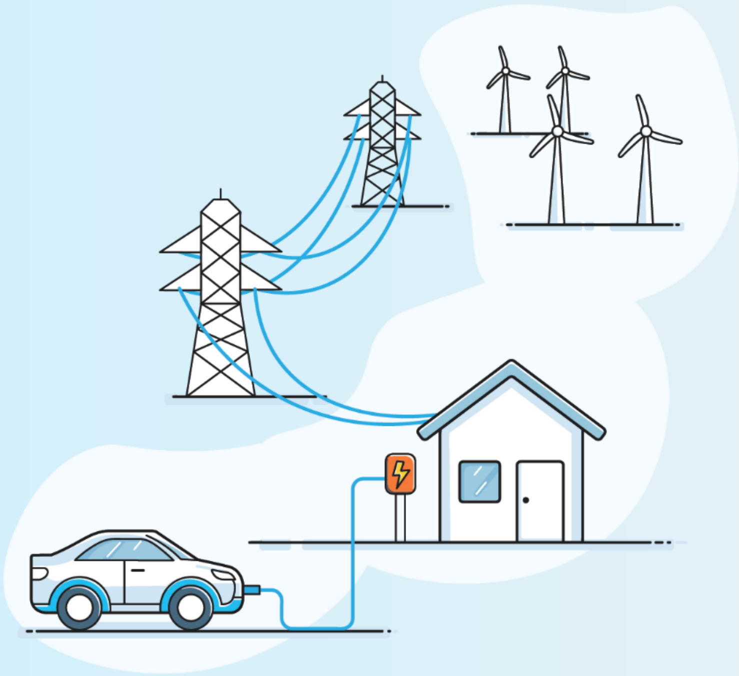
V2G-Quests

Vehicle to Grid for Equitable Zero-Emission Transitions in positive energy districts.



Institute of Electricity Economics and Energy Innovation

TU Graz

Integrated Planning of V2G-Enabled Charging Infrastructure and Distribution Grid Operation in Positive Energy Districts

Insights from the V2G-QUESTS Project

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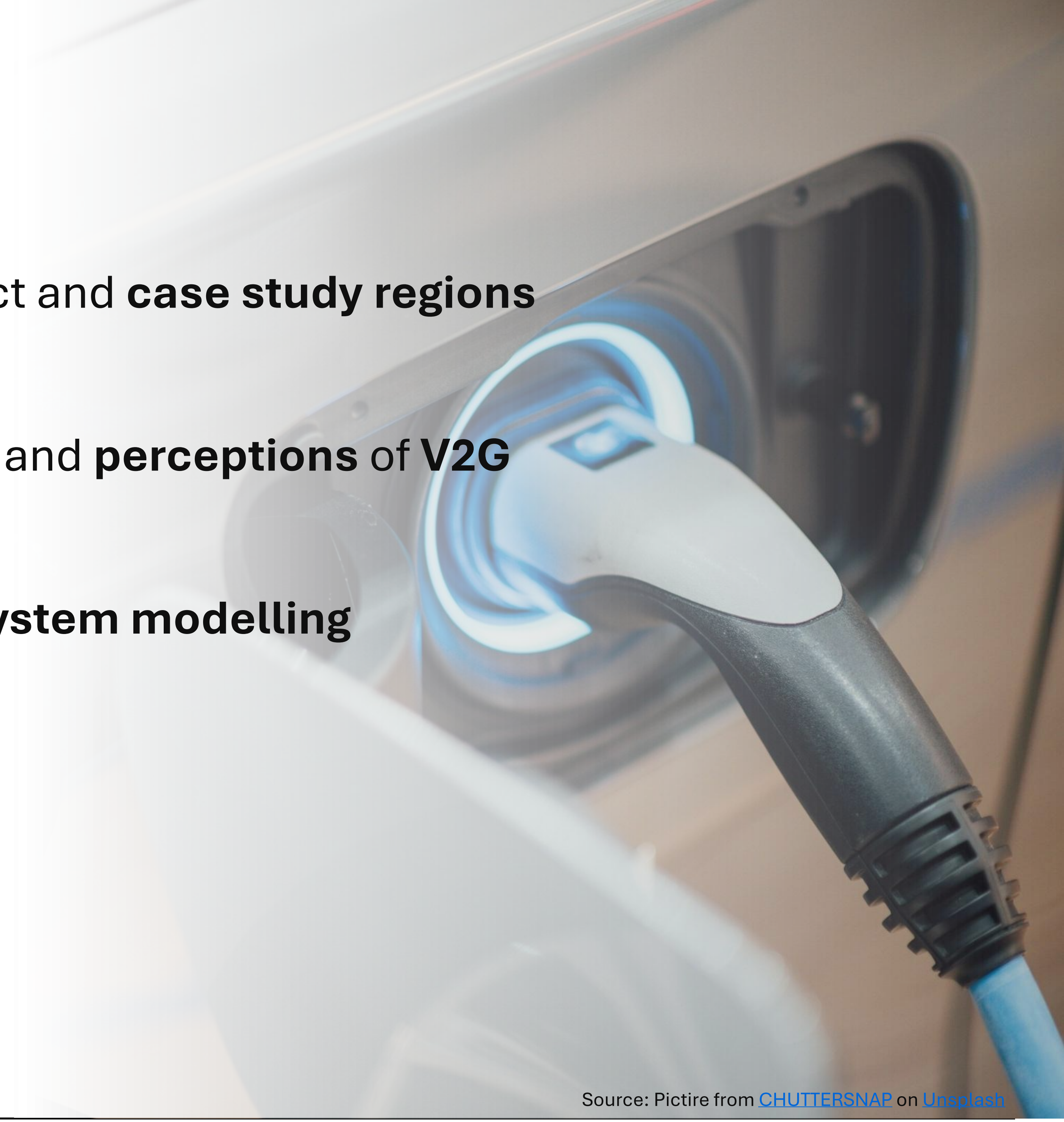
Agenda



