UNIVERSITY OF APPLIED SCIENCES UTRECHT

CENTRE OF EXPERTISE SMART SUSTAINABLE CITIES

Utrecht University

DECARBONIZATION OF THE UTRECHT SCIENCE PARK

PED StepWise

DUT Driving Urban Transitions

Sara Herreras Martínez

Co-funded by the European Union

PED CONCEPT

CENTRE OF EXPERTISE
SMART SUSTAINABLE
CITIES

Collaborative ecosystem of smart technologies and smart planning, working toward shared goals:

- Achieving an energy-efficient and energy-flexible district that produces more renewable energy than it consumes on an annual basis
- Achieving a better quality of life in an area (including economic and social aspects)

PED concepts **mainly applied to (new) buildings and the electricity sector up to now**

Implementing PEDs is challenging: Requires fundamental changes in the ways that cities are planned, designed, and operated

(JPI Urban 2021)

PED StepWise

DUT Driving Urban Transitions — EUROPEAN PARTNERSHIP — Co-funded by the European Union

towards zero carbon neighbourhoods.

GOALS

A participatory and **step-by-step implementation plan** for carbon zero districts in existing neighbourhoods.

Evaluation & validation on **3 Living Labs**

METHODS

- **Research & analysis** of already existing carbon zero neighbourhood concepts.
- **Development of a prototype** for the integrated decarbonisation of existing neighbourhoods.
- **Data-survey/collection of existing data in the Living Labs,** needs & requirement of the residents/users.
- **Developing an integrated energy concept** for each Living Lab.
- **integrating the local conditions of the Living Labs** into the plan.

climate-neutral districts by 2050

THE PARTNERS

Field of Expertise
- Energy, Technology
- Financial assesment
- Organisational process
- Participation process
- Representative of Living Lab

Austria
- e7 Energy Markt Analyse GmbH
- Arsenal Tech GmbH
- realitylab GmbH
- Gartenheim

Sweden
- City of Malmö
- Energy Infrastructure Solution Nordic (E.ON)
- KTH Royal Institute of Technology
- Research Institute of Sweden AB
- White Architects
- Malmö FF
- Malmö FF Stadium

Netherlands
- University of Applied Sciences Utrecht
- Utrecht University

THE LIVING LABS

The aim is to **replace the gas heater** in all buildings and apartments and decarbonize the heat supply of the community.

Gartenheim, Vienna:

- Around 200 single family houses.
- 8 multifamily houses.
- All residential buildings.
- All gas heated.

The aim is to develop a **comprehensive solution for an efficient energy system** in the area, aligning with city planning efforts to **increase renewable energy** production and foster sustainable cooperation models.

Stadionområdet, Malmo:

- City's main district for sport and education.
- Includes the Malmö FF soccer stadium and several sports facilities.
- A few residential buildings.

The aim is to develop of a **local microgrid** in order to maximize sustainable energy production and minimize the mismatch between local production and local demand.

Utrecht Science Park (USP), Utrecht:

- Largest science park in the Netherlands.
- 80 buildings hosting two universities, 170 businesses, sports facilities, student housing, and a botanical garden.
- Daily 30.000 employees and over 55.000 students – 5.000 students live in the student dorms.

CENTRE OF EXPERTISE
SMART SUSTAINABLE
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ENERGY SITUATION UTRECHT SCIENCE PARK

Energy from **CHP plants** fuelled with natural gas (UU and UMC)

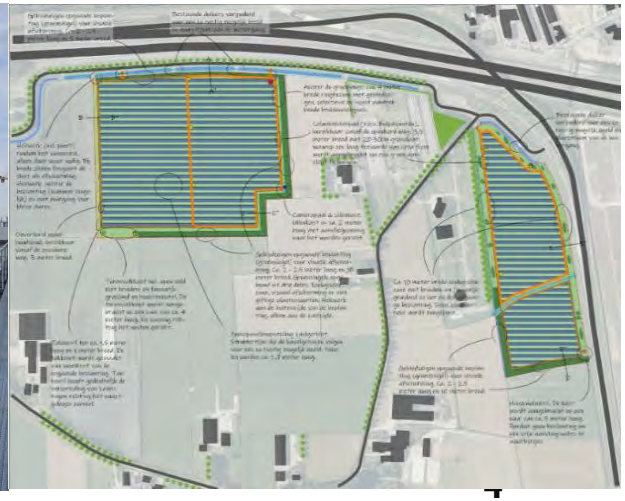
Many **building roofs have PV** (~8,000 units)

Ongoing sustainable plans USP:

Solar park (10 hectares, 11 MW)

