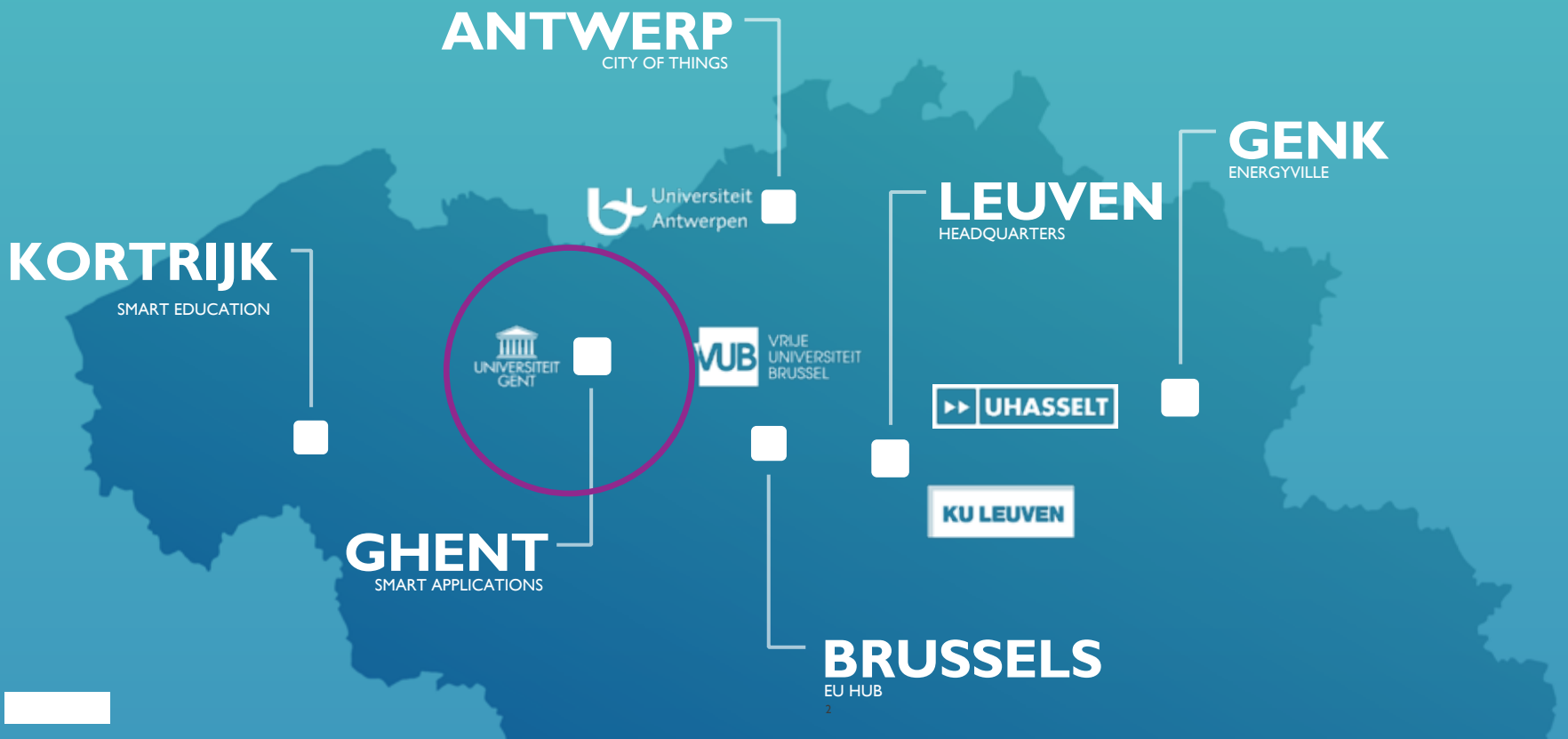
AI FOR ENERGY COMMUNITIES: MODELLING AND CONTROLLING FLEXIBLE POWER CONSUMPTION

MATTHIAS STROBBE

IDLab
INTERNET & DATA LAB

GHENT UNIVERSITY

Universiteit Antwerpen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