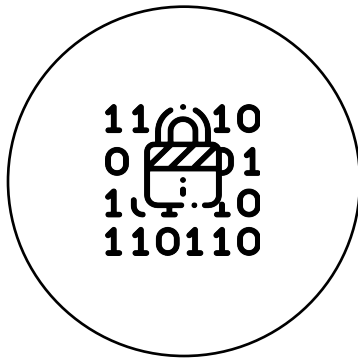
Publishing aggregated data is a way of making information accessible.



A web-based dashboard with key KPI's for charging infrastructure utilization.

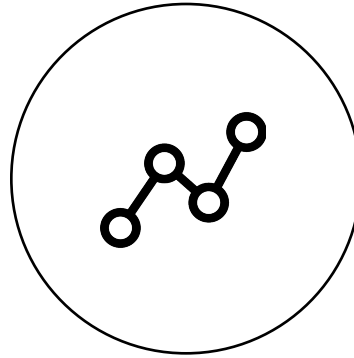


Soon to be published



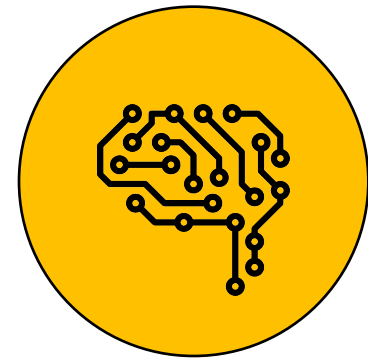
data

charging session
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insights

public charging
infrastructure
utilization

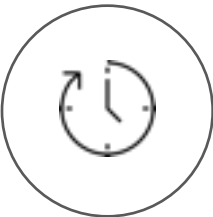


algorithms

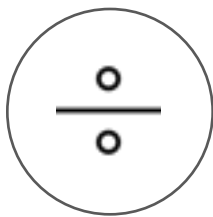
optimization and
smart charging
algorithms

The effect of different Smart Charging strategies is measured using three main indicators.

SMART CHARGING STRATEGIES



Postpone strategy
Postpone charging sessions at a later moment. The shift is determined based on the Smart Charging Potential.



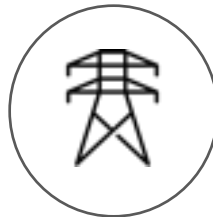
Cut and divide strategy
A charging sessions is split in smaller sessions. These sessions are scheduled within the connection window.



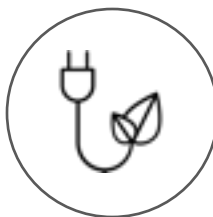
Variable charging speed
Vary charging speed throughout the day. Varying charging speed influences the connection duration



PERFORMANCE INDICATORS



Grid
What is the influence of smart charging strategies on the grid?



Sustainable energy
What is the influence of smart charging on sustainable energy utilization?



Price
What is the influence of smart charging strategies on the price?

Over the years 2015, 2016 and 2017 there were...