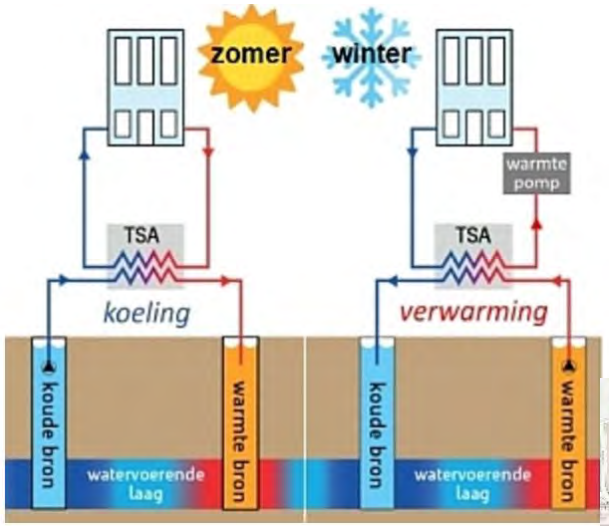
Reduce demand: e.g., insulation during the renovation of existing buildings

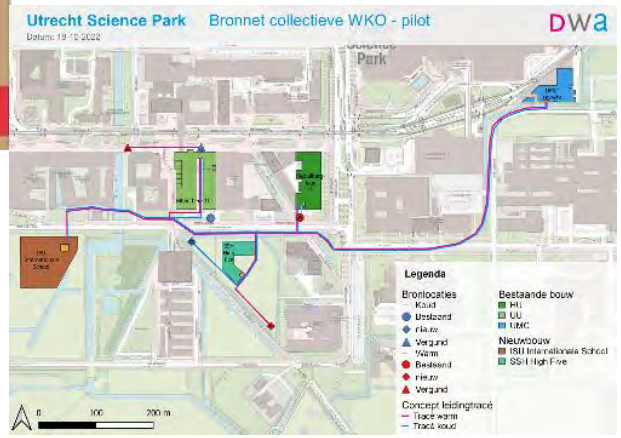
New construction should meet energy-neutral standards



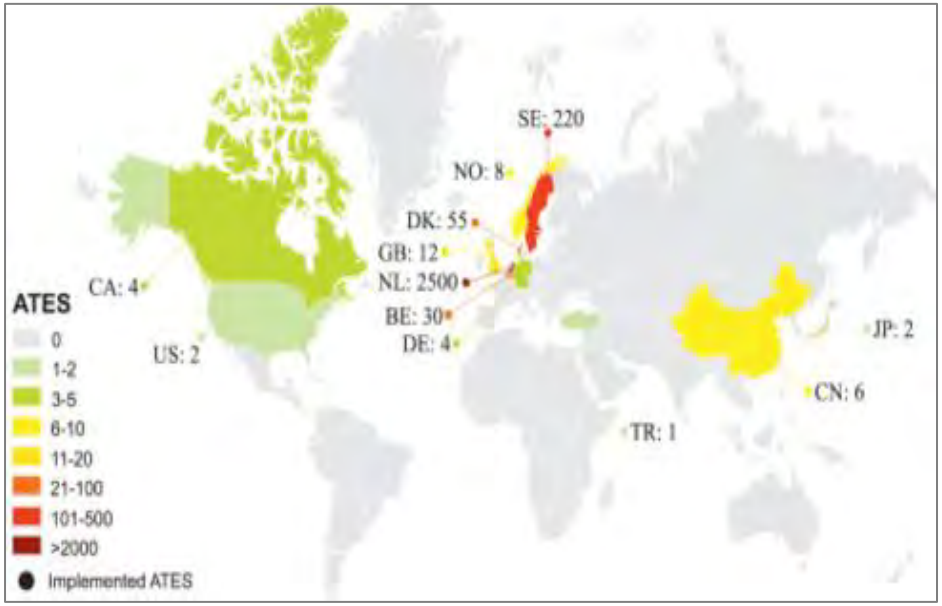
SUSTAINABLE PLANS UTRECHT SCIENCE PARK

- Implement EMS and smart technologies
- Transition from high temperature district heating to low-temperature heat: Expansion and optimisation of **Aquifer Thermal Energy Storage** with heat pumps (existing and new buildings) → **Student project**