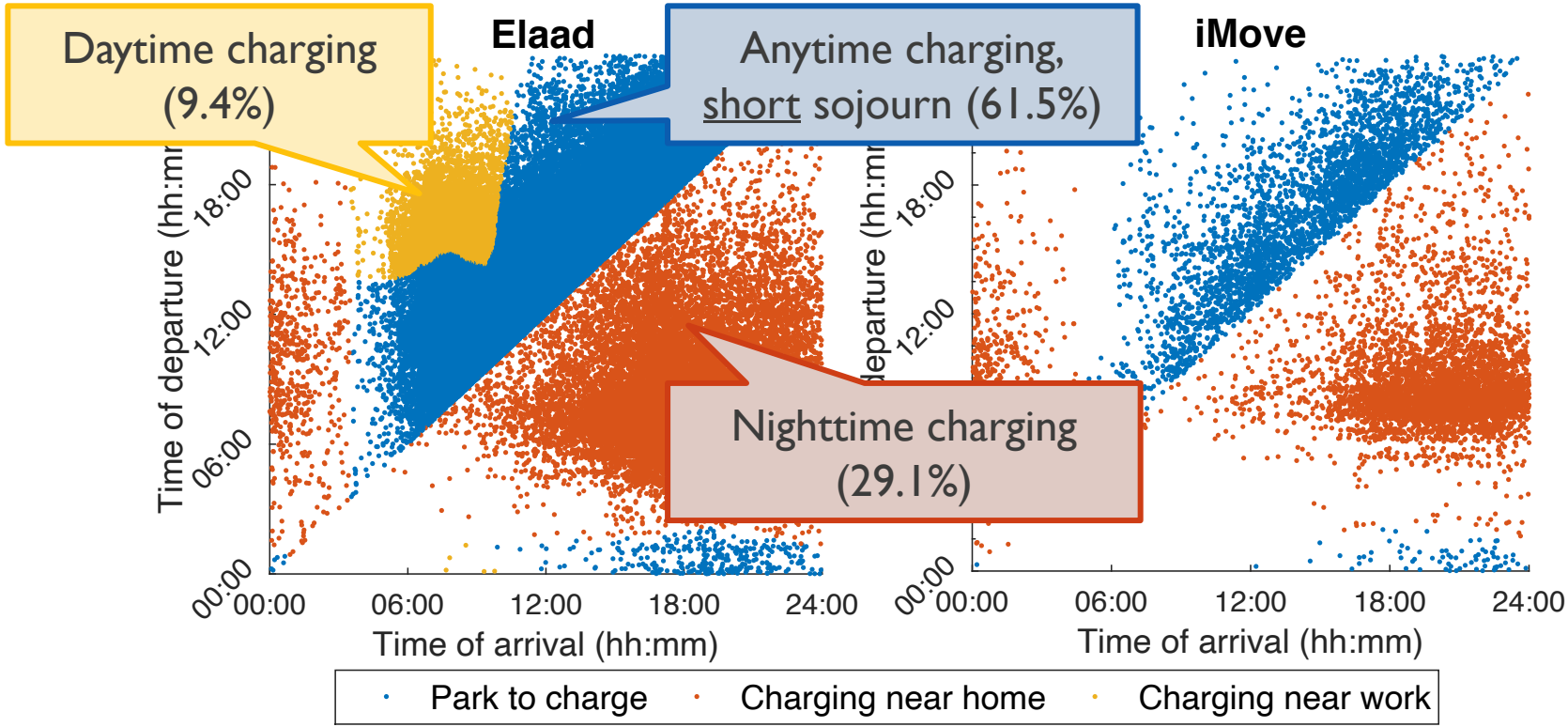
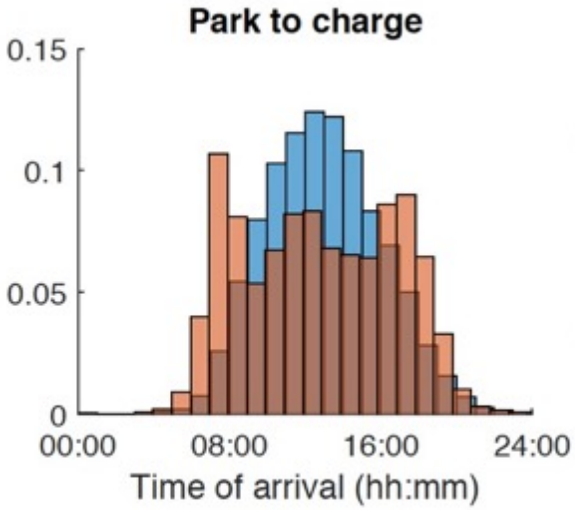
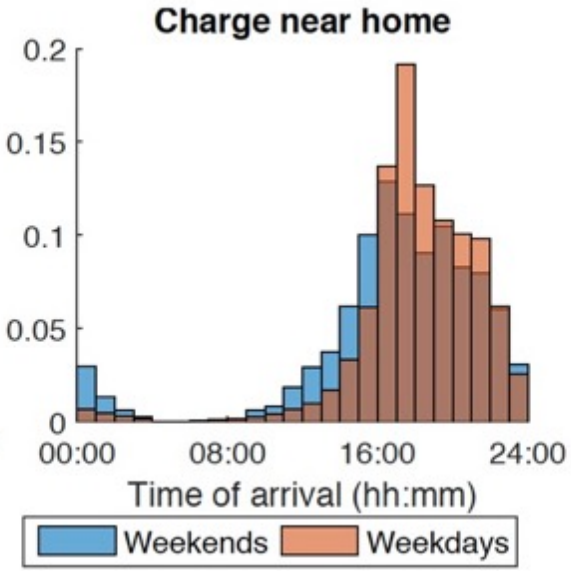
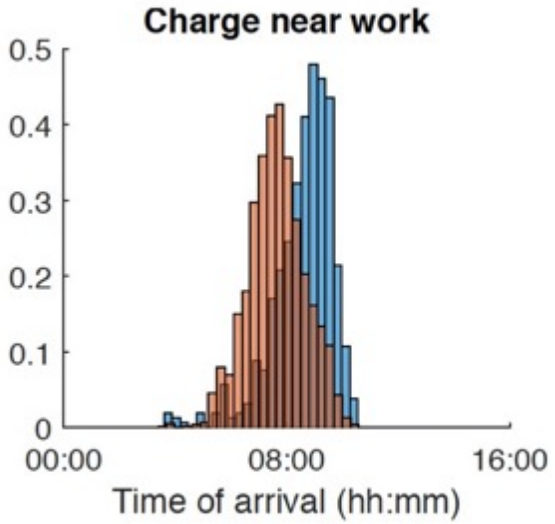
TYPICAL ARRIVAL AND DEPARTURE TIMES (1/2)