I **Introduction** to the **V2G-QUESTS** project and **case study regions**

II **Survey-based insights** on **EV adoption** and **perceptions** of **V2G**

III Linking **mobility patterns** with **power system modelling**

IV Key **takeaways** and **outlook**

Source: Pictire from CHUTTERSNAP on Unsplash

Introduction to V2G-QUESTS

V2G-QUESTS – **V**ehicle-to-**G**rid for E**qu**itable Z**e**ro-Emi**ss**ion **T**ransitions in Urban Distric**ts**

1. EV adoption growing rapidly but concentrated among high-income groups.

What barriers exist, and what incentives can drive adoption over all income levels?

2. Renewable energy sources are growing but intermittent.

Can EVs stabilize power grids by acting as large batteries?

3. V2G must be inclusive across regions and income levels.

What governance and regulatory frameworks are needed to support V2G deployment?

Power system challenges exist across all regions, not only in high-income areas.

European Project funded under the **Driving Urban Transition (DUT2022)** call

Partners

Introduction to V2G-QUESTS

V2G-QUESTS – **V**ehicle-to-**G**rid for E**qu**itable Z**e**ro-Emi**s**sion **T**ransitions in Urban Distric**ts**

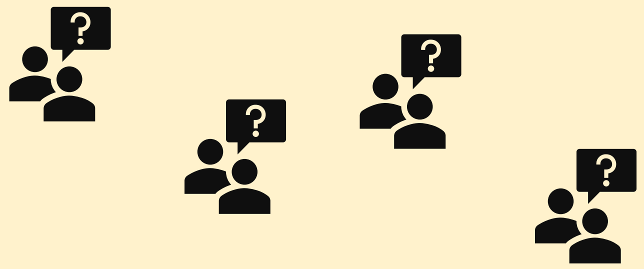
1.	**EV adoption growing rapidly but concentrated among high-income groups.**	
	What barriers exist, and what incentives can drive adoption over all income levels?	
2.	**Renewable energy sources are growing but intermittent.**	
	Can EVs stabilize power grids by acting as large batteries?	
3.	**V2G must be inclusive across regions and income levels.**	
	What governance and regulatory frameworks are needed to support V2G deployment?	

Power system challenges exist across all regions, not only in high-income areas.