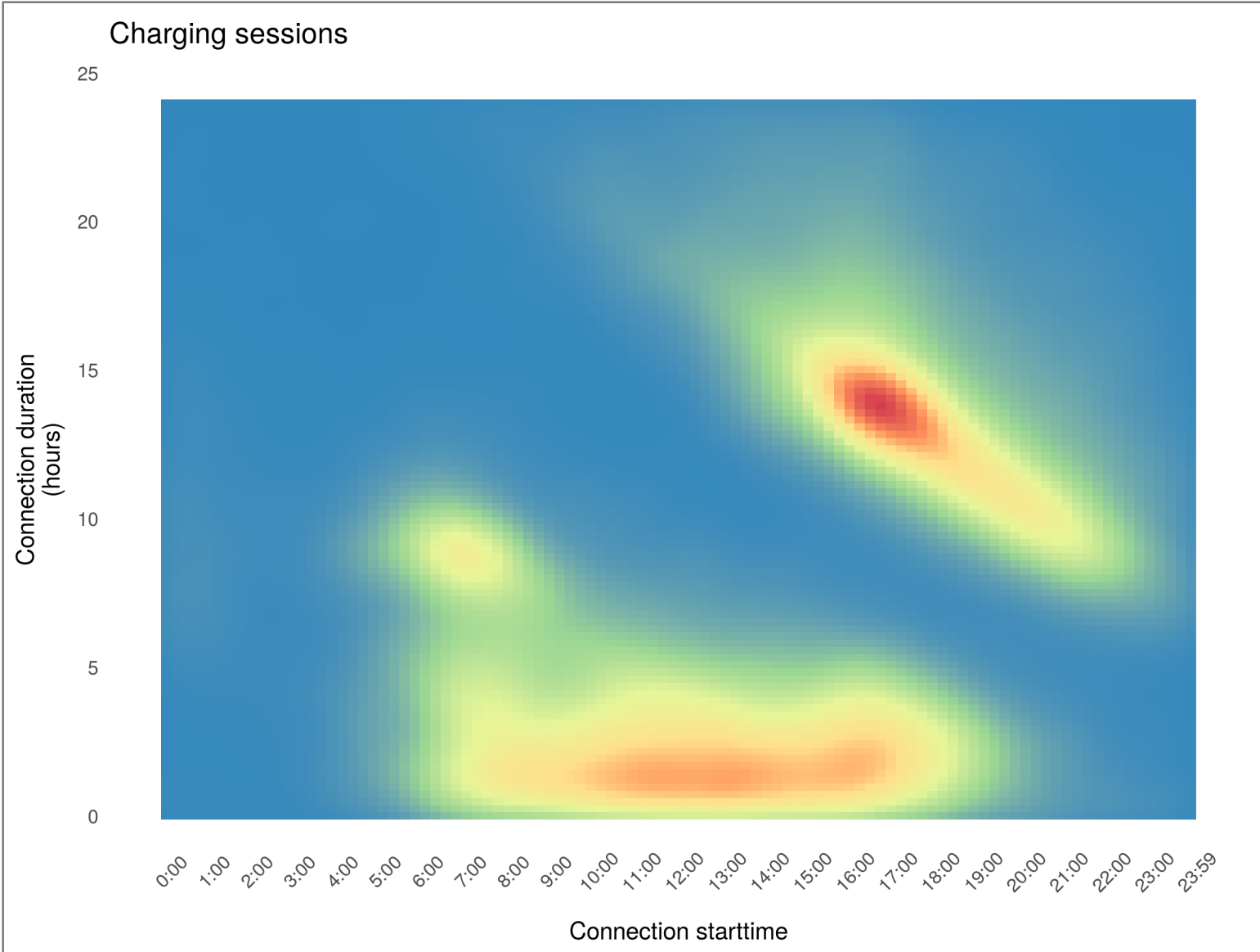
**12 million
sessions**

**101 million
kWh charged**

**20 million
hour charging**

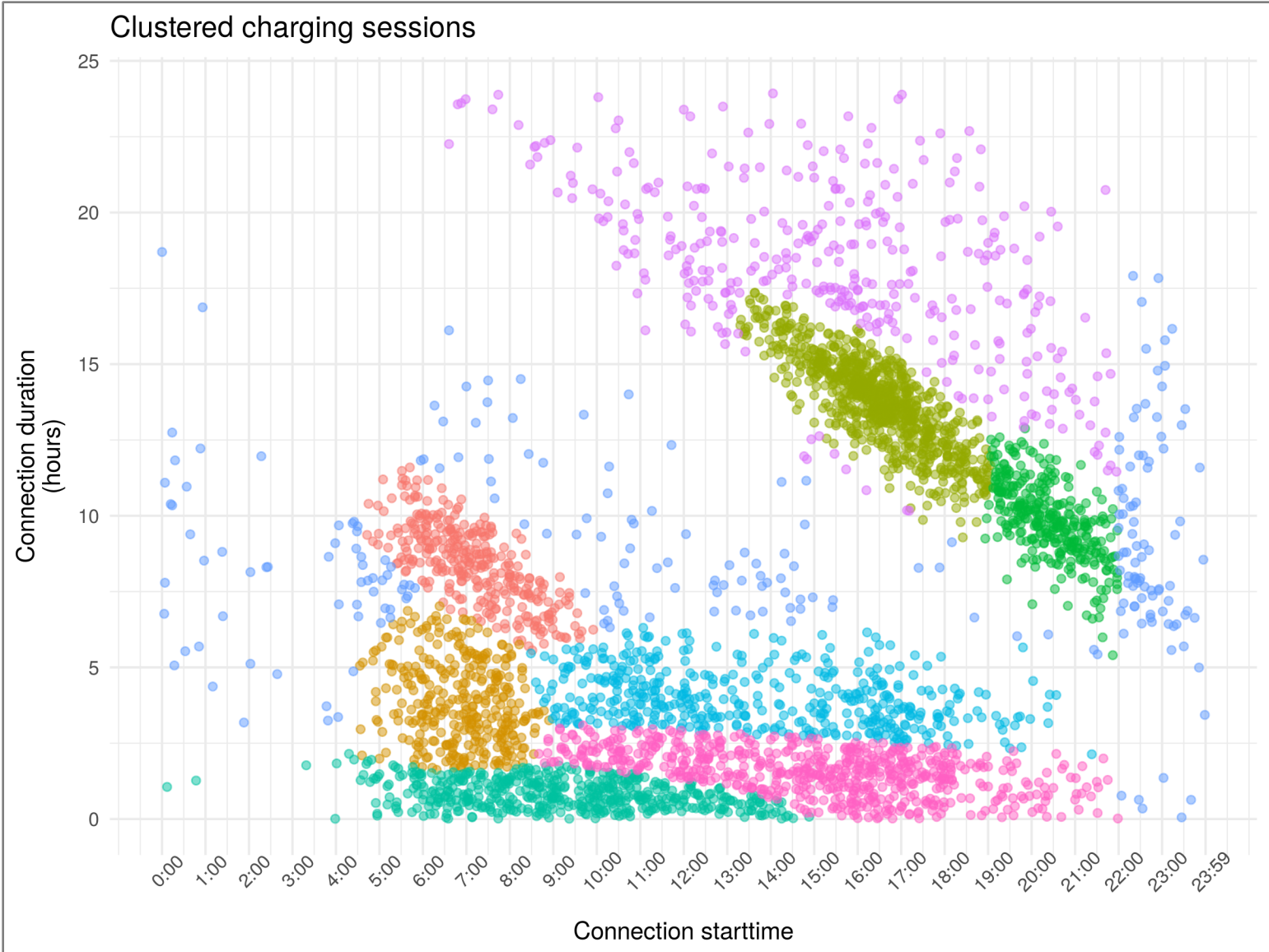
**7 thousand
charging points**

Charging sessions have a characteristic distribution.