CHARACTERISATION OF CHARGING BEHAVIOR





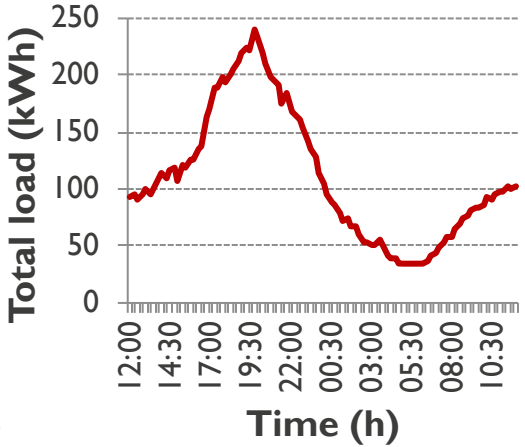


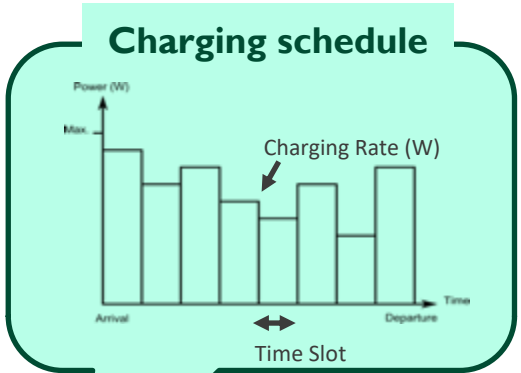
	Park to charge	Charge near home	Charge near work
Connection time	2h28	13h24	8h42
Charge time	1h40	3h24	3h12
Flexibility	48’	10h	5h30