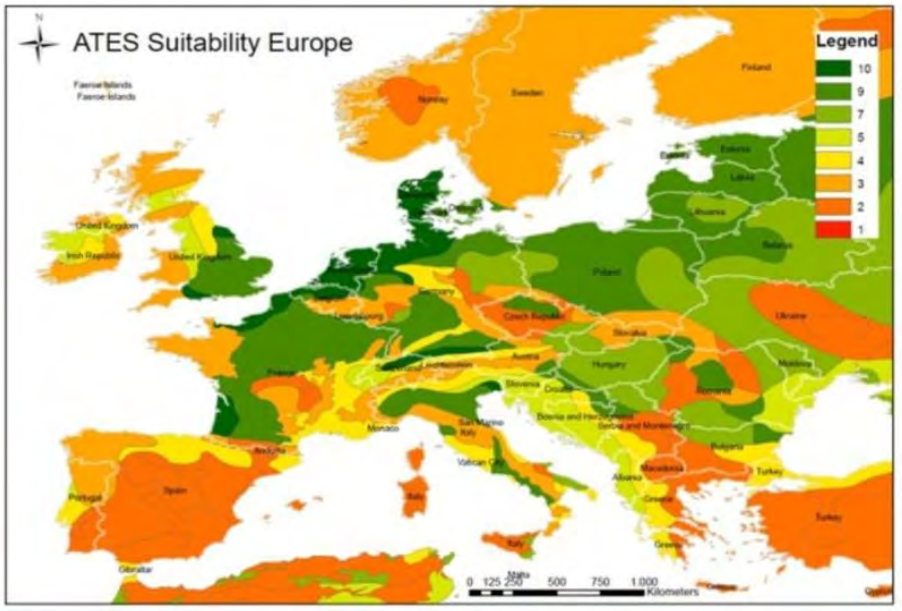




THE NETHERLANDS - FRONTRUNNER IN ATES SYSTEMS



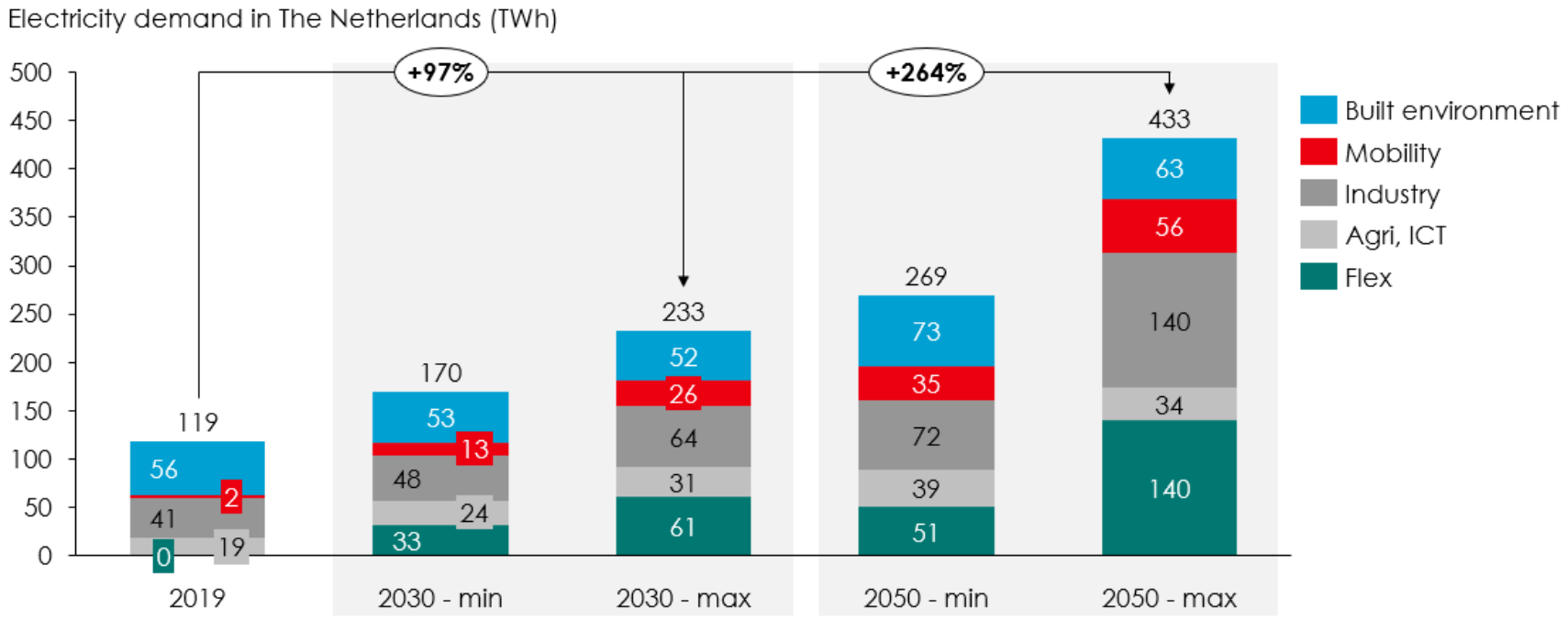
(Fleuchaus et. al. 2018)



(Deltares 2023)

STRONG INCREASE IN ELECTRICITY USAGE EXPECTED

Shift from gas to electricity in ATES systems/HPs will **increase electricity demand USP**

