



EV Charging and Grid Integration Tool

Launch event, 28 March 2023

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Renewable Integration and Secure Electricity unit

- Background
- Presentation of the tool features
- Live demo
- Q&A

Thematic Working Groups

- Knowledge materials and tools
- Network for advocacy, technology and policy advice



2 & 3 wheelers



Light-Duty Vehicles

Heavy-Duty Vehicles

Charging, grid integration, RE power supply, batteries

Regional Platforms

- Capacity building
- Establish communities of practice
- Replication and upscaling



Asia & Pacific



Europe, Middle East, West Asia



Latin America & Caribbean



Africa

Country Projects

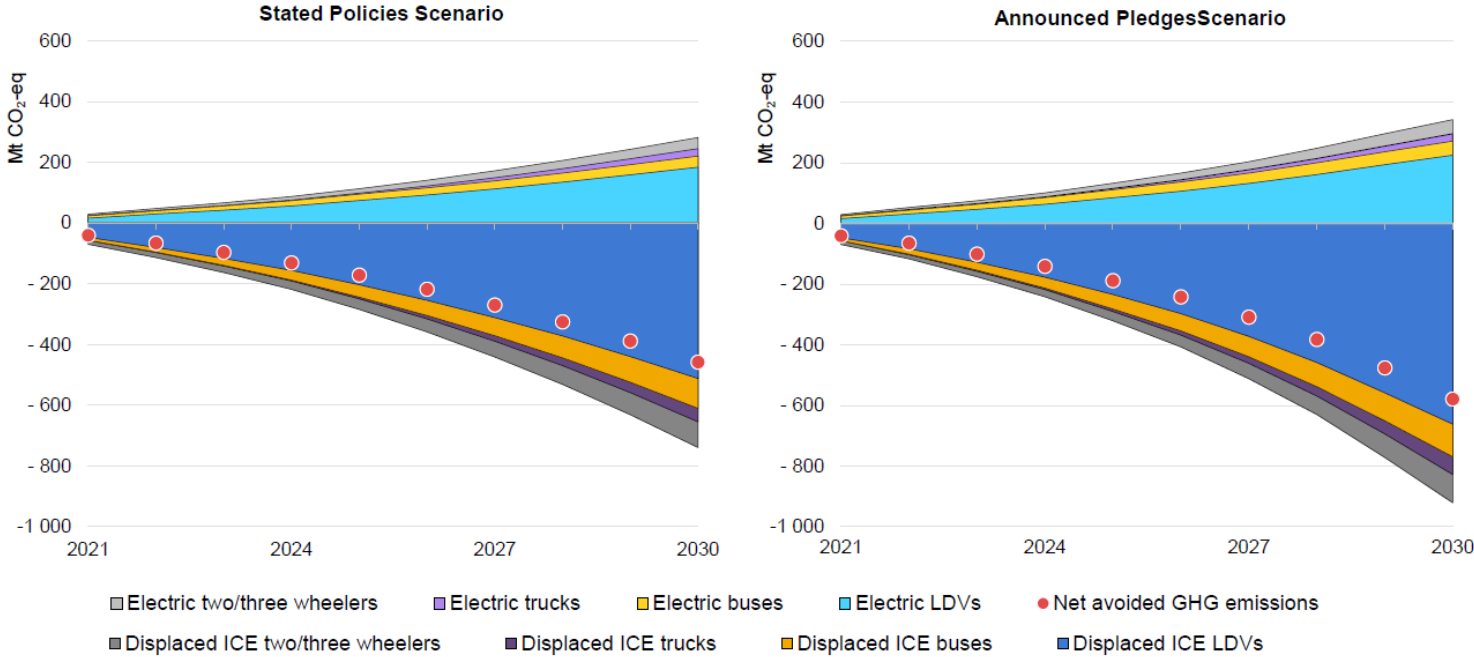
- Onsite demonstration

30+ country projects

<https://www.thegef.org/project/global-programme-support-countries-shift-electric-mobility>

Emissions from Electric Vehicles (EV) charging

Well-to-wheel GHG emissions from the global EV fleet, 2021-2030

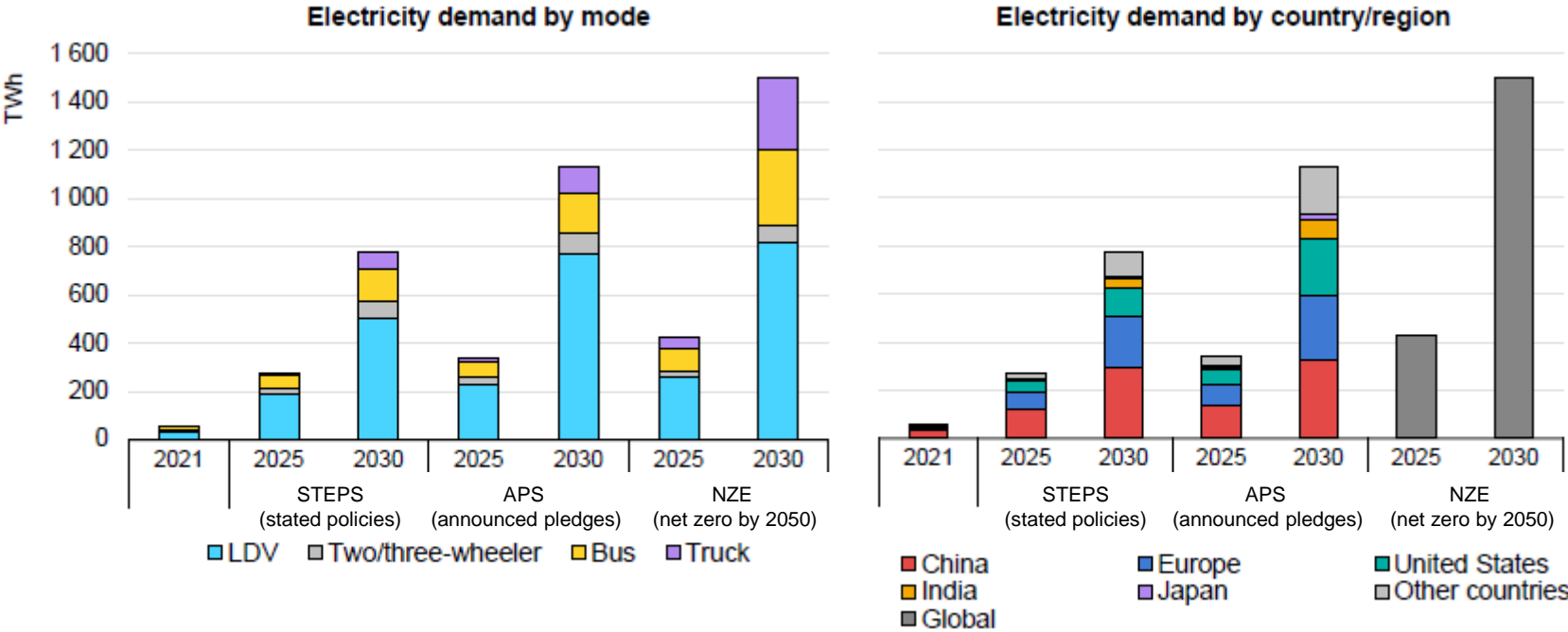


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As the power sector decarbonises, net reduction of GHG emissions from shift to EV accelerates.

Electricity demand from Global EV fleets

Electricity demand from the global EV fleet by scenario, 2021-2030

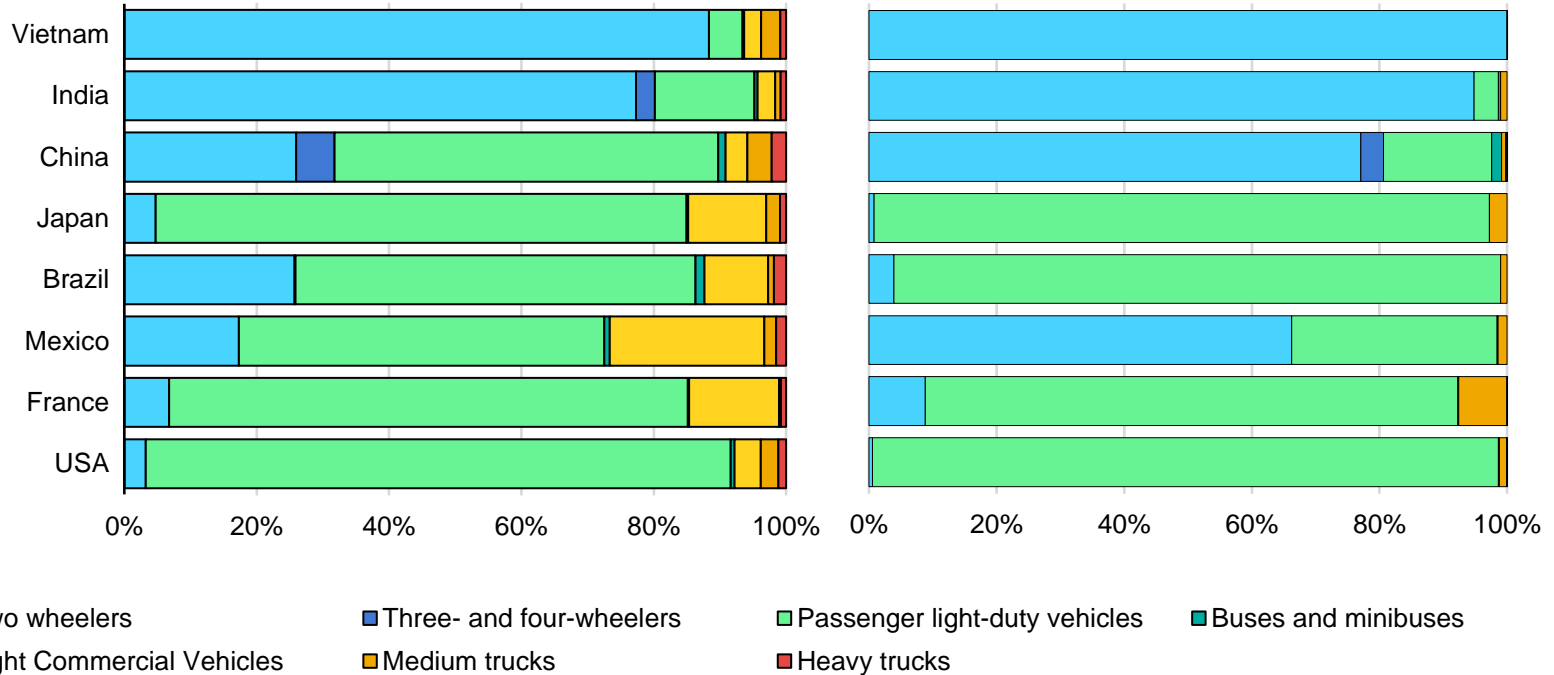


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Meeting climate pledges will require electricity demand for EV to grow 20 times by 2030 compared to 2021.

A wide range of road transport electrification priorities

Stock share of all vehicles (left) and EVs (right) by vehicle type in selected countries



Assessing grid impacts is a necessary step for planning the uptake of EV.

Motivation #1

Assessing the impact of EV charging on the power system

Motivation #2

Assessing effect of measures for mitigating EV charging impacts

Motivation #3

Estimating the CO₂ emissions related to EV charging

Module 1

Simulation of EV charging behaviour

Output: weekly EV charging demand profile

Module 2

Simulation of EV charging behaviour with managed charging

Output: weekly EV charging demand profile with managed charging

Module 3 (API)

Simplified representation of the electricity mix

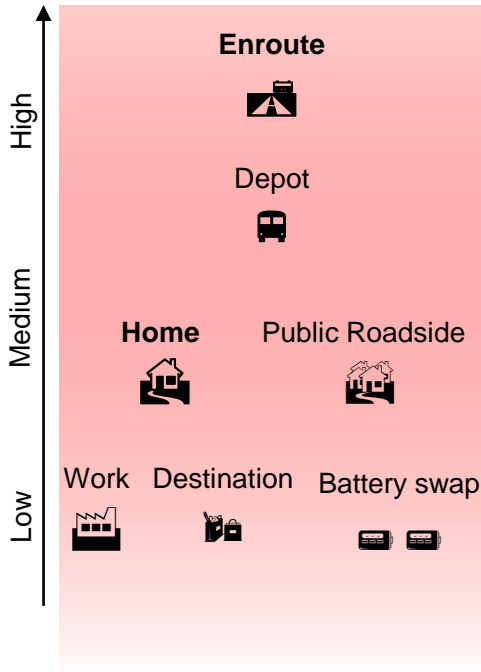
Output: calculation of yearly CO₂ emissions

Motivation #1 (Module 1)

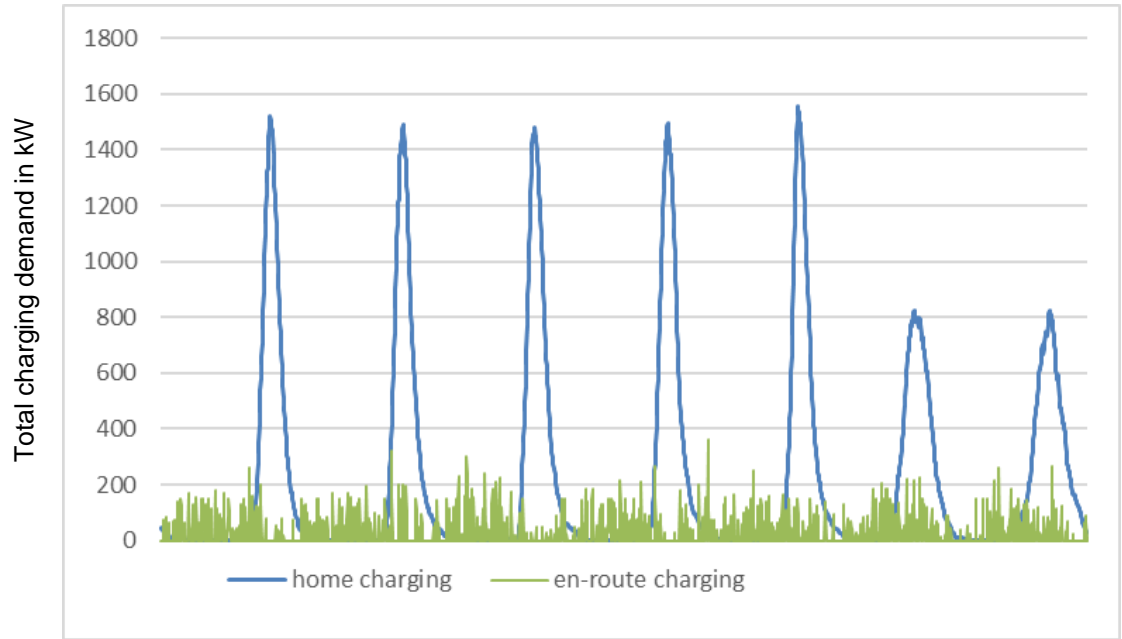
Assessing the impact of EV charging on the power system

Many factors influence the profile of electricity demand by EV

Grid impacts
of EV charging



Power demand profile from EV charging
of 1000 private cars driving (one week)



Grid impacts of charging solutions vary based on EV fleet and electricity system characteristics.

Example : 1 000 private cars – fleet size and driving pattern

How can tool users enter a fleet?

Fleet

Label
Private LDVs

Vehicle type **LDV**

Average battery capacity
46.0 kWh

Energy consumption
0.18 kWh/km

Average weekday driving +/-

Average weekend driving +/-

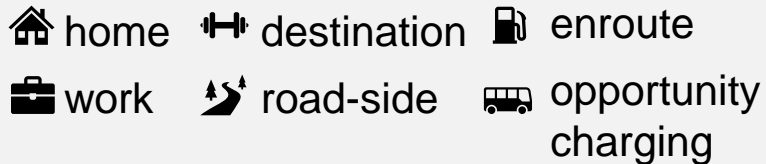
Behaviour profile
Private driving

User inputs

Charging needs



Charging location types



Weekly based model

Weekday



Weekend

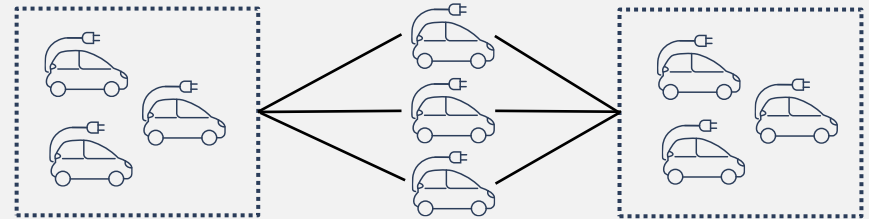


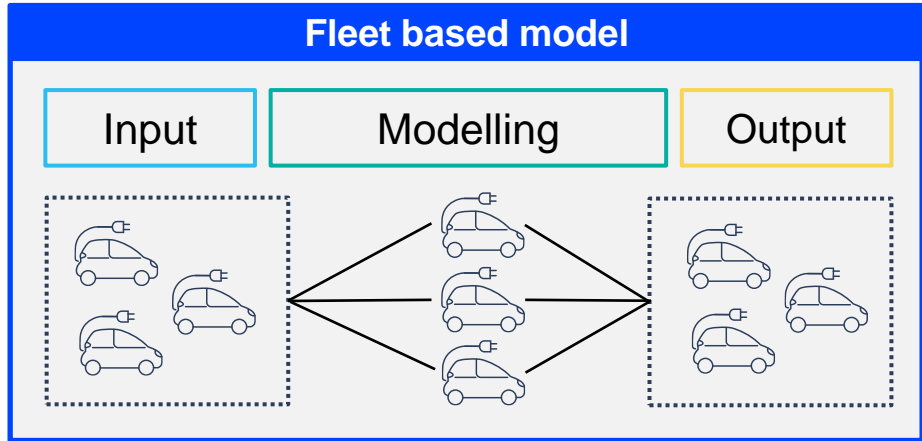
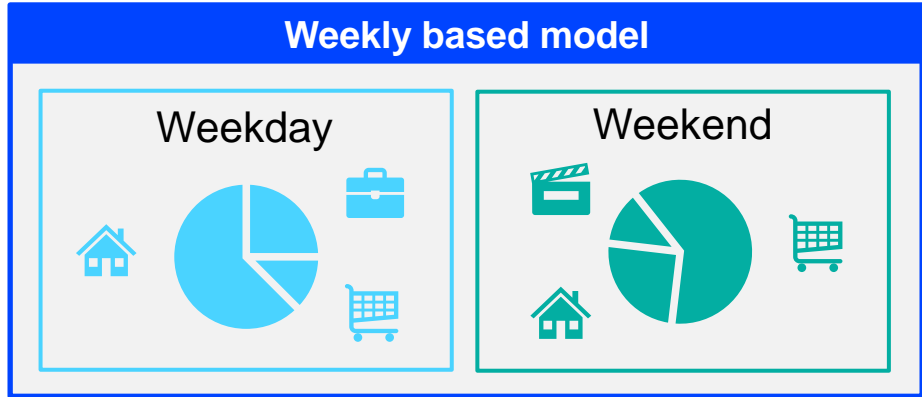
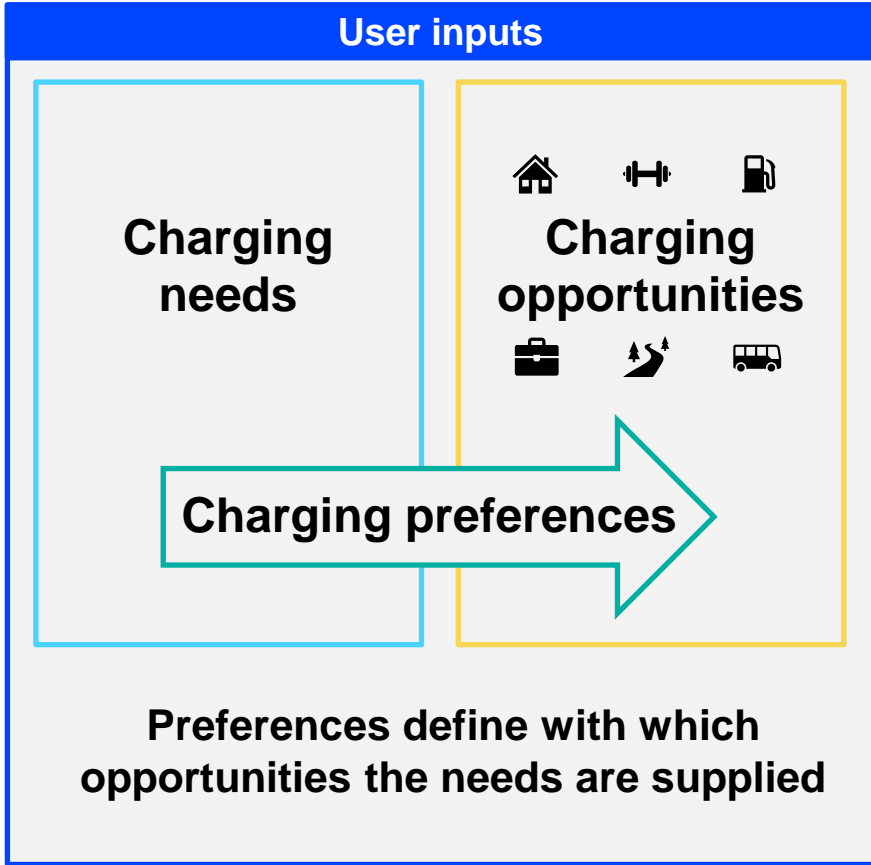
Fleet based model

Input

Modelling

Output





Example : 1 000 private cars – charging behaviour

How can tool users define the charging preference and opportunities?

Availability

Home/Depot ?	Workplace ?	Road-side charging ?	En route ?	Destination ?
Charger power 3.5 kW	Charger power 3.5 kW	Charger power 11 kW	Charger power 50 kW	Charger power 11 kW
Weekday availability 90%	Weekday availability 60%	Weekday availability 0%	Weekday availability 0%	Weekday availability 50%
Weekend availability 90%	Weekend availability 5%	Weekend availability 0%	Weekend availability 0%	Weekend availability 50%

Example : 1 000 private cars – charging behaviour

How can tool users define the charging preference and opportunities?

The image displays three overlapping screenshots of a user interface for defining charging preferences. The central screenshot is highlighted with a blue dashed border.

- Central Screenshot (Home/Depot):**
 - Header: Home/Depot ?
 - Charger power: 3.5 kW (dropdown menu)
 - Weekday availability: 90% (slider)
 - Weekend availability: 90% (slider)
- Left Screenshot (Home/Depot):**
 - Header: Home/Depot ?
 - Charger power: 3.5 kW (dropdown menu)
 - Weekday availability: 90% (slider)
 - Weekend availability: 90% (slider)
- Right Screenshot (Destination):**
 - Header: Destination ?
 - Charger power: 11 kW (dropdown menu)
 - Weekday availability: 50% (slider)
 - Weekend availability: 50% (slider)

Example : 1 000 private cars – charging behaviour

How can tool users define the charging preference and opportunities?

Preference

Home/Depot ?

Preference for charging here
80%



Workplace ?

Preference for charging here
15%



Road-side charging ?

Preference for charging here
1%



En route ?

Preference for charging here
1%



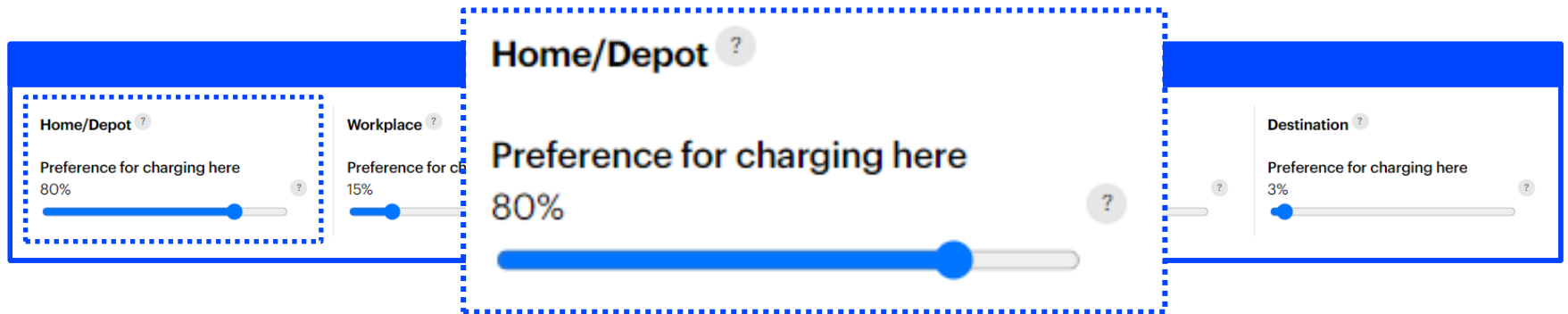
Destination ?

Preference for charging here
3%



Example : 1 000 private cars – charging behaviour

How can tool users define the charging preference and opportunities?



Example : 1 000 private cars – charging behaviour

How can tool users define the charging preference and opportunities?

Typical charging times

Weekday

Arrival time	+/-
19:00	1 hours
Typical stay time	
12 hours	

Weekday

Arrival time	+/-
09:00	1 hours
Typical stay time	
9 hours	

Weekday

Arrival time	+/-
12:00	12 hours
Typical stay time	
3 hours	

Weekday

Arrival time	+/-
12:00	12 hours
Typical stay time	
15 minutes	

Weekday

Arrival time	+/-
15:00	2 hours
Typical stay time	
2 hours	

Weekend

Arrival time	+/-
16:00	2 hours
Typical stay time	
12 hours	

Weekend

Arrival time	+/-
09:00	1 hours
Typical stay time	
9 hours	

Weekend

Arrival time	+/-
12:00	12 hours
Typical stay time	
4 hours	

Weekend

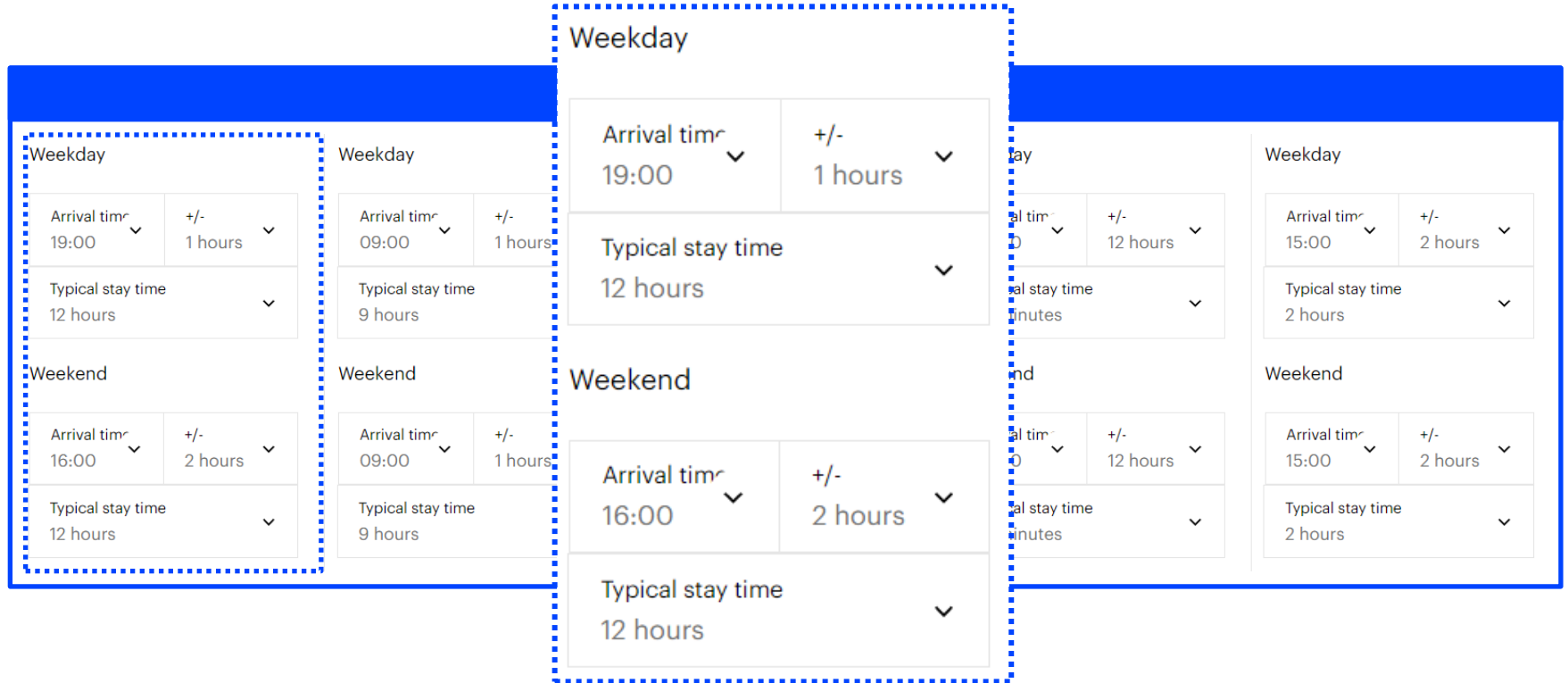
Arrival time	+/-
12:00	12 hours
Typical stay time	
15 minutes	

Weekend

Arrival time	+/-
15:00	2 hours
Typical stay time	
2 hours	

Example : 1 000 private cars – charging behaviour

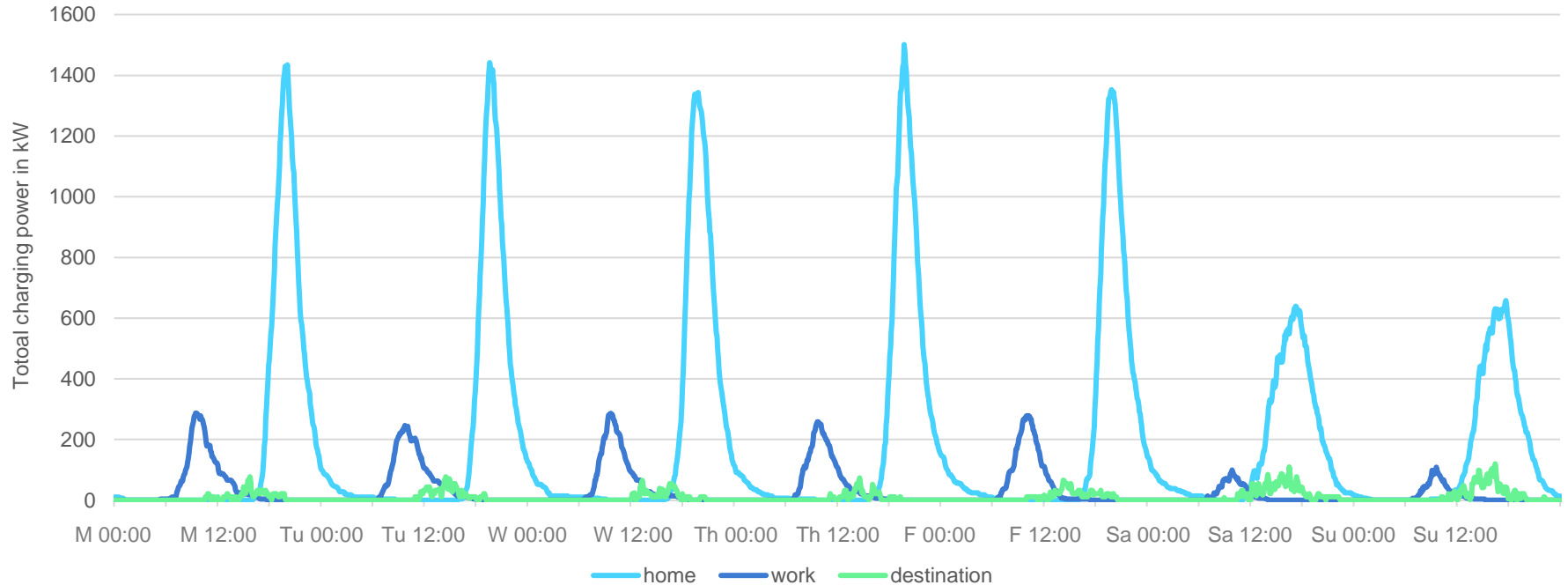
How can tool users define the charging preference and opportunities?



Day	Arrival time	+/-	Typical stay time
Weekday	19:00	1 hours	12 hours
Weekday	09:00	1 hours	9 hours
Weekend	16:00	2 hours	12 hours
Weekend	09:00	1 hours	9 hours
Weekday	19:00	1 hours	12 hours
Weekday	15:00	2 hours	2 hours
Weekend	16:00	2 hours	12 hours
Weekend	15:00	2 hours	2 hours

Example : 1 000 private cars

Tool output 1: Power demand profile from EV charging over one week



If unmanaged, most charging takes place in the early evening, when the non-EV electricity demand peaks. This can overload grids and require expensive thermal units to cover the additional demand.

Example : 1 000 private cars – lower access to home charging

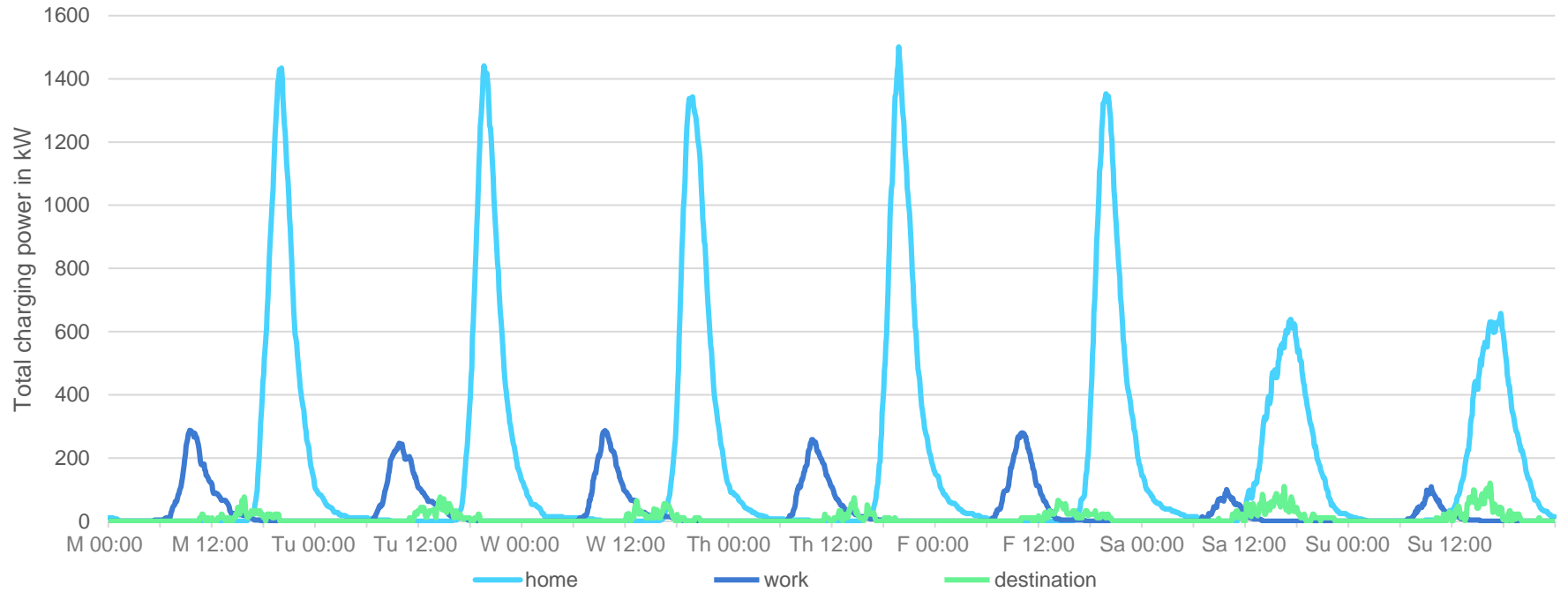
What does happen, if the charging availability change?

Availability

Home/Depot ?	Workplace ?	Destination ?
<p>Charger power 3.5 kW</p> <p>Weekday availability 90%</p> <p>Weekend availability 90%</p>	<p>Charger power 11 kW</p> <p>Weekday availability 60%</p> <p>Weekend availability 5%</p>	<p>Charger power 11 kW</p> <p>Weekday availability 50%</p> <p>Weekend availability 50%</p>
<p>Charger power 3.5 kW</p> <p>Weekday availability 40%</p> <p>Weekend availability 40%</p>	<p>Charger power 11 kW</p> <p>Weekday availability 30%</p> <p>Weekend availability 0%</p>	<p>Charger power 11 kW</p> <p>Weekday availability 80%</p> <p>Weekend availability 80%</p>

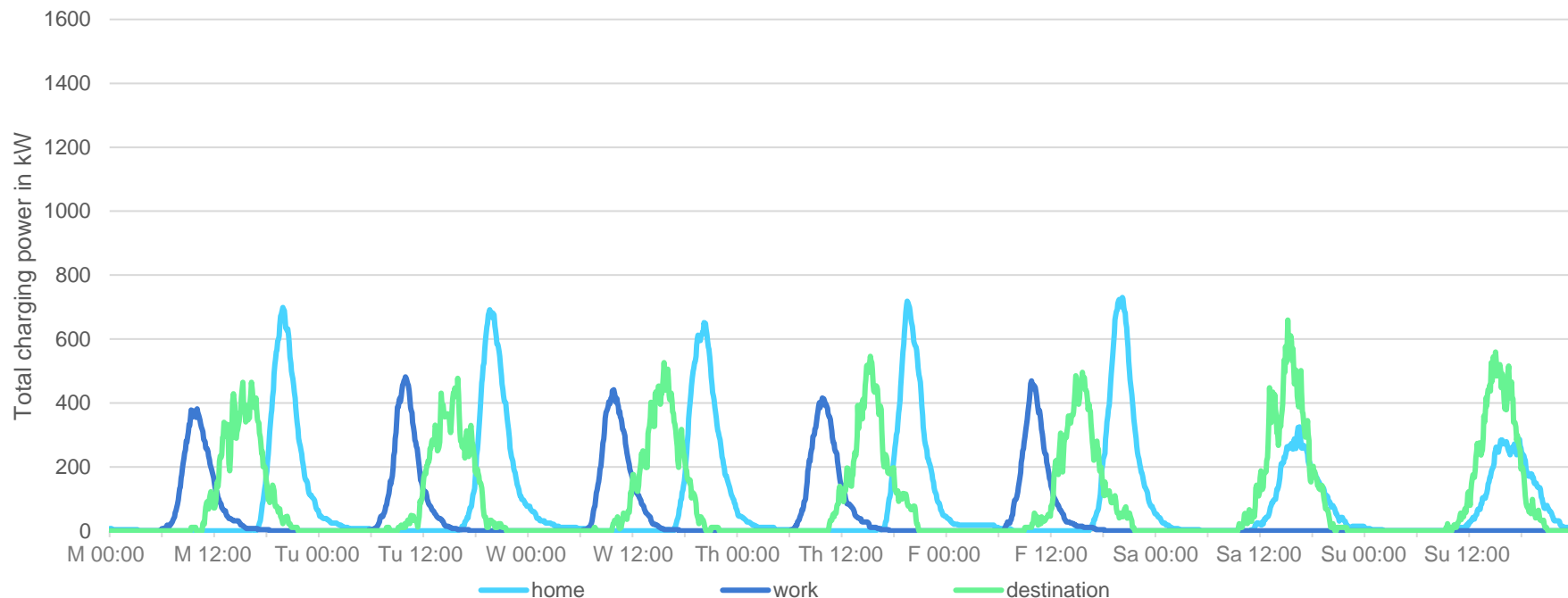
Example : 1 000 private cars – lower access to home charging

Tool output 1: Power demand profile from EV charging over one week



Example : 1 000 private cars – lower access to home charging

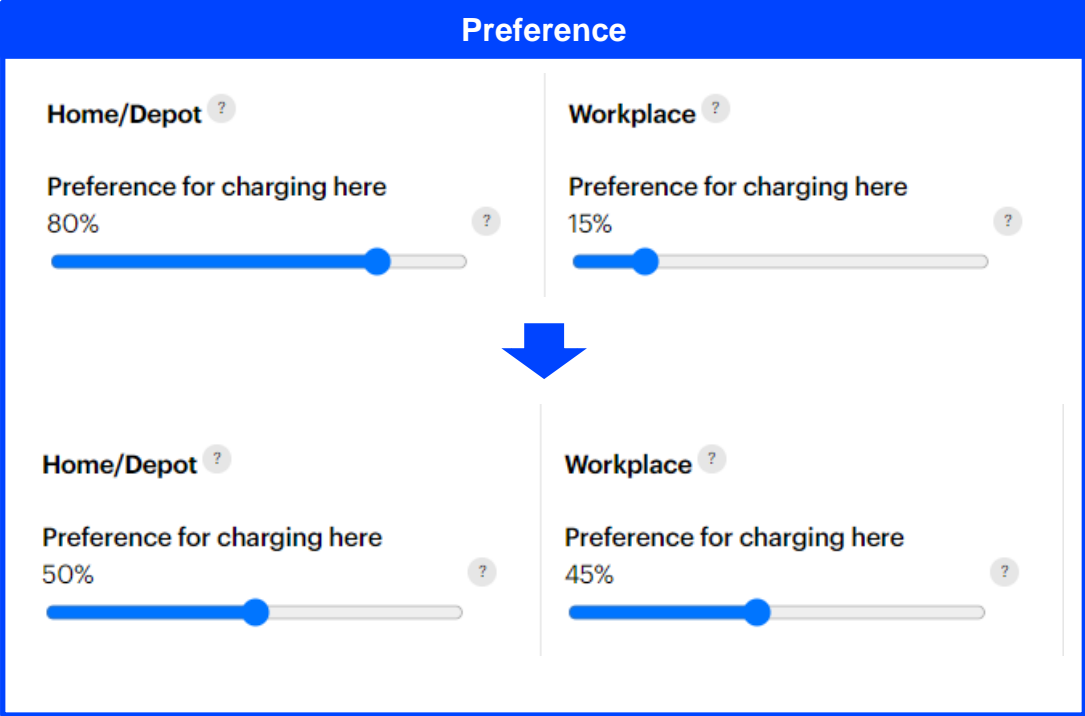
Tool output 1: Power demand profile from EV charging over one week



High reliance on public charging network could create sharp surges in demand.

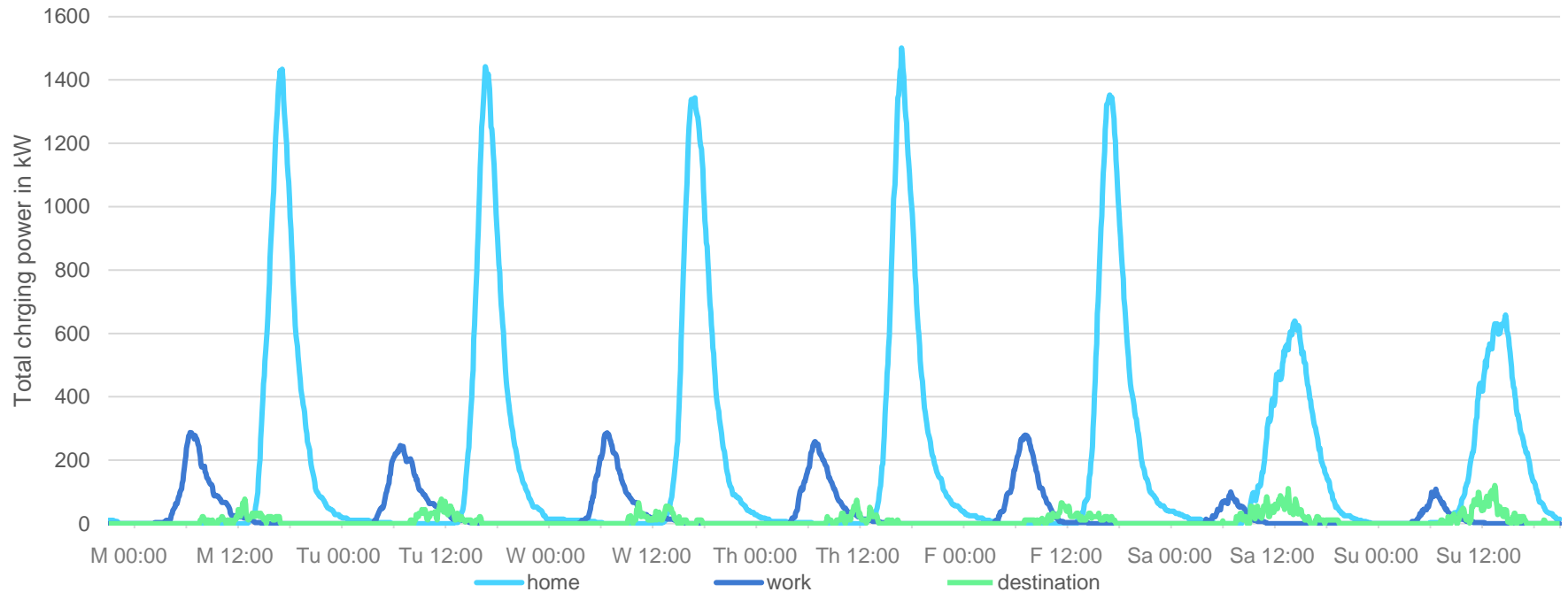
Example : 1 000 private cars – increased access to workplace charging

What does happen, if the charging preferences change?



Example : 1 000 private cars – increased access to workplace charging

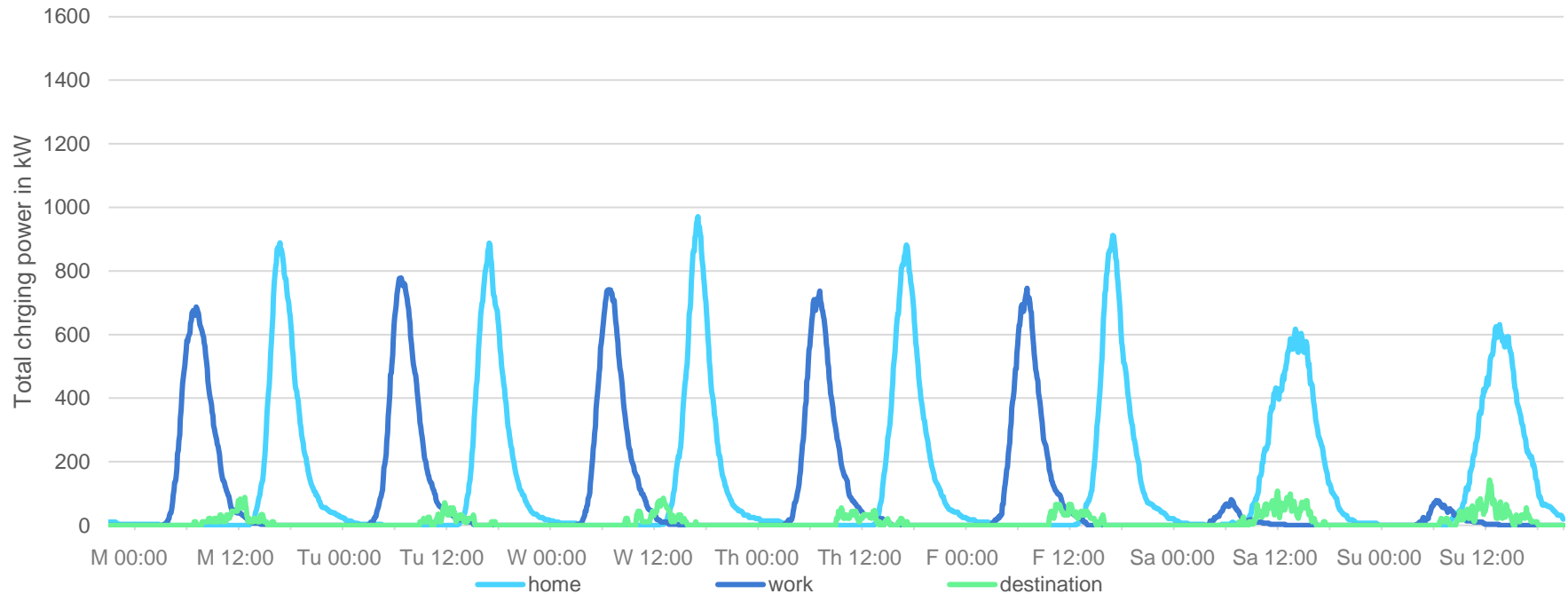
Tool output 1: Power demand profile from EV charging over one week



Daytime charging reduces amplitude of evening peak and makes better use of solar energy.

Example : 1 000 private cars – increased access to workplace charging

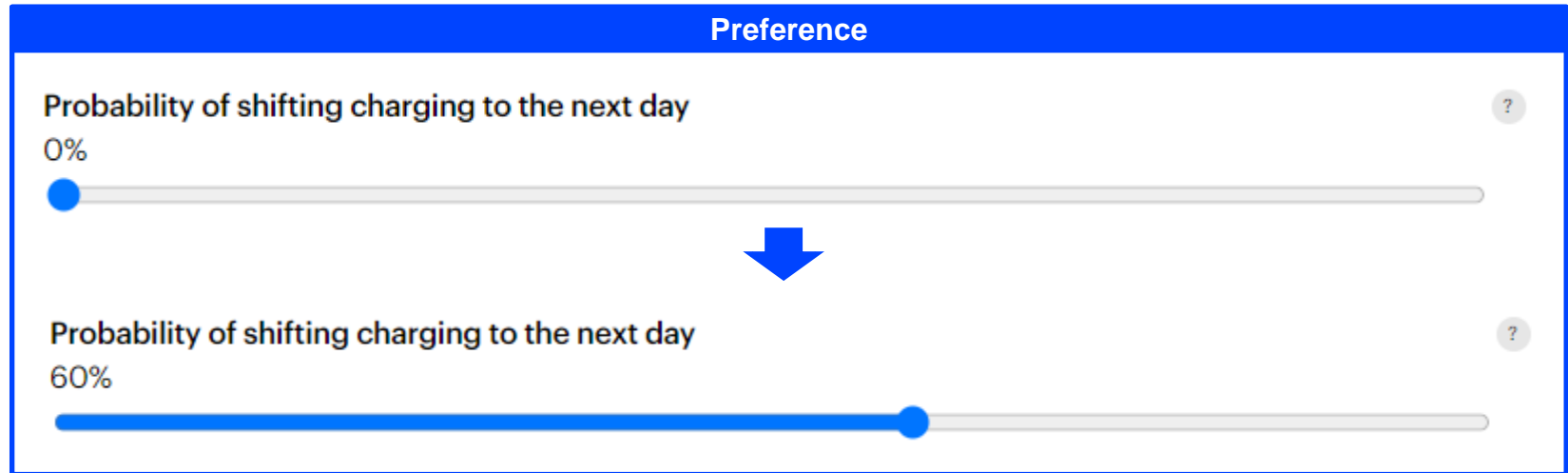
Tool output 1: Power demand profile from EV charging over one week



Daytime charging reduces amplitude of evening peak and makes better use of solar energy.

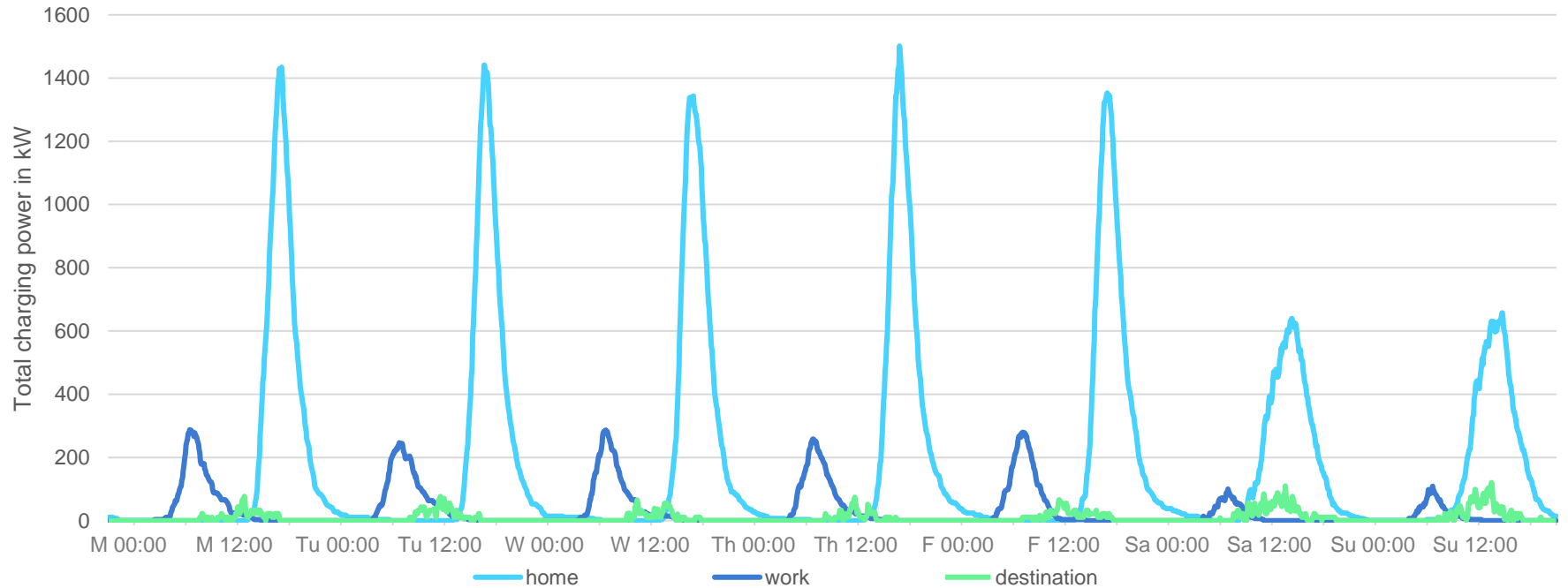
Ex: 1 000 private cars – drivers less proactive in connecting to grid

What does happen, if 600 (60%) EV-drivers wait for charging until state of charge of battery = 50%?



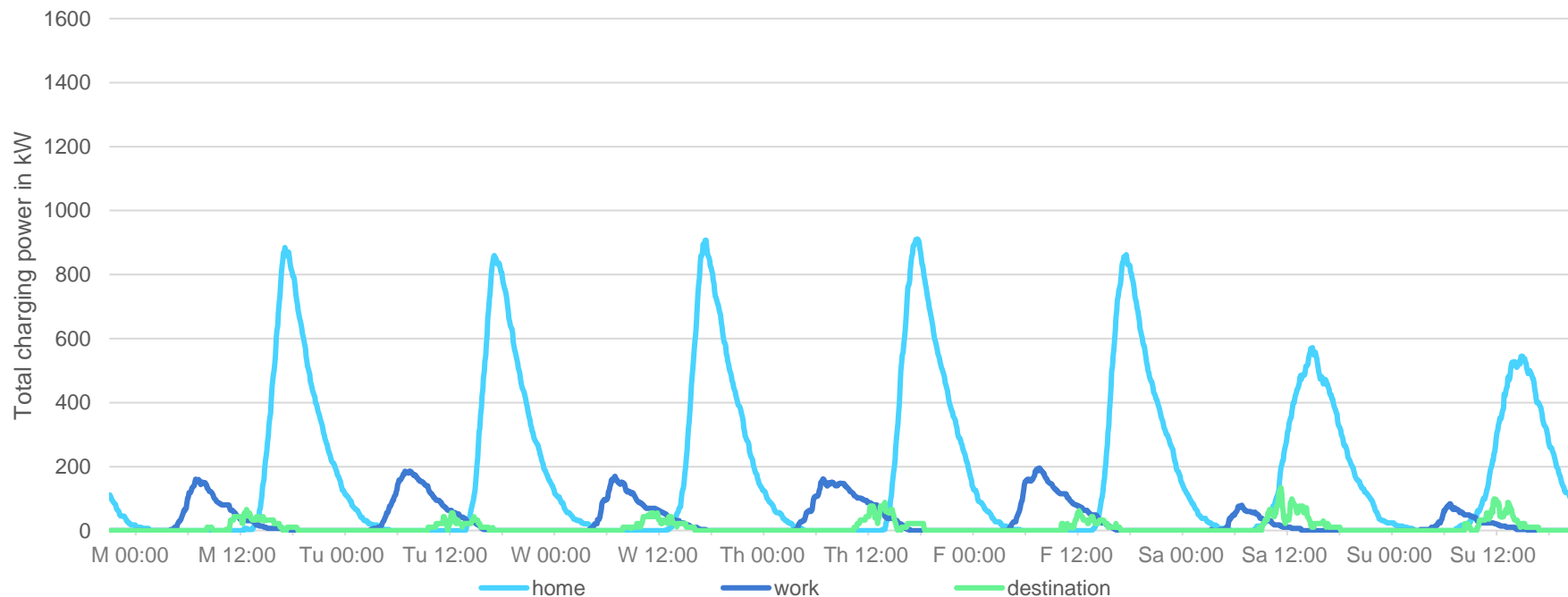
Ex: 1 000 private cars – drivers less proactive in connecting to charger

Tool output 1: Power demand profile from EV charging over one week



Ex: 1 000 private cars – drivers less proactive in connecting to charger

Tool output 1: Power demand profile from EV charging over one week



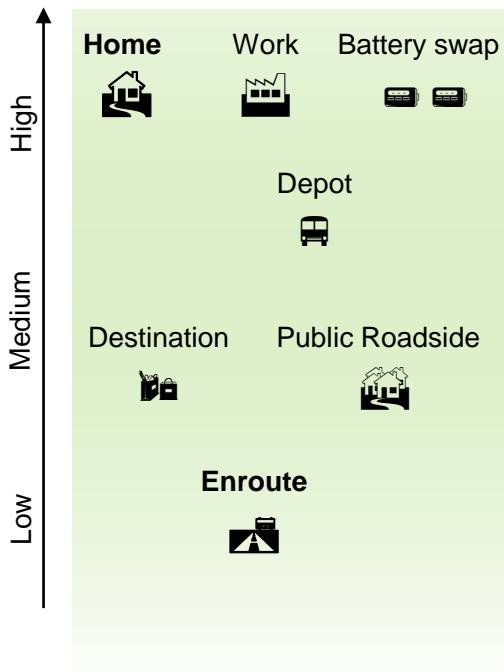
Charging events are less intense but longer if drivers tend to charge only when the battery state of charge is low.

Motivation #2 (Module 2)

Assessing effect of measures for mitigating EV charging impacts

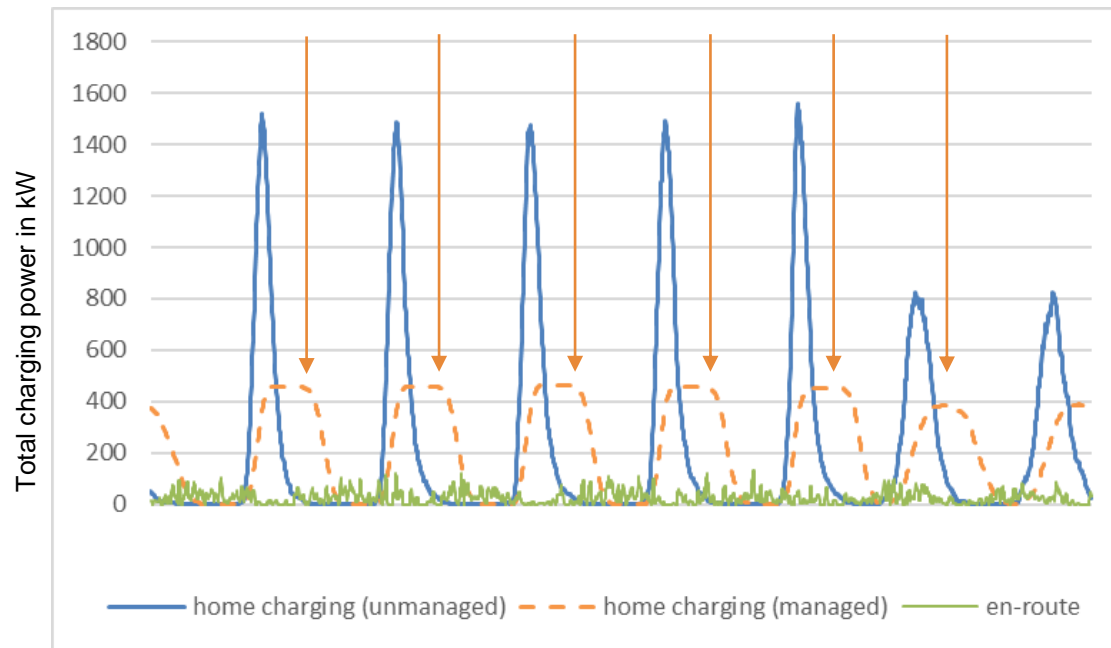
Opportunities of road transport electrification

Flexibility opportunity with managed charging



Power demand profile from EV charging of 1000 private cars driving (one week)

Managed charging effects



Managed charging unlocks demand flexibility, reduces peak demand and grid congestions, and accelerates electricity decarbonisation.

Is managed charging possible?

Checking flexibility

Energy required to charge EV

Flexibility

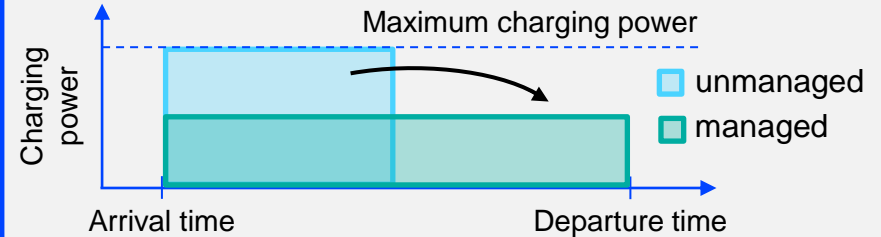
Energy available for charging (during connection time)

Participation rate

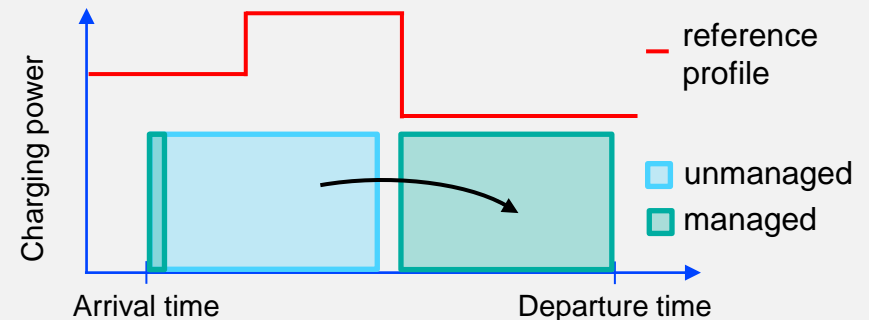
Is the infrastructure adapted? AND
Is the driver willing to participate?

**Apply
a managed charging measure**

Balanced charging



Time-of-Use (ToU) tariffs and smart charging (API)



➤ Shift of energy depending on the **hourly tariff schedule**
reference electricity demand curve

Ex: 1 000 private cars – applying balanced charging

How can a managed charging strategy be applied?

Managed charging and participation rate

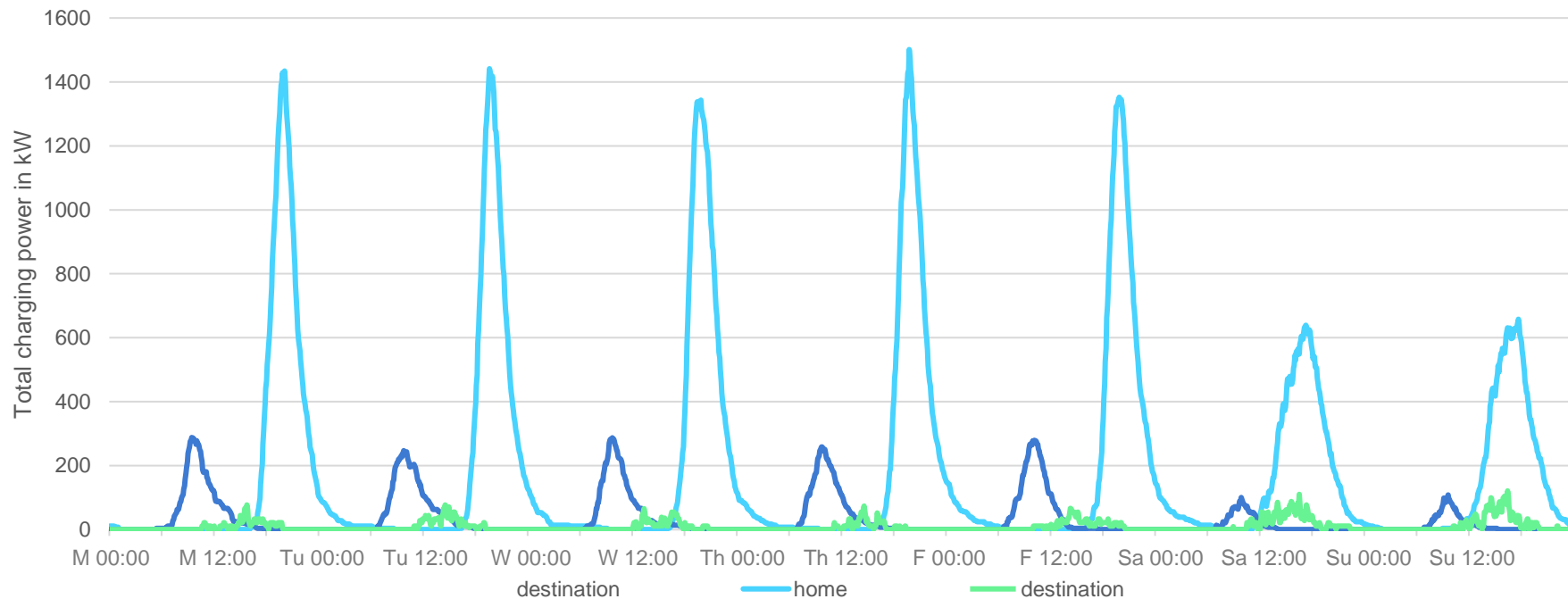
Fleet		Charging strategy		
Private LDVs		Unmanaged		
Home/Depot ?	Workplace ?	Destination ?	En route ?	Road-side charging ?
Charging strategy participation rate 0%	Charging strategy participation rate 0%	Charging strategy participation rate 0%	Charging strategy participation rate 0%	Charging strategy participation rate 0%

↓

Fleet		Charging strategy		
Private LDVs		Balanced		
Home/Depot ?	Workplace ?	Destination ?	En route ?	Road-side charging ?
Charging strategy participation rate 70%	Charging strategy participation rate 90%	Charging strategy participation rate 40%	Charging strategy participation rate 0%	Charging strategy participation rate 0%

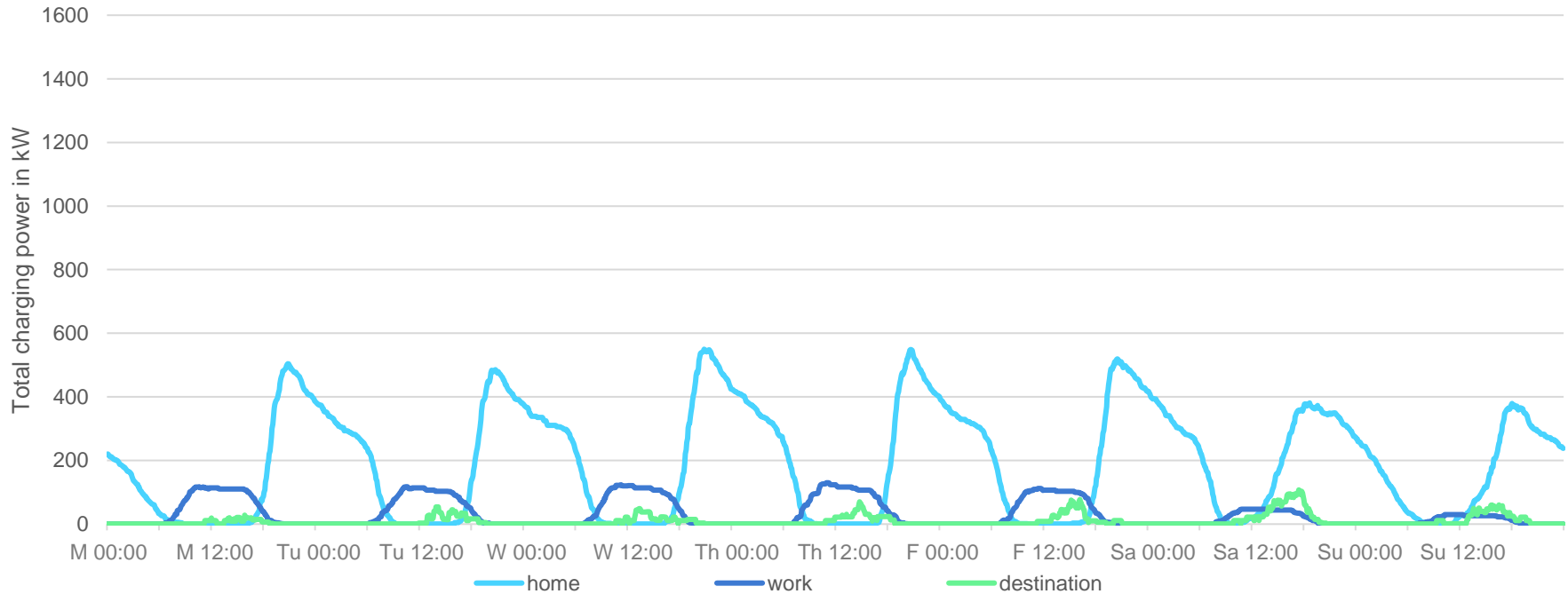
Ex: 1 000 private cars – applying balanced charging

Tool output 2: Power demand profile from EV charging over one week with managed charging



Ex: 1 000 private cars – applying balanced charging

Tool output 2: Power demand profile from EV charging over one week with managed charging



**Balanced charging has a significant smoothing effect on demand.
Peak power is reduced, leading to lower impact on electricity supply capacity.**

Key messages

- Electrification of road transport is ongoing and will accelerate as it contributes to decarbonisation and helps reducing dependency to fossil fuels
- Electrification will contribute to the increase in electricity demand but is an opportunity for the electricity system as the new electricity end-uses have some embedded flexibility
- The power sector can accommodate a wide range of charging solutions but encouraging managed charging can bring gains in avoided generation costs and emissions, and support faster growth of renewables
- Flexibility of new electricity-end uses needs to be incentivised from early stages
- Expansion of grids and charging infrastructure supports the update of EVs, but this requires breaking silos between sectors



Thank you for your attention.

Thank you to all contributors:

- Tool specifications: **Luis Lopez, Jacques Warichet**
- Algorithm developers: **Luis Lopez, Juha Koÿkka, Woan Ho Park, Andreas Bong**
- Digital support (web tool and API): **Barbara Moure, Jon Custer**
- Guidance and review: **Per-Anders Widell, Julia Guyon, Javier Jorquera, Shane McDonnagh, Elizabeth Connelly, Brendan Reidenbach, Alejandro Hernandez, Pablo Hevia-Koch**

Live Demonstration

Interactive web tool:
**EV Charging and Grid Integration
tool**

[http://www.iea.org/
data-and-statistics/data-tools/
ev-charging-and-grid-integration-tool](http://www.iea.org/data-and-statistics/data-tools/ev-charging-and-grid-integration-tool)



Report (December 2022)
**Grid Integration of Electric Vehicles:
A Manual for Policy Makers**

[https://www.iea.org/
reports/
grid-integration-of-electric-vehicles](https://www.iea.org/reports/grid-integration-of-electric-vehicles)