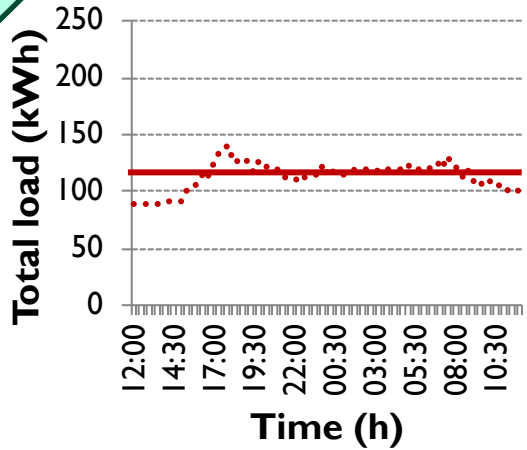
CONTROLLING EV CHARGING?

Objectives:

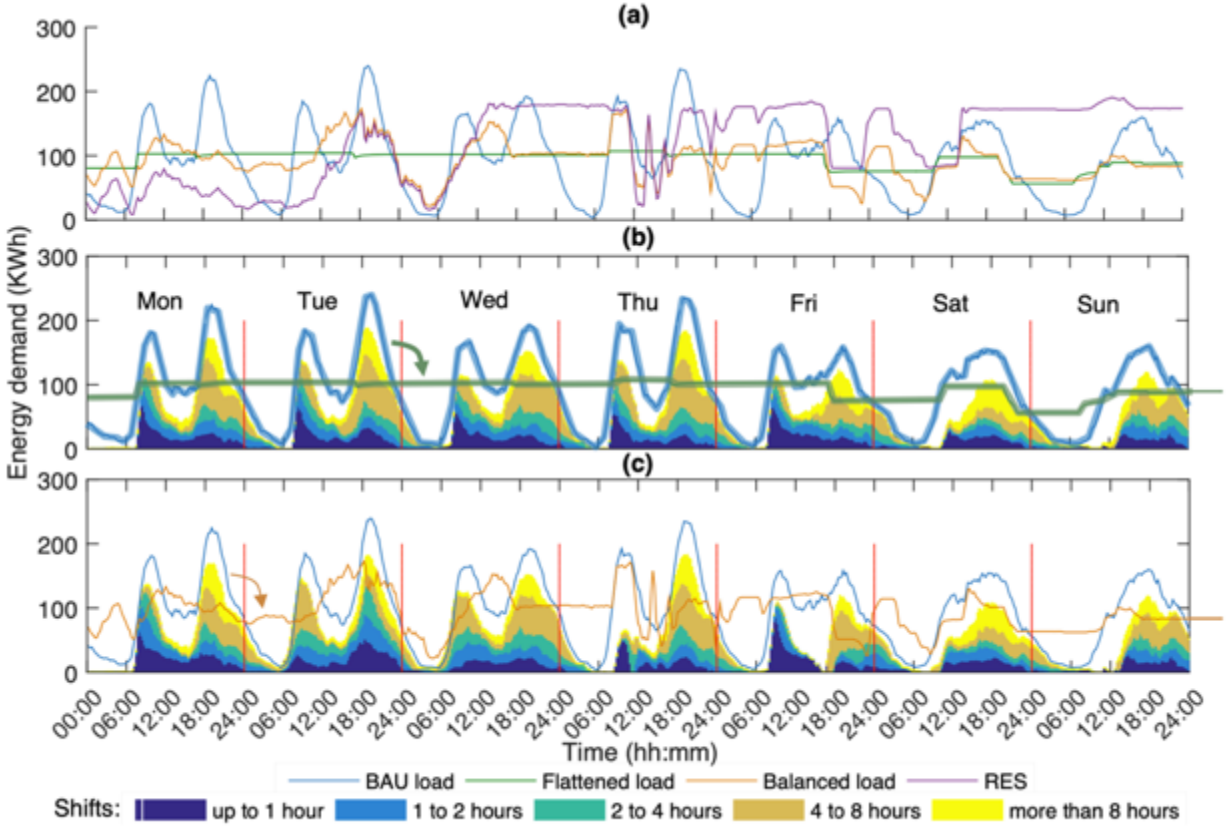
- **Flatten load**: peak shaving & valley filling
- **Balance** renewable sources
- Avoid voltage violations