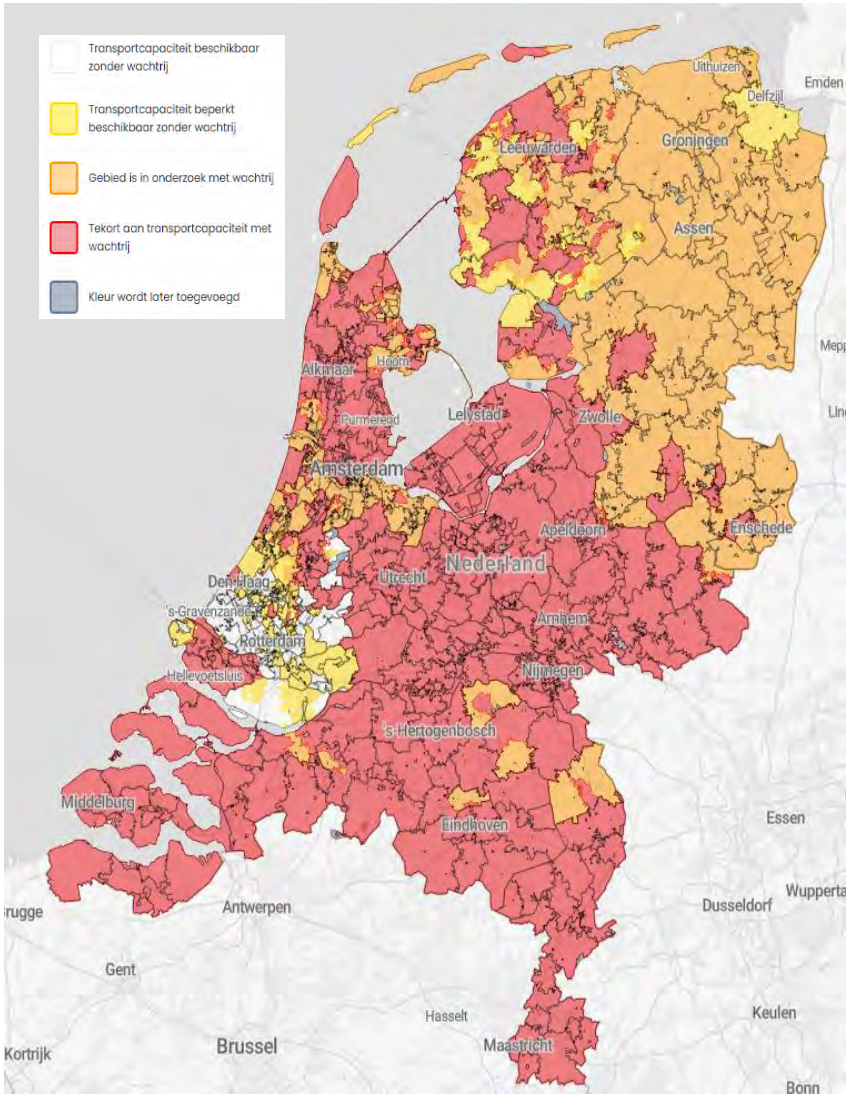


Source: The energy system of the future – Netbeheer Nederland – 6 April 2023

GRID CONGESTION PROBLEM

Solutions grid congestion USP:

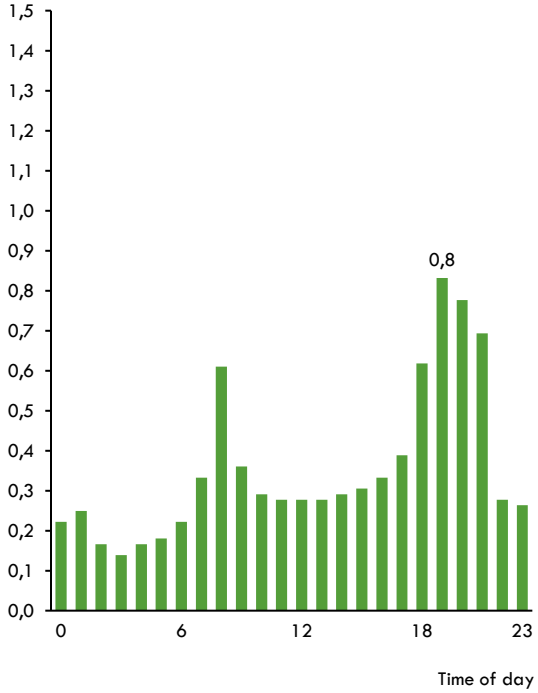
- Peak load shifting and flatten peak demand
- Flexible capacity (e.g., batteries or fossil fuel sources)
- Upgrading physical infrastructure (powerlines, substations and distribution equipment)



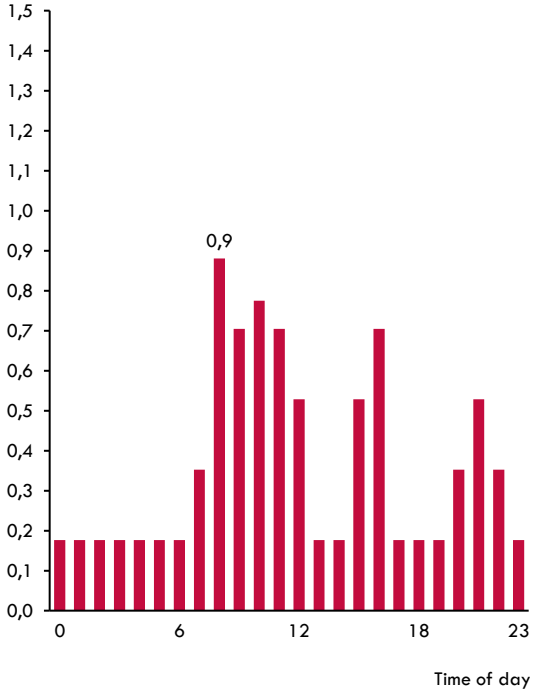
Red areas: no available capacity on the electricity network for (additional) electricity consumption.