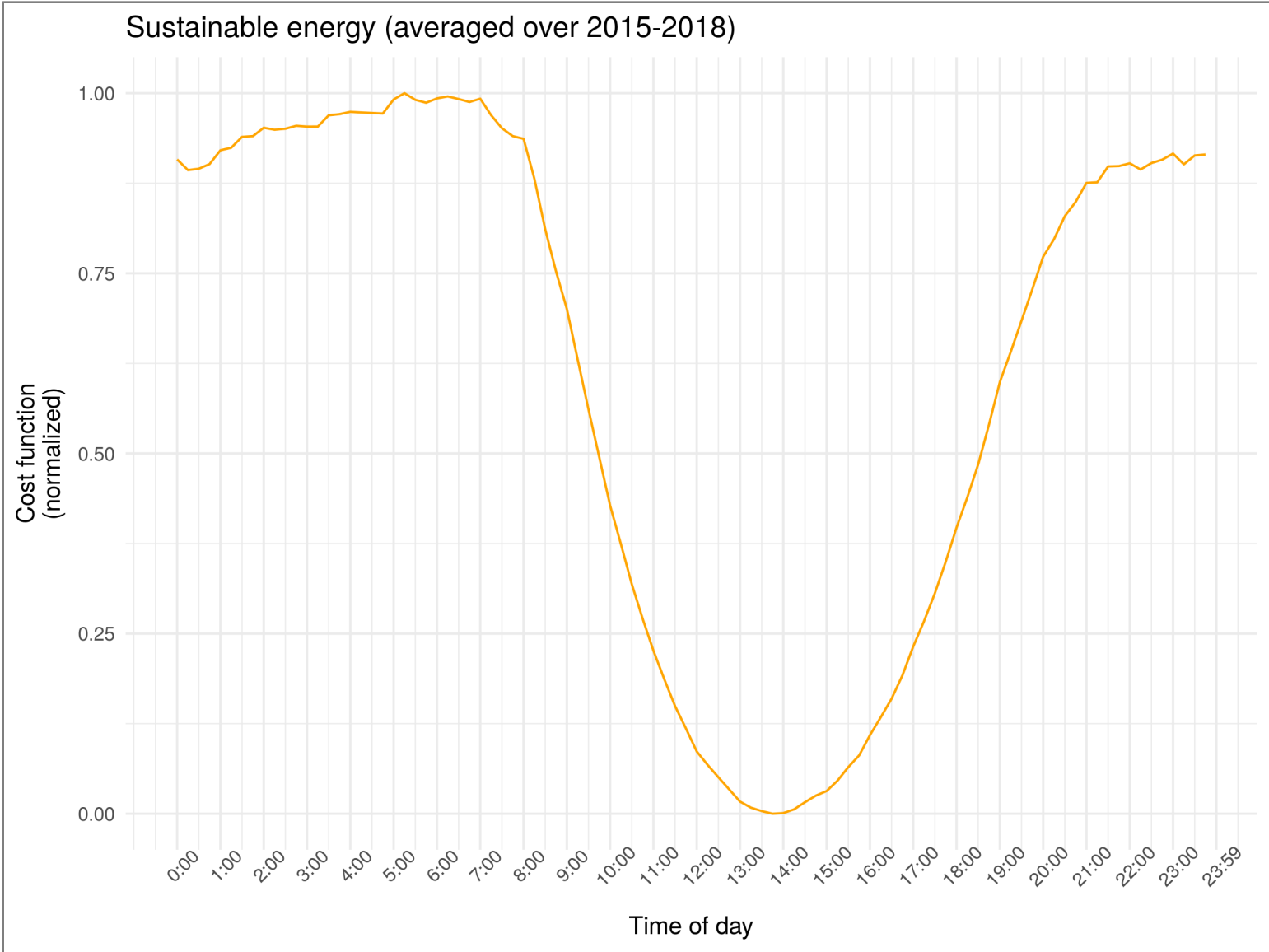
**Can we use machine learning to find
clusters in charging sessions?**

Gaussian Mixture Models are used to find clusters in charging sessions.