DEMAND RESPONSE CONTROL ALGORITHMS

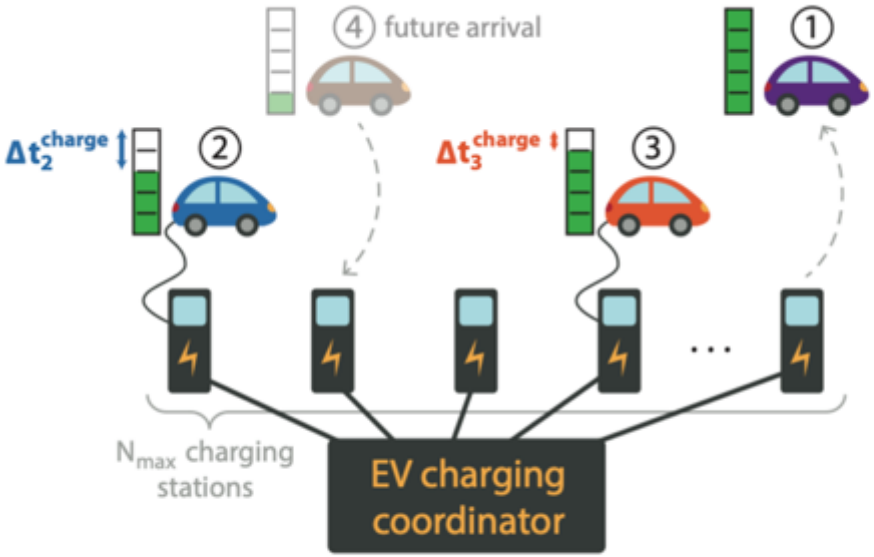


Case (1):
Load flattening

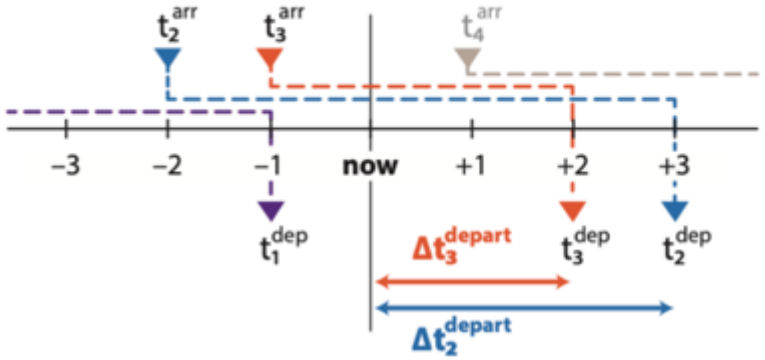
Case (2):
RES balancing

Fill = over what time span the load is deferred