ADDING HEAT PUMP TO A HOUSEHOLD ALMOST DOUBLES PEAK LOAD OF THE HOUSE

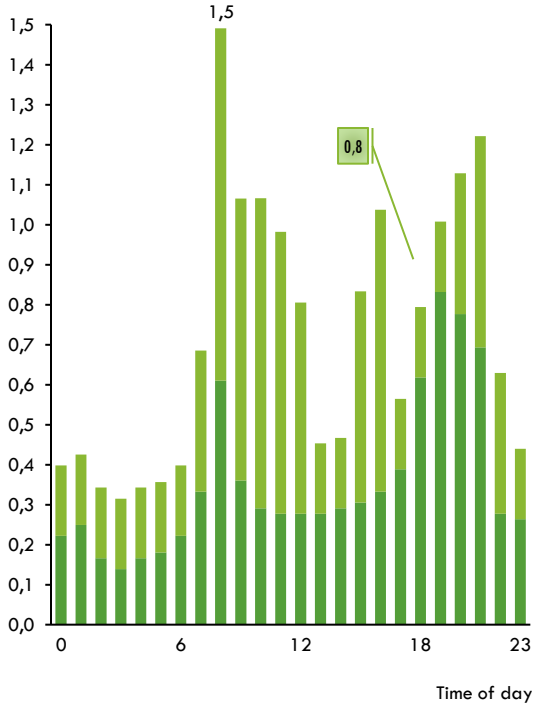
Electricity usage per hour (kWh) - household



Electricity usage per hour (kWh) – heat pump

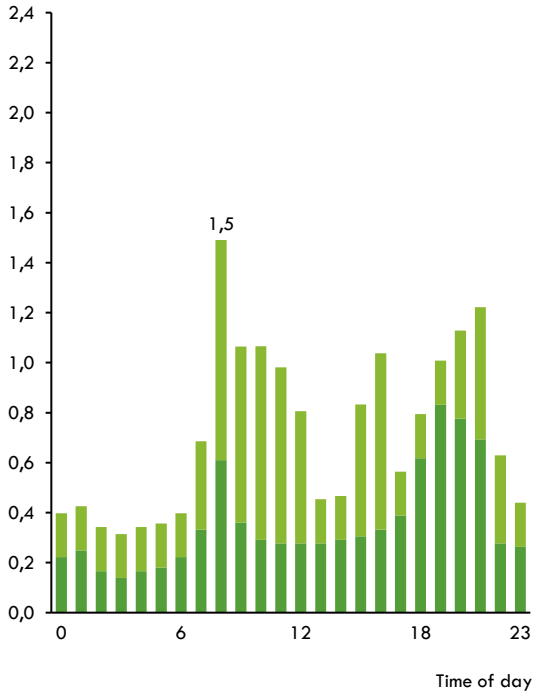


Electricity usage per hour (kWh) – combined (1)