Linking Driving Needs with the Power System

From Surveys to Power System Modelling

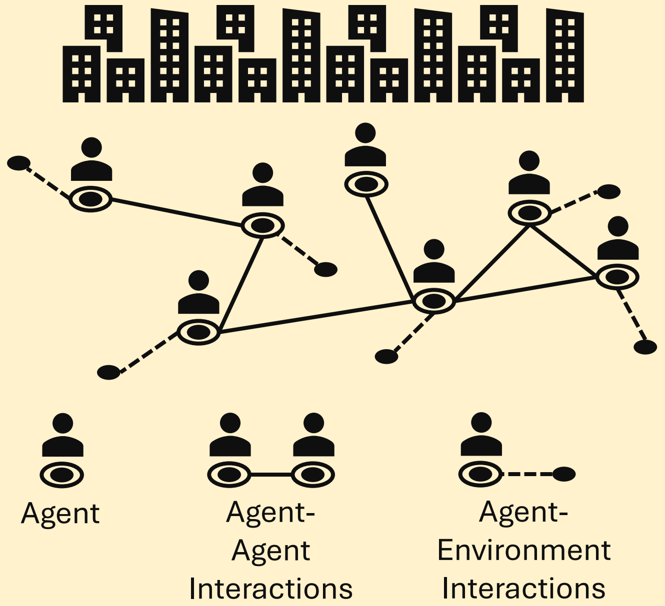
Survey



Get an idea for the barriers, **needs**, **schedules**, and equitable access to EVs.

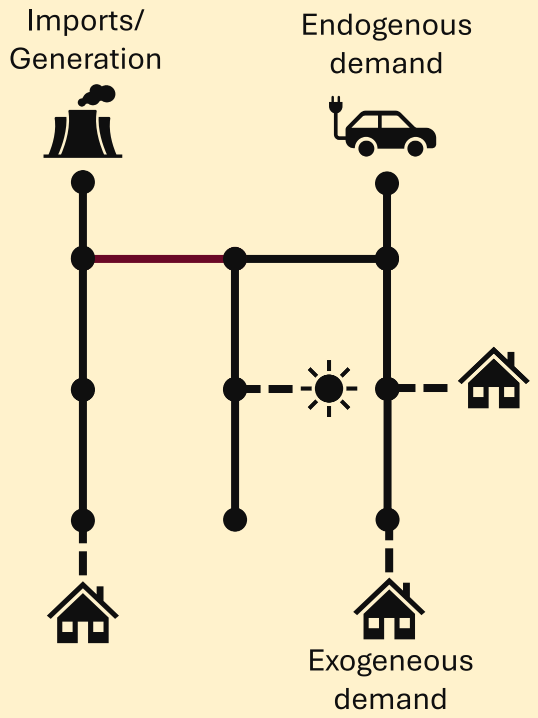
Mobility needs

Endogenous charging demand



Agent-Based Model

Power System Model



Environment — affects on → **Citizen's behavior** — affects on → **Power grid**

Survey-based insights

EV adoption and V2G perceptions

I Main barriers & key concerns

EV

- **High upfront costs** of EVs
- **Range anxiety**
- **Fear** of limited **charging infrastructure**

V2G

- Lack of awareness: most citizens had **never heard** of **V2G** before
- **Battery degradation**
- Added **complexity** in daily mobility decisions