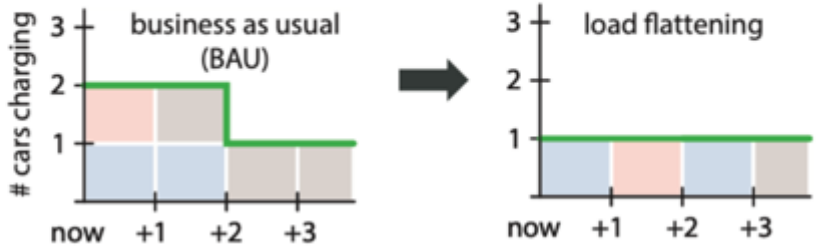
REINFORCEMENT LEARNING FOR DEMAND RESPONSE OF EVS



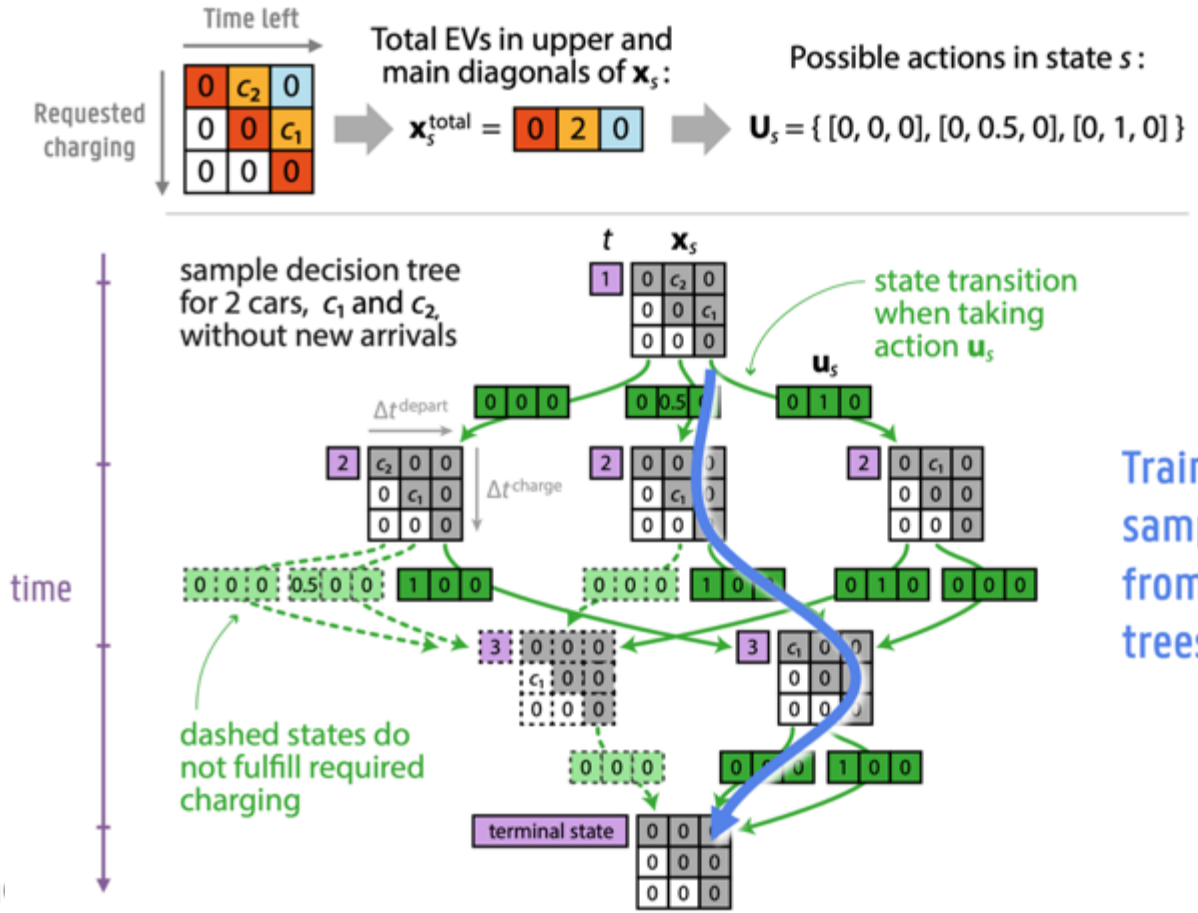
input: arrival & departure times, charging needs
output: which EVs to charge now?