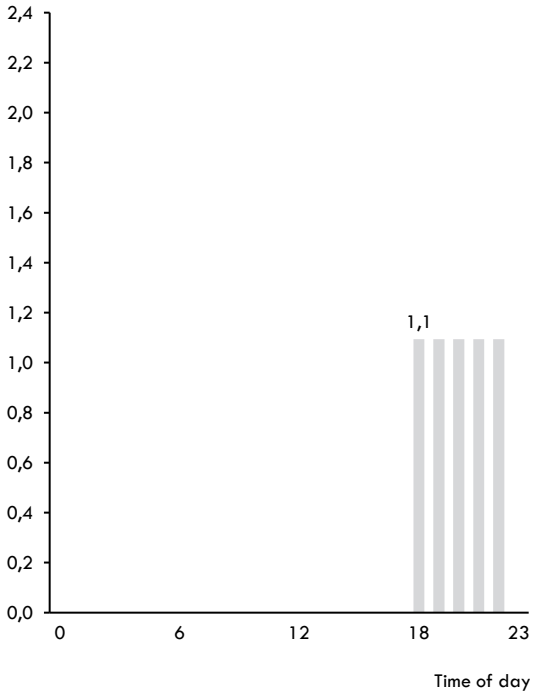


CHARGING ELECTRIC VEHICLES INCREASES PEAK LOAD CHALLENGE WITH ANOTHER 50%

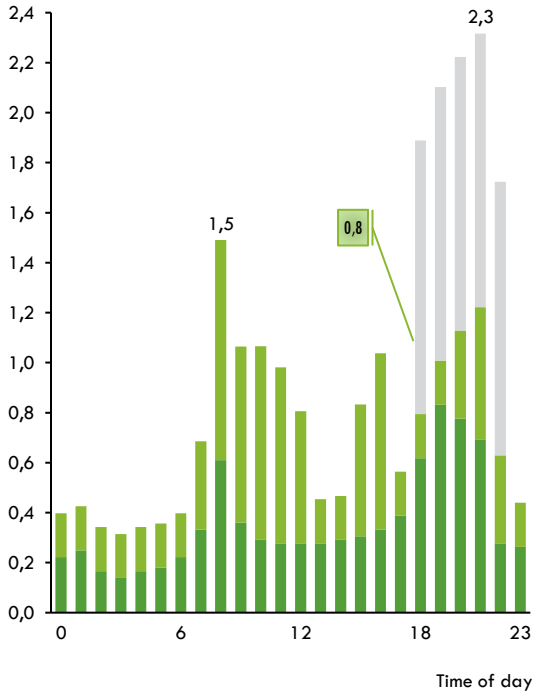
Electricity usage per hour (kWh) – combined (1)



Electricity usage per hour (kWh) – Electric Vehicle



Electricity usage per hour (kWh) – combined (2)



Household

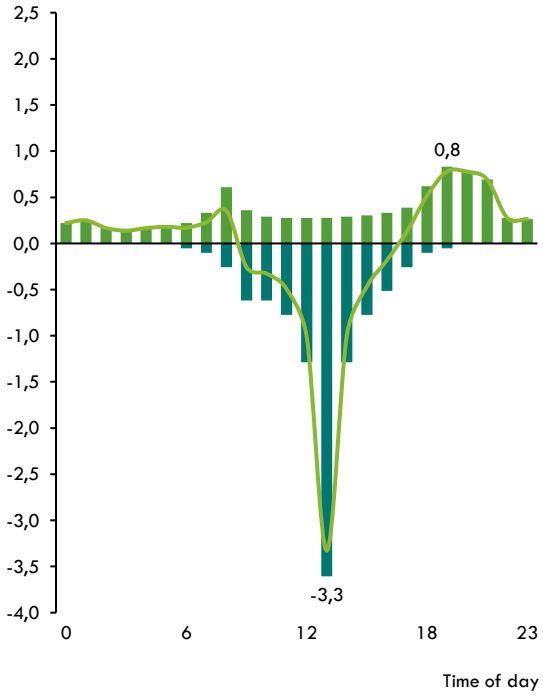
EV

Heat pump

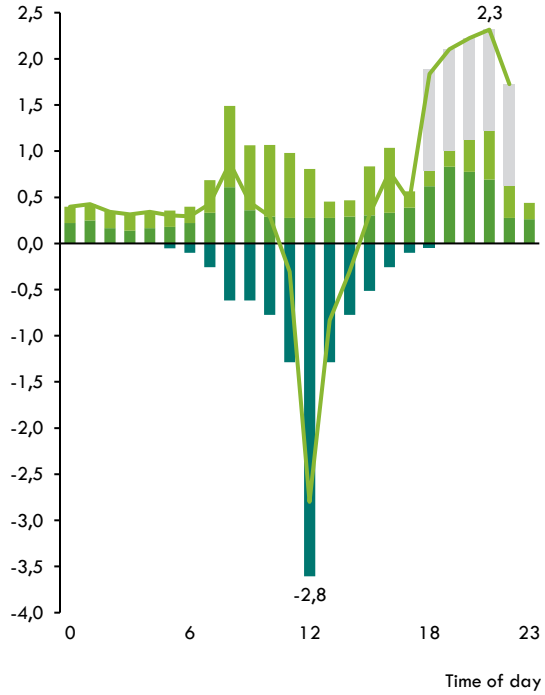
SOLAR PANELS: SUPPORTING INCREASED ELECTRICITY USAGE?

Electricity usage per hour (kWh) – solar panels

Electricity usage per hour (kWh) – household with solar



Electricity usage per hour (kWh) – combined (2)