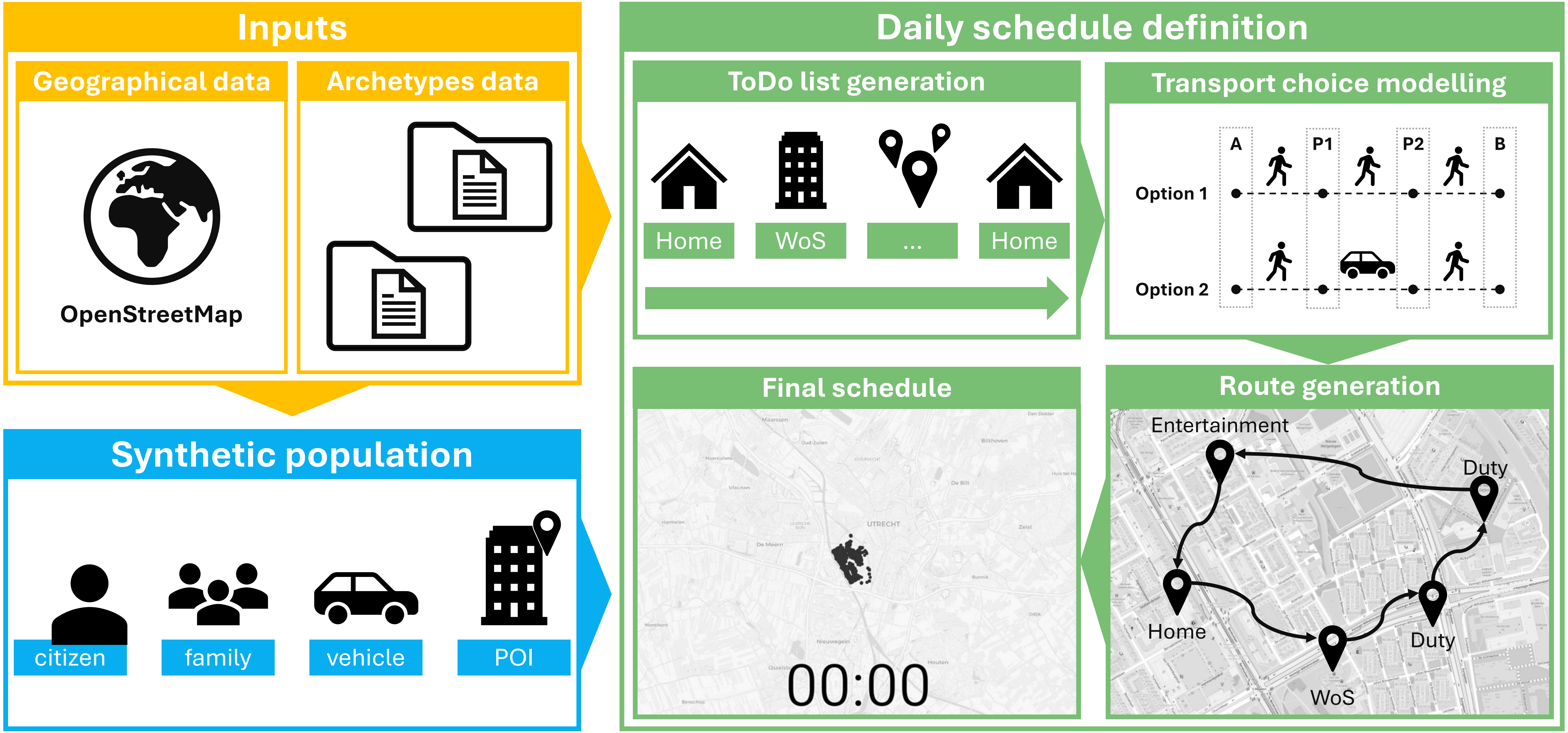
After explanation, V2G is generally seen as positive and promising

II Driving needs & traveling options

- Where do they **need to go** to fulfill their duties?
- How far are they **willing to walk** to fulfill these duties?
- Which **traveling option** do they have **available**?
- Which **traveling option** do they **choose**?
- The **survey results** are used as **input** parameters for a **multi-agent based model** (ABM)

Agent-Based Model (ABM)