objective: meet target load profile



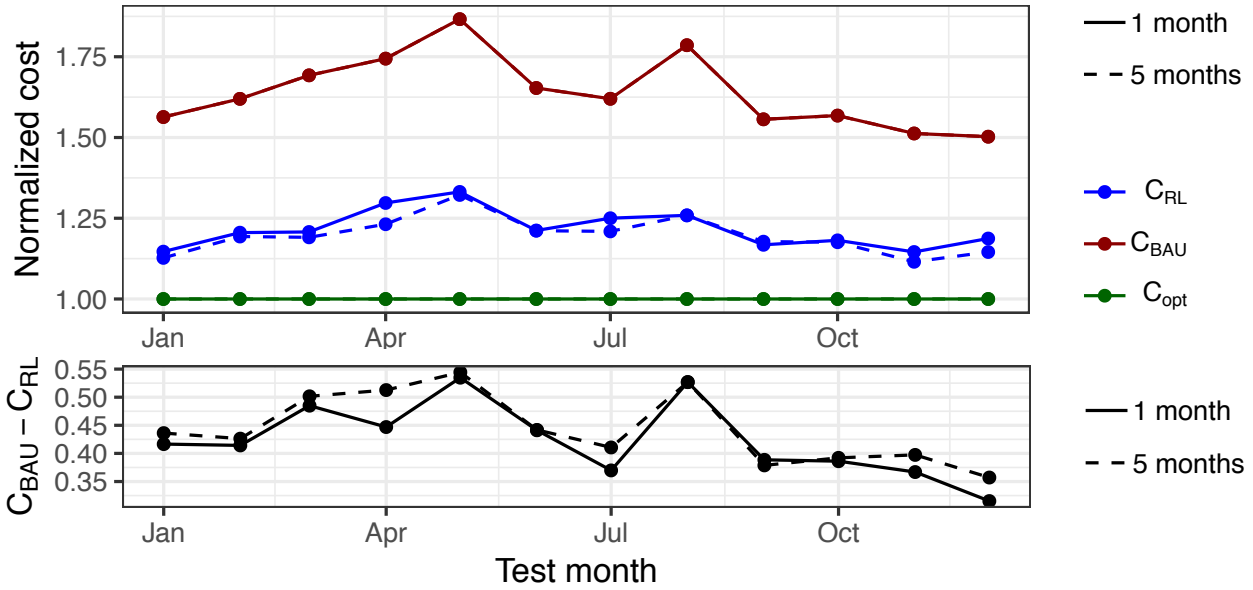
REINFORCEMENT LEARNING MODEL



Train the system using sample trajectories from possible decision trees

EXPERIMENTAL EVALUATION

- Flexibility varies: higher cost difference between **BAU** and **optimal**
- **RL policy** exploits flexibility to varying degree



NILM … WHAT & WHY?

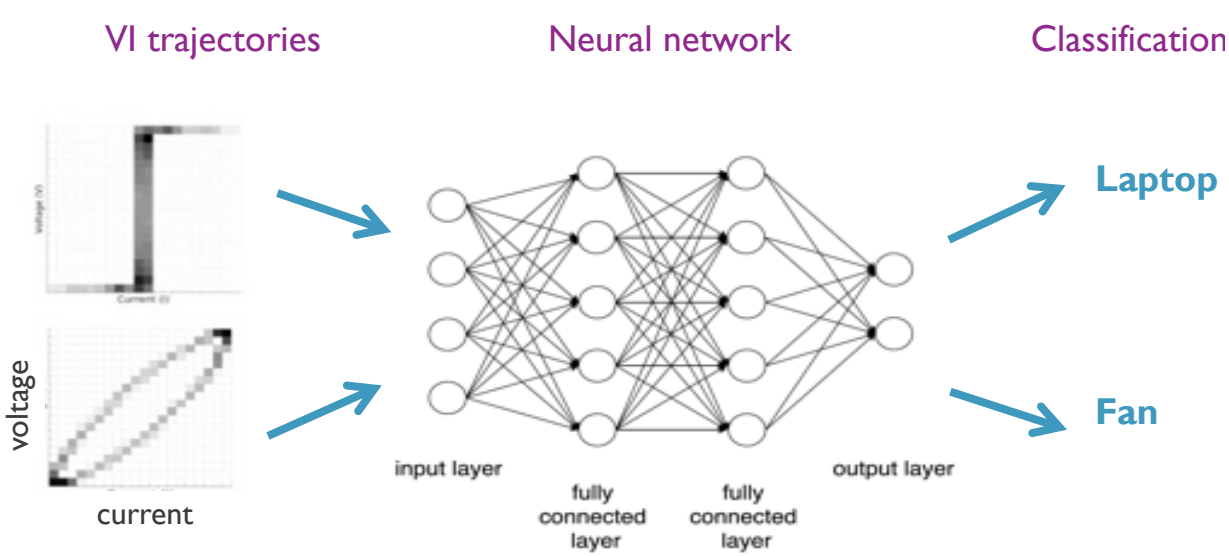
NILM = non-intrusive load monitoring