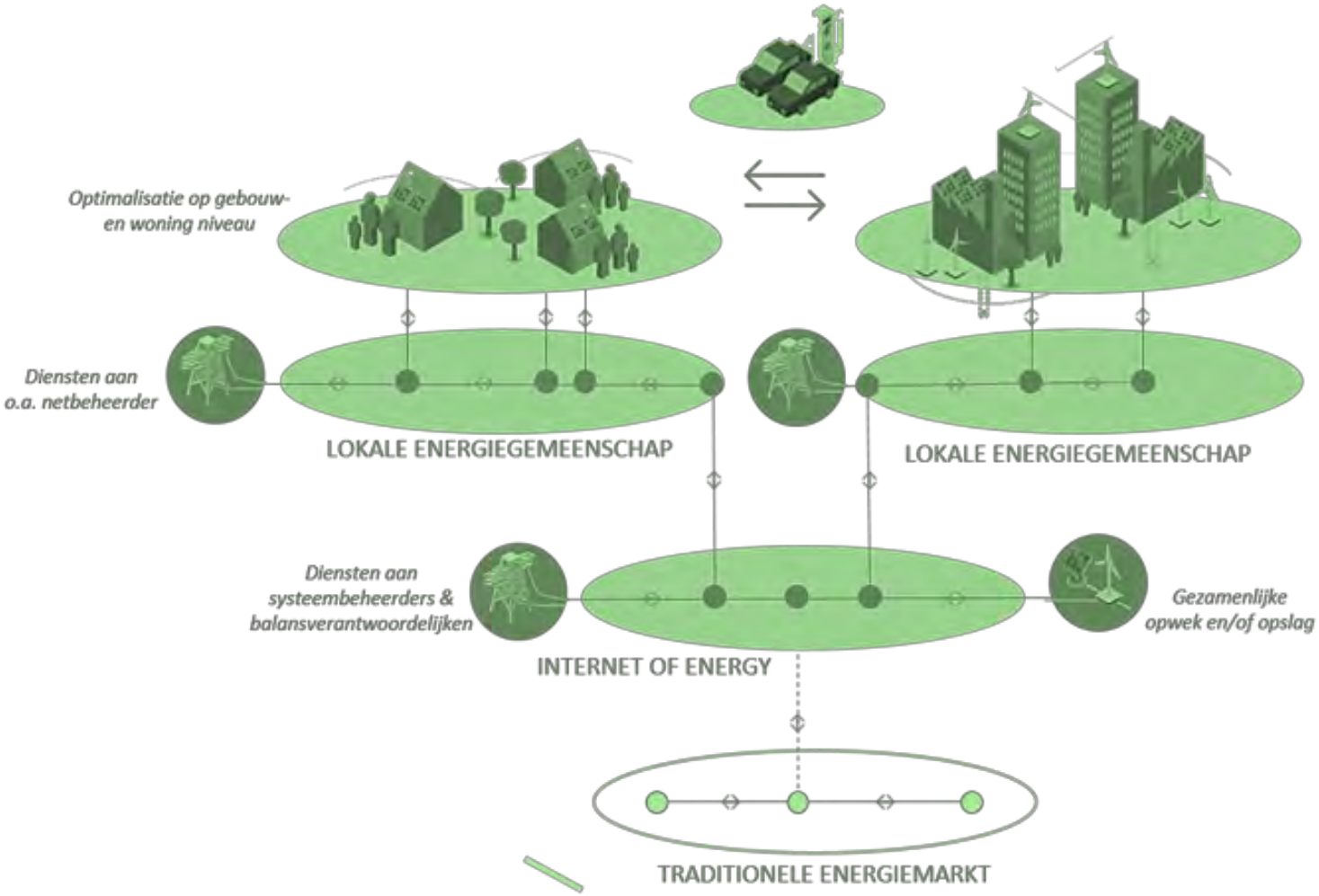


Household Heat pump EV Solar Combined

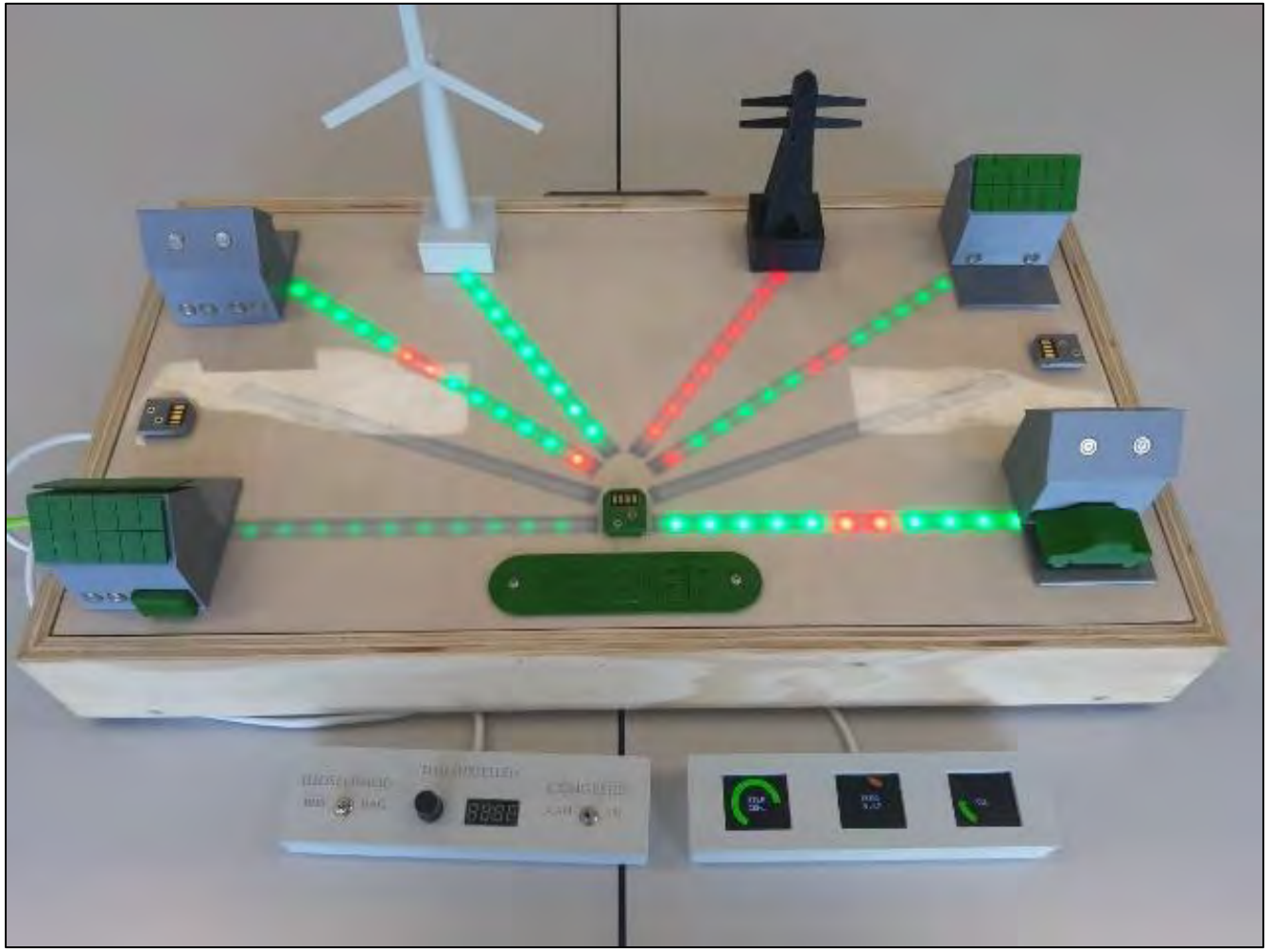
TROEF

SHARING ENERGY

PROJECT'S GOAL – SMART ENERGY SYSTEMS WHERE END-USERS PLAY AN ACTIVE ROLE IN THE ENERGY TRANSITION