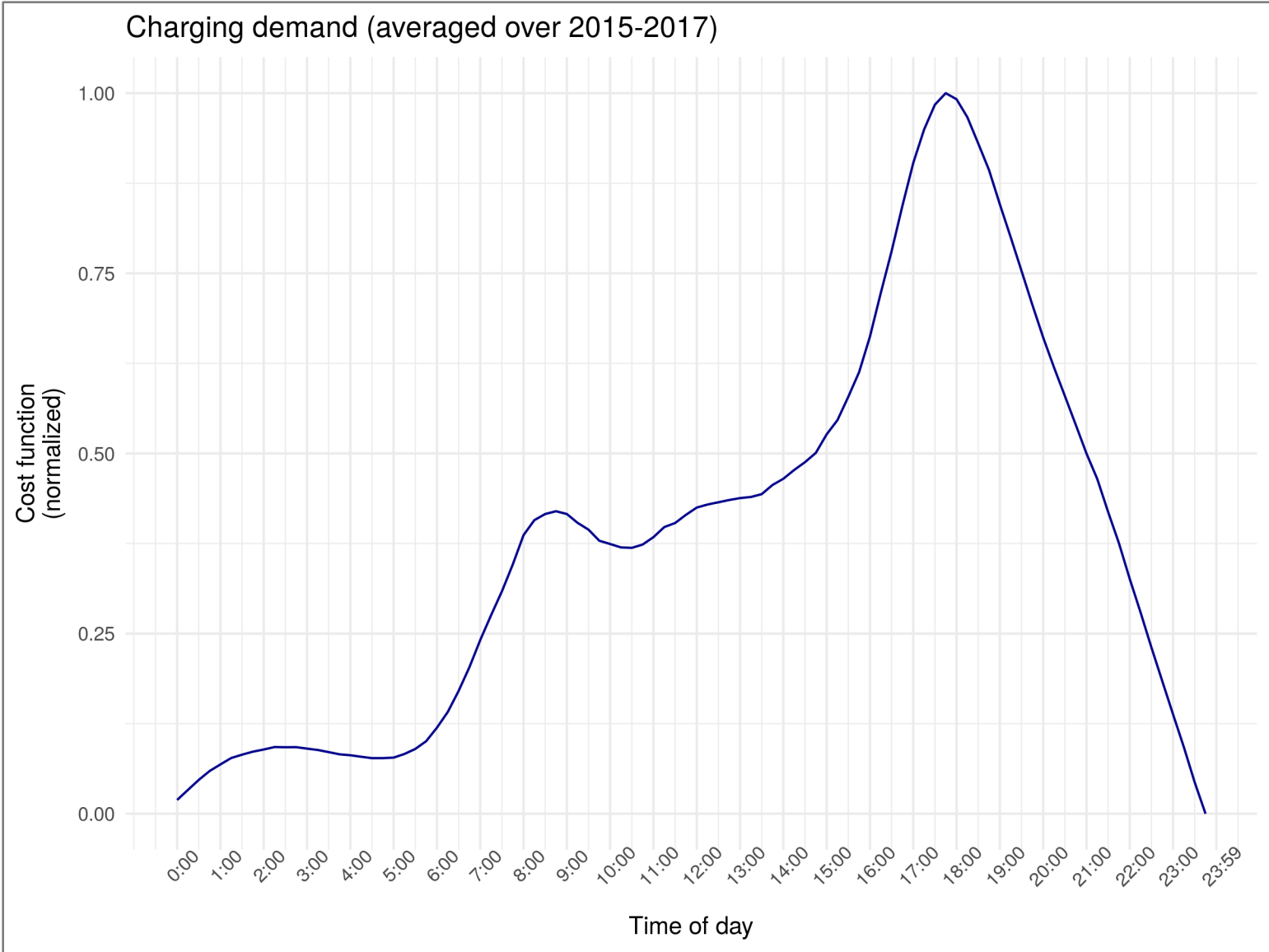


How can we **optimize** each **cluster** for different optimization objectives?

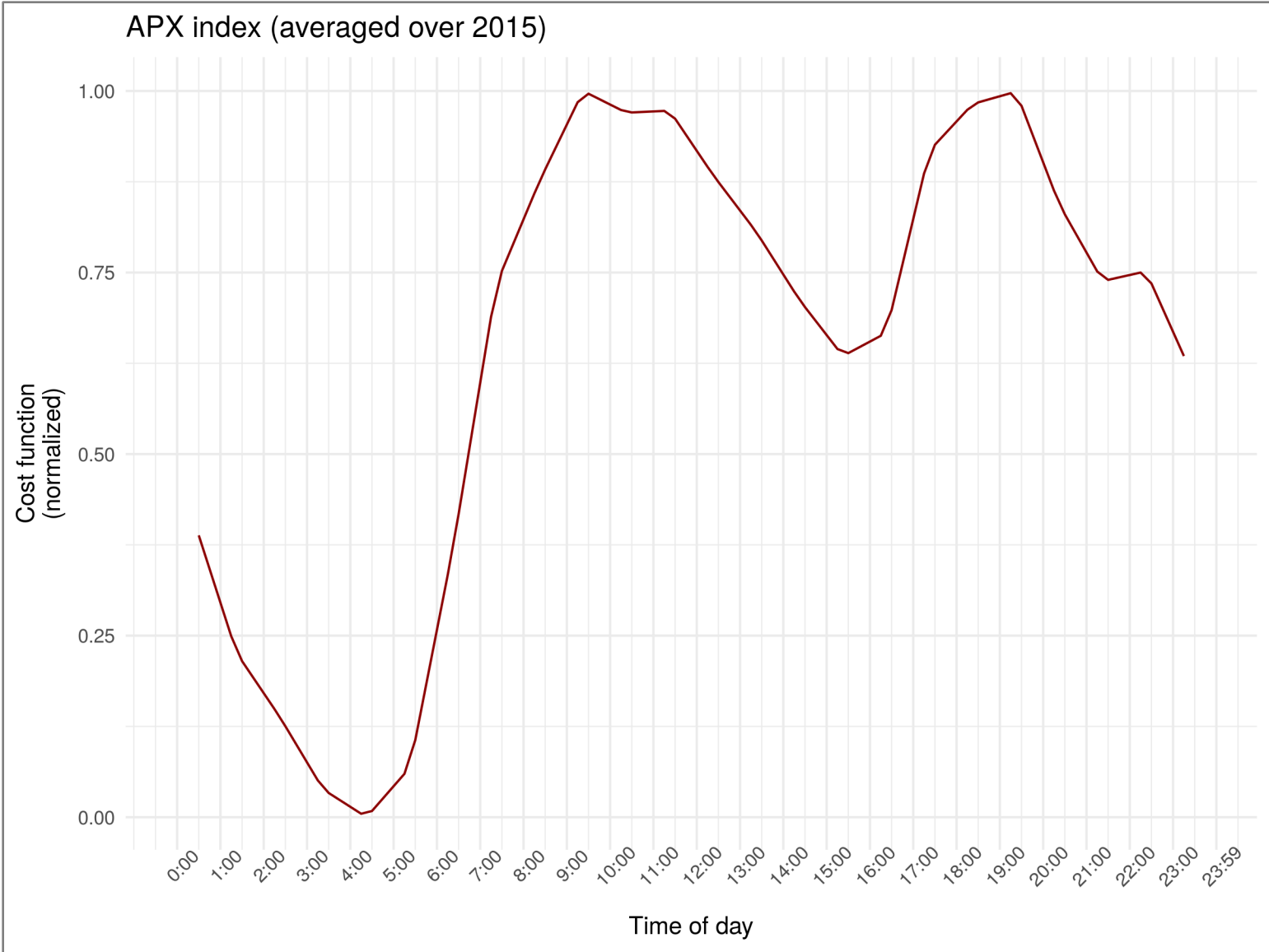
The optimization cost function for sustainable energy.



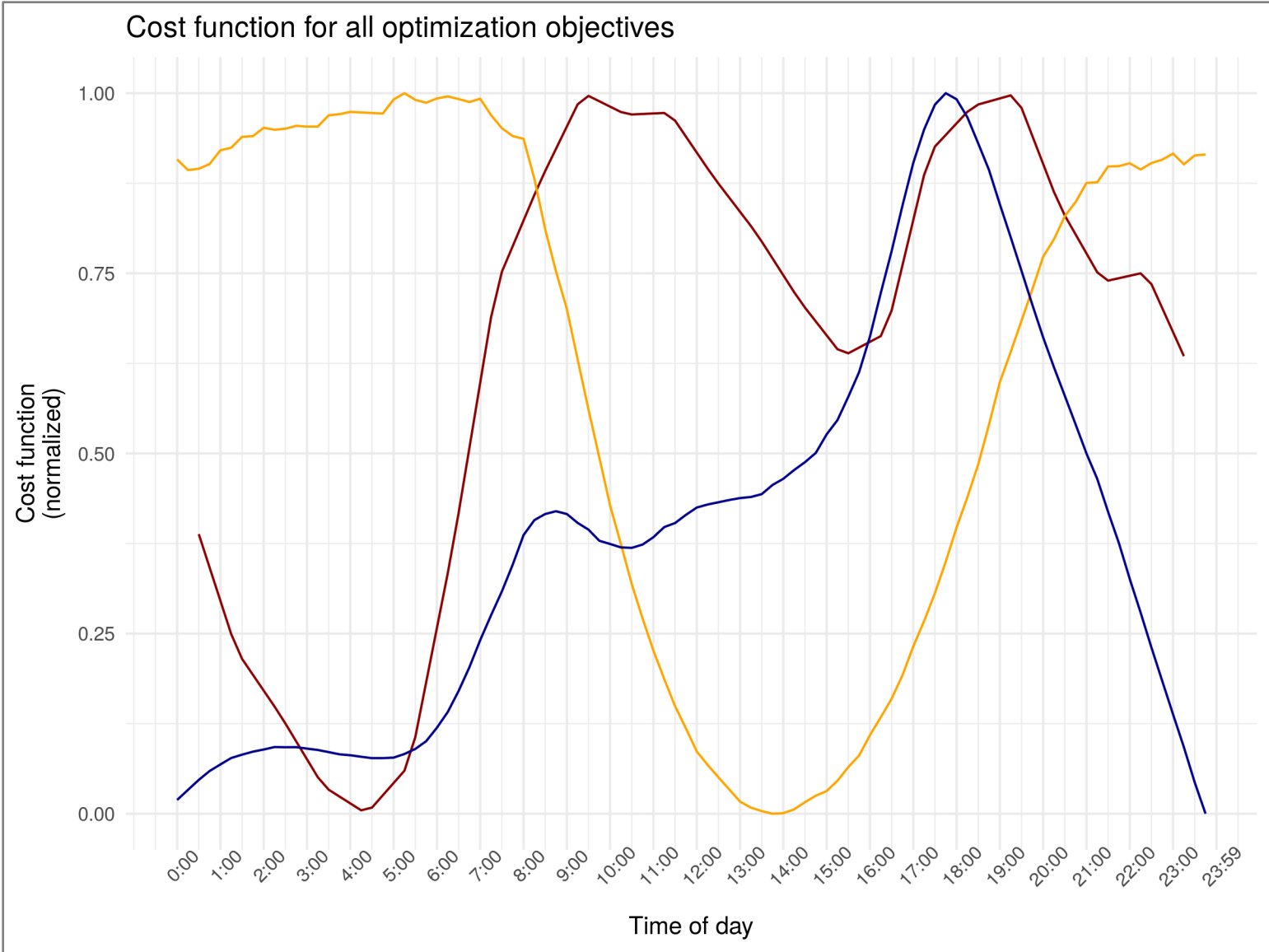
The optimization cost function for power demand for EV charging.



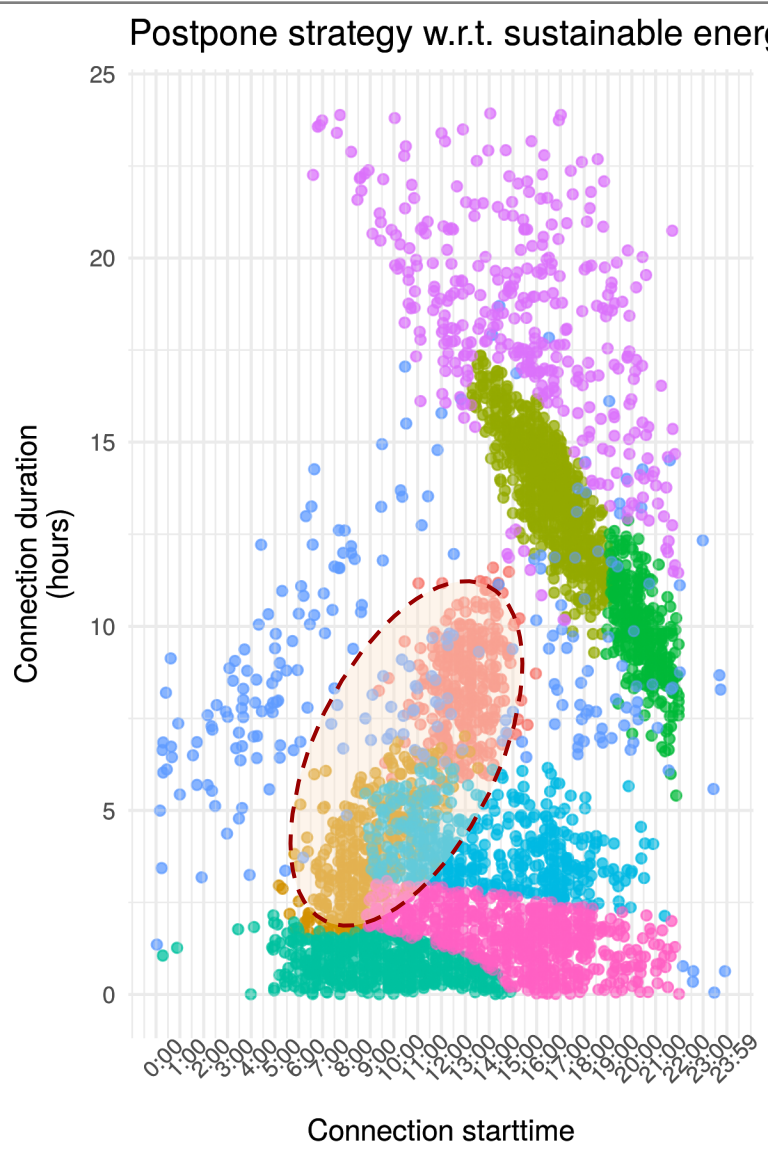
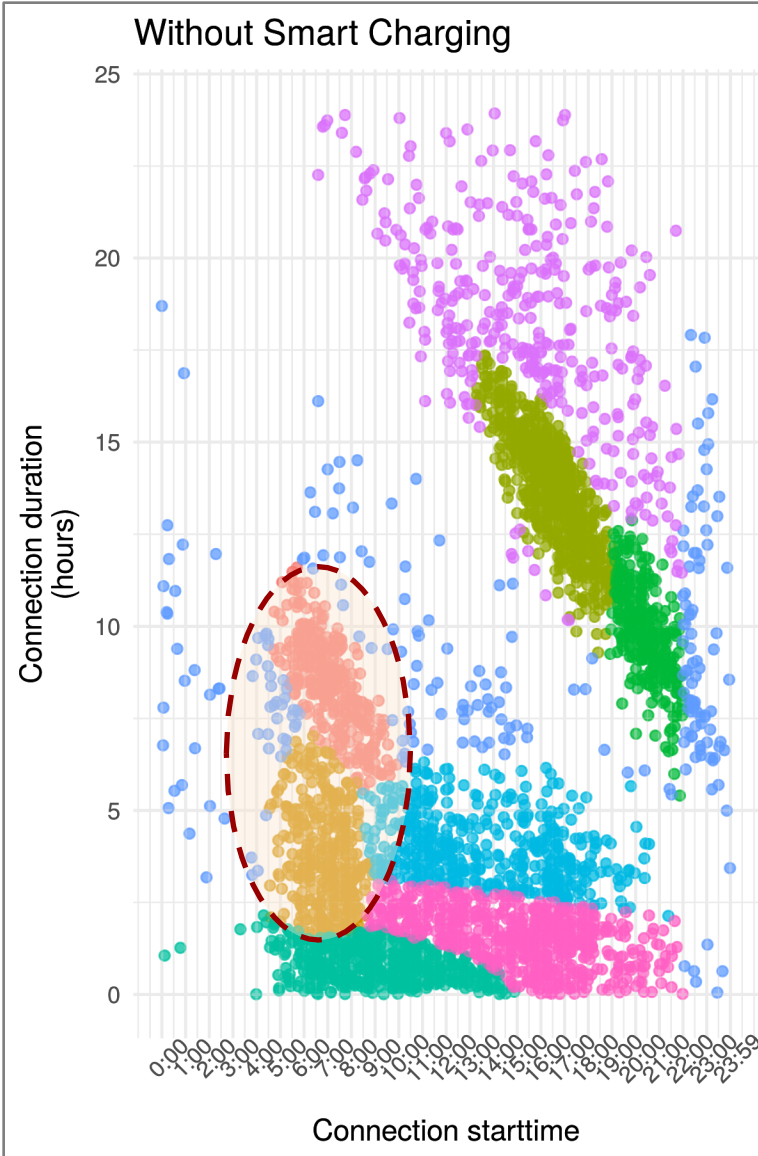
The optimization cost function for APX index.



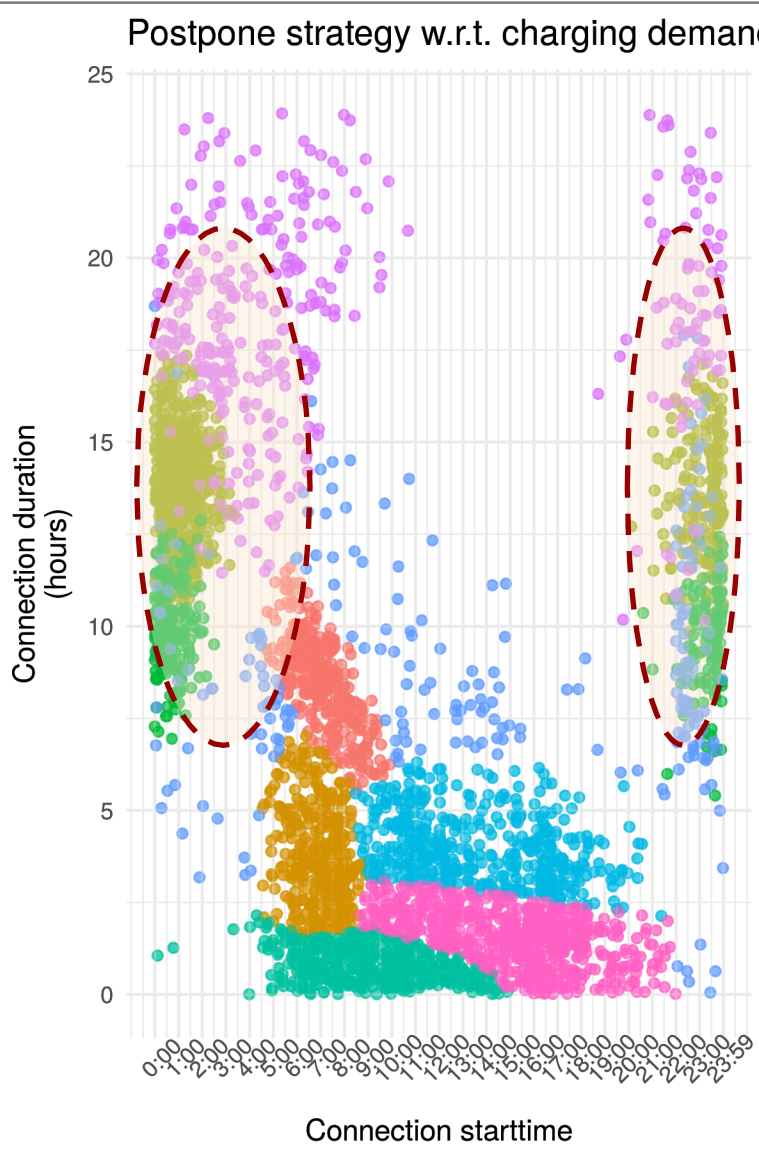
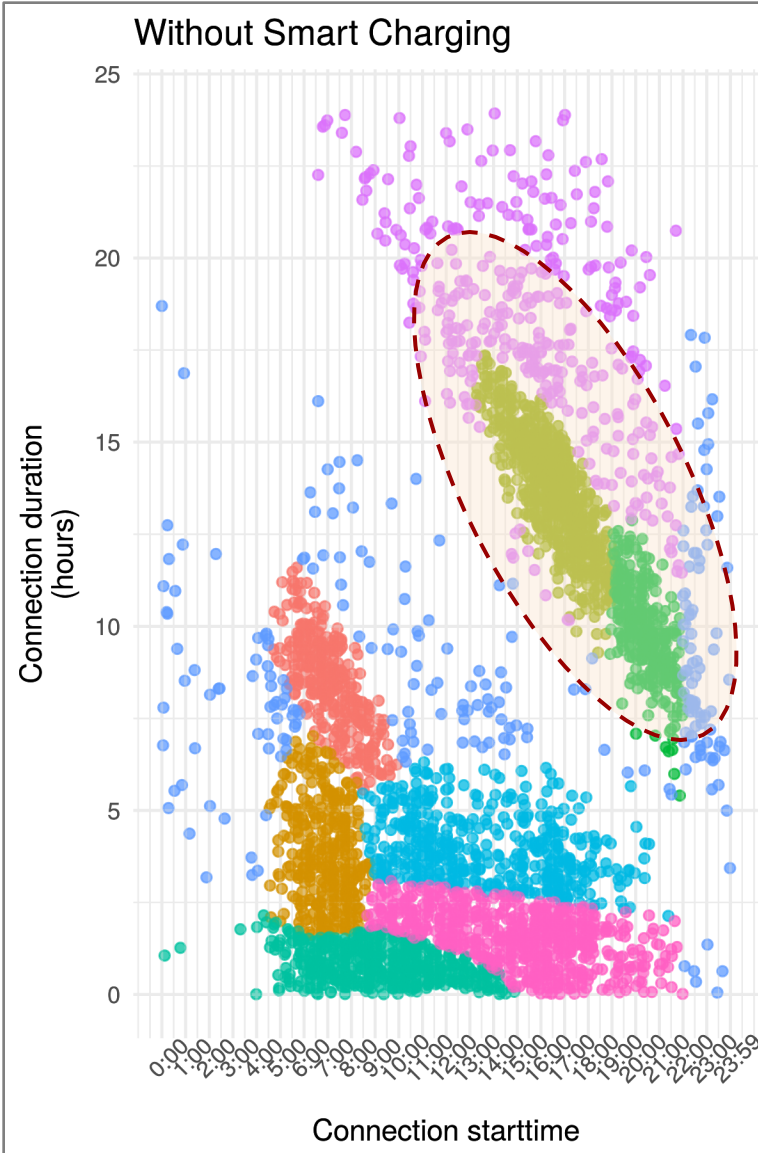
Trade-offs have to be made when choosing an optimization objective.



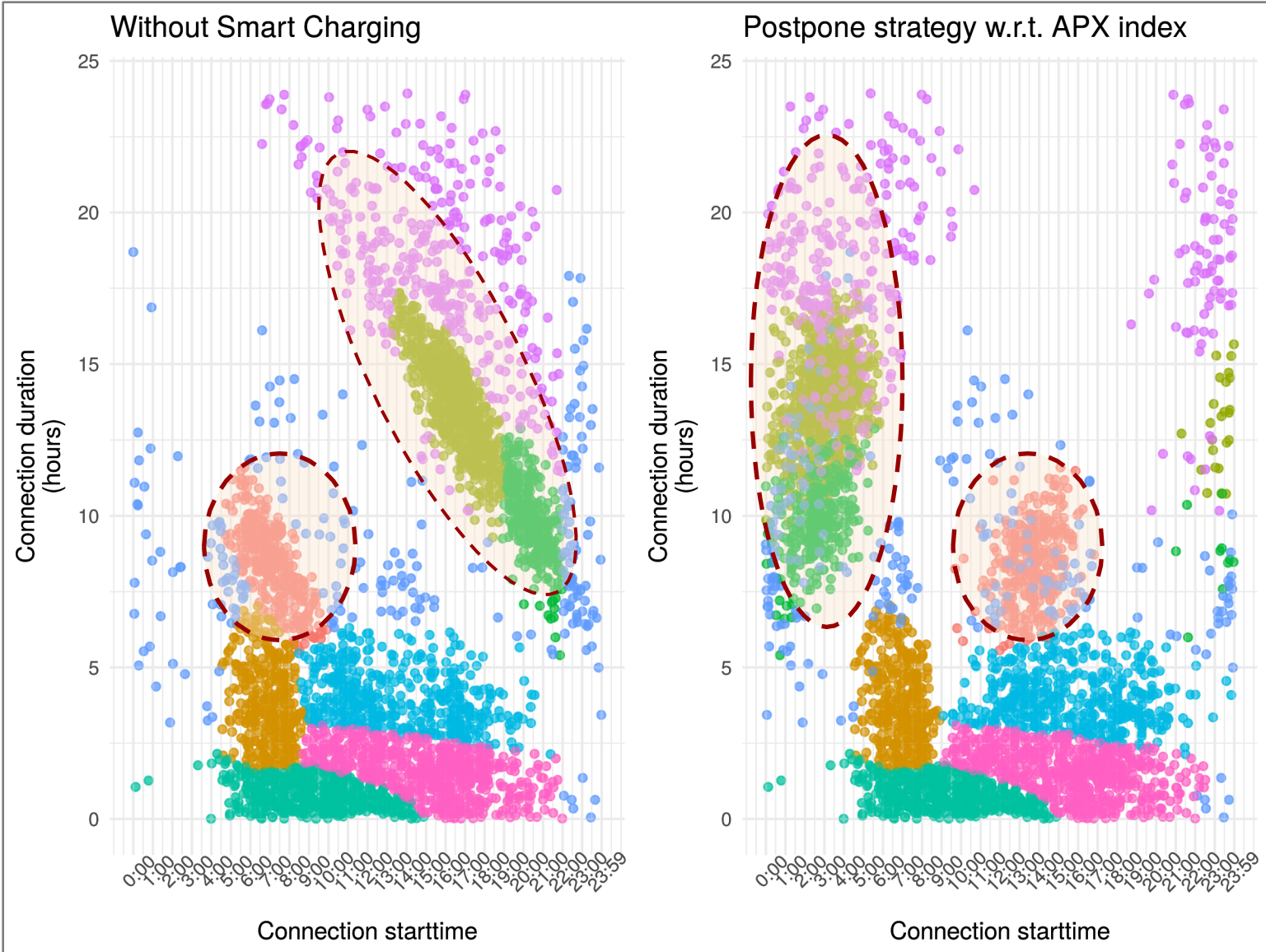
Optimizing for sustainable energy has an influence mainly on morning sessions.



Optimizing for power demand has an influence mainly on evening sessions.



Optimizing for APX has an influence mainly on morning and evening sessions



Key takeaways...

Charging behaviour is complex so there is no one-size-fits-all solution to apply Smart Charging.

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Charging behaviour is complex so there is no one-size-fits-all solution to apply Smart Charging.

Optimization outcome depends on optimization objectives.

Key takeaways...

Charging behaviour is complex so there is no one-size-fits-all solution to apply Smart Charging.

Optimization outcome depends on optimization objectives.

More data per cluster enables better understanding of charging behaviour.

The value of charging intelligence

Using charging data to develop insights and algorithms

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