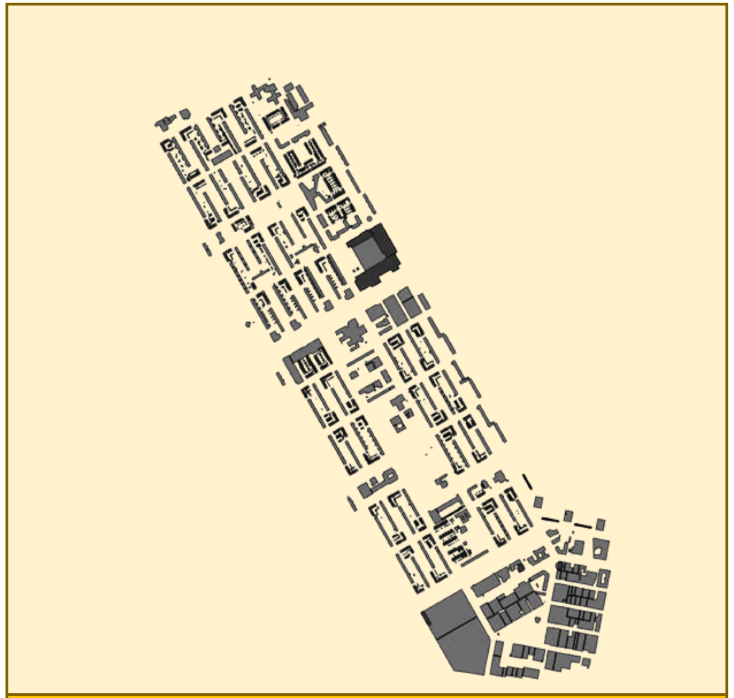
Daily schedule definition



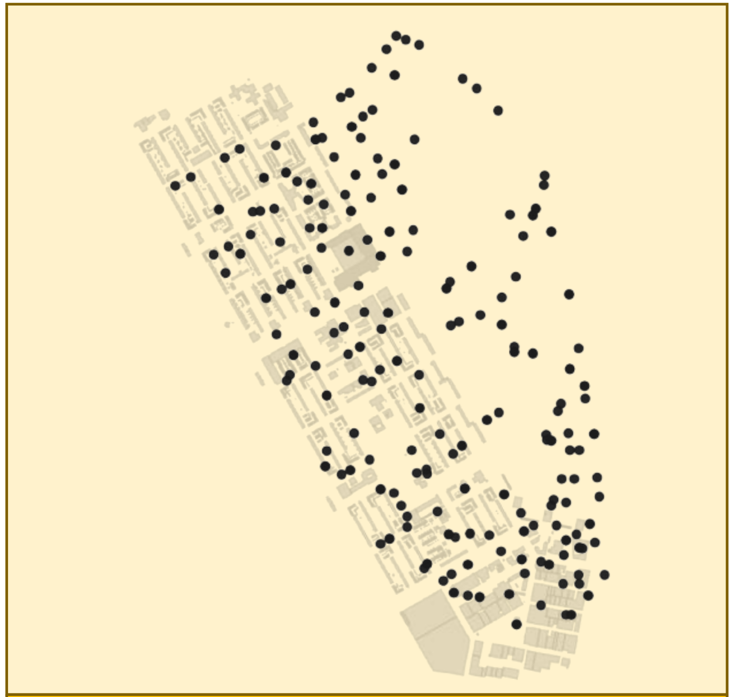
Connecting the ABM with the Power System Model

From mobility behaviour to power system modelling

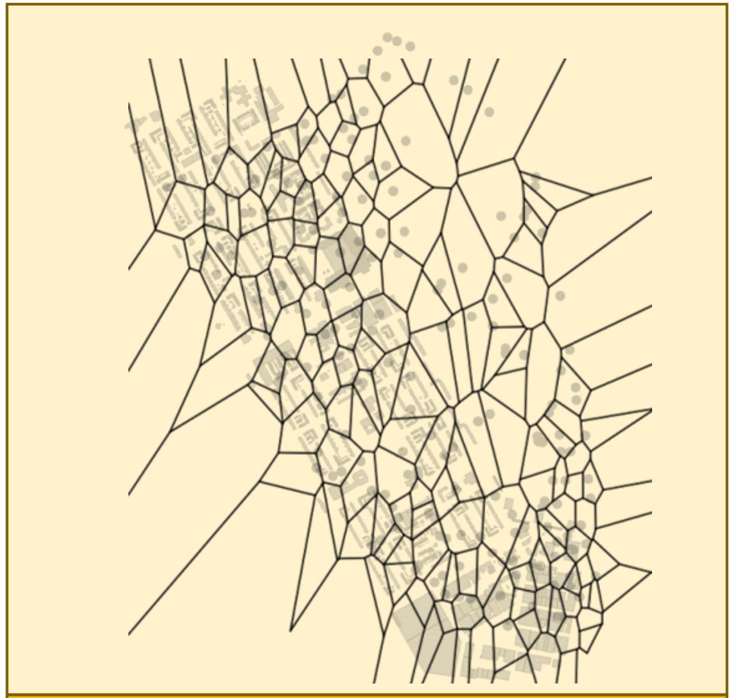
- **Agents** move between **buildings** according to their daily activities.
- The **power grid** is **not** represented at the **same spatial resolution** as the mobility model.
- **Buildings** are **assigned** to **power grid nodes** using **Voronoi partitioning.**



Buildings distribution



Nodes distribution



Voronoi partitioning

Power System Modelling

Analysing the effects of V2G

Inputs

Schedule of ABM

Agent	Archetype	Node	In	out
Vehicle_4	EV	Node_18	0	479
Vehicle_4	EV	Node_68	510	750
Vehicle_4	EV	Node_63	781	1230
Vehicle_84	V2G	Node_7	0	506
Vehicle_84	V2G	Node_72	540	870
Vehicle_84	V2G	Node_29	904	994
Vehicle_92	EV	Node_89	0	441
⋮	⋮	⋮	⋮	⋮

- Which vehicle is located at which charging station
- At what time and for how long it is connected

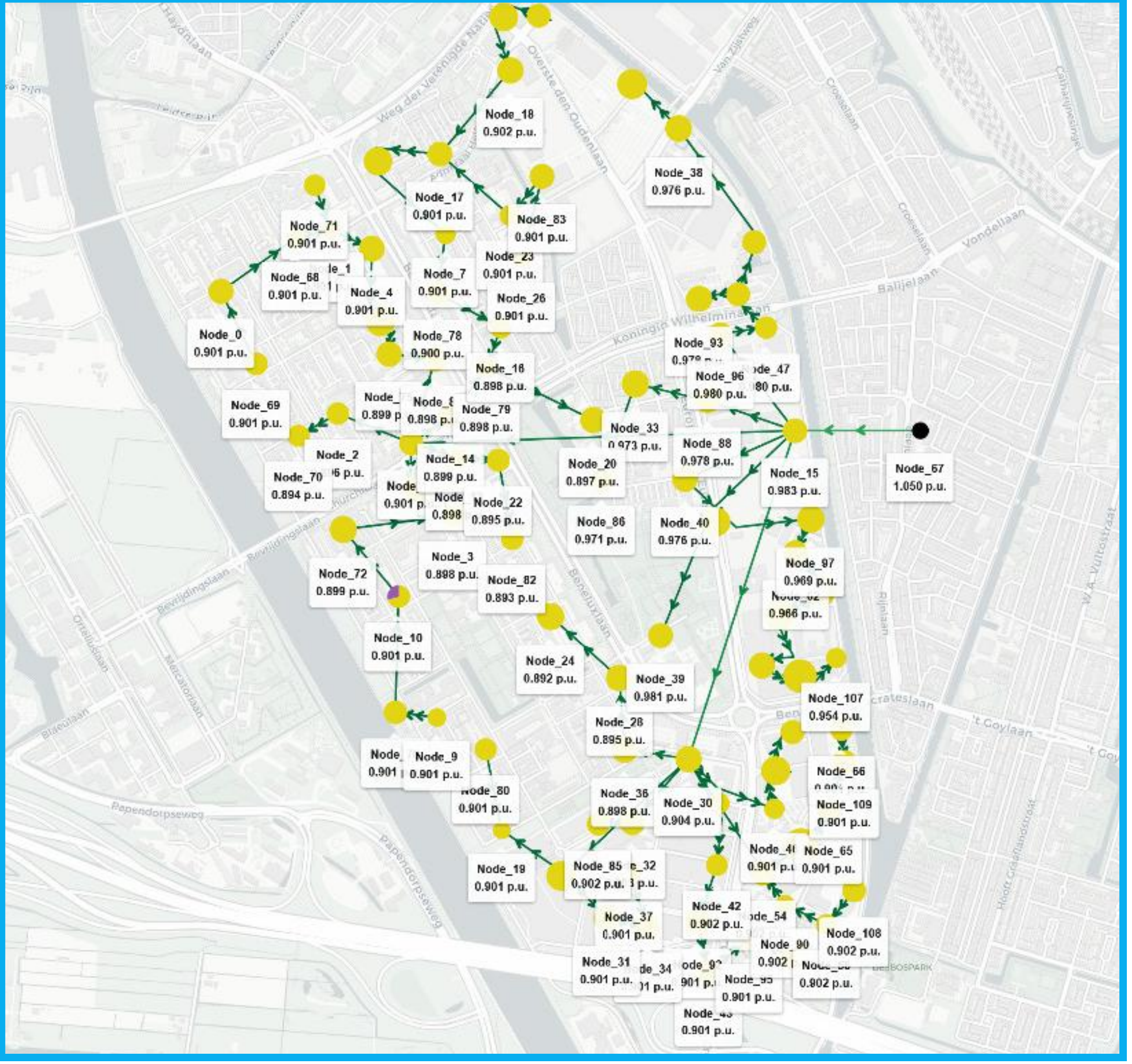
Power System

- Power Grid
- Demand per node (based on Demand profile generator)
- Generators (PV)
- Time series of electricity prices for imports

Scenarios

- Uncontrolled charging
- Intelligent charging
- V2G (dis-)charging

Power System Model Results



Summary

Key takeaways and outlook

EV adoption and **V2G acceptance** are **strongly influenced** by **costs, trust**, **infrastructure availability**, and **daily mobility needs**.

An **Agent-Based Model translates** heterogeneous **citizen behaviour** into **realistic mobility** and **charging time series**.

These time series enable a **consistent coupling** of **mobility behaviour** and **power system models**.

Comparing uncontrolled charging, **intelligent charging**, and **V2G** highlights the **system value** of **coordinated** and **bidirectional charging**.

Integrated, **behaviour-aware modelling** is **crucial** for designing **equitable** and **grid-compatible V2G solutions**.

V2G-Quests

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Driving Urban Transitions

EUROPEAN PARTNERSHIP

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