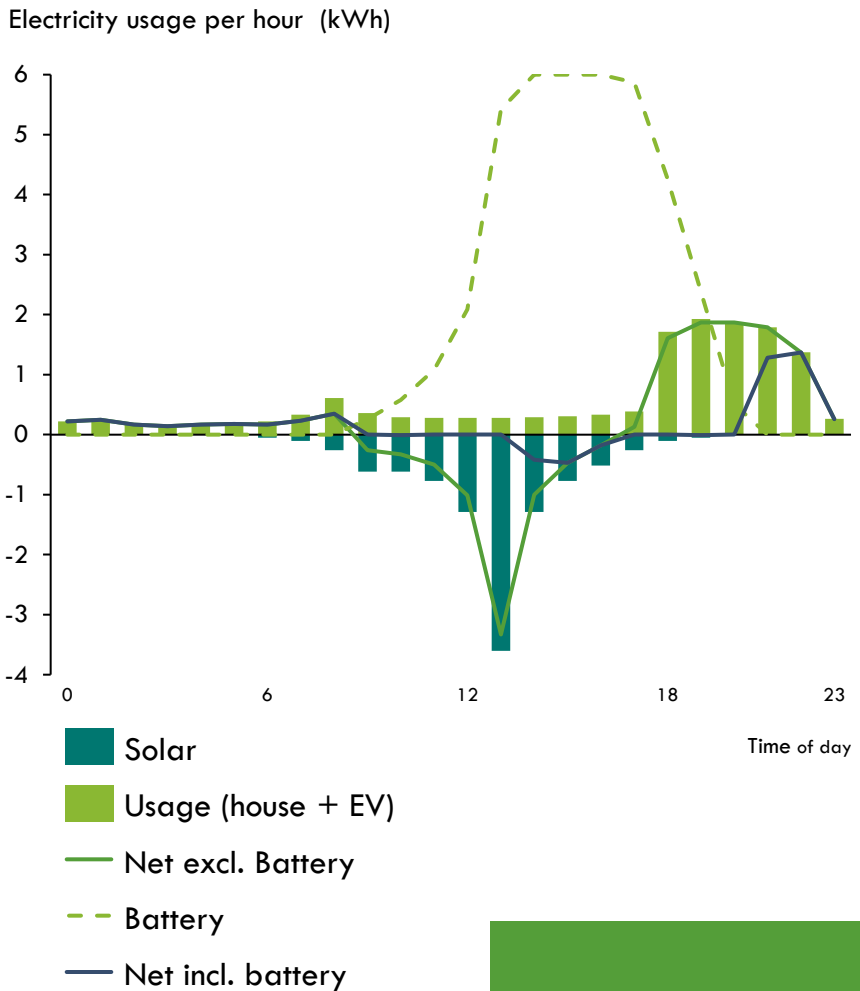


TROEF GAME – EXPLAINING GRID CONGESTION



POTENTIAL SOLUTIONS TO ADDRESS CONGESTION CHALLENGES (2/2)

Adding a battery to reduce grid load



Battery characteristics

Capacity: 6 kWh

Rate: 0.5 C

Power: 3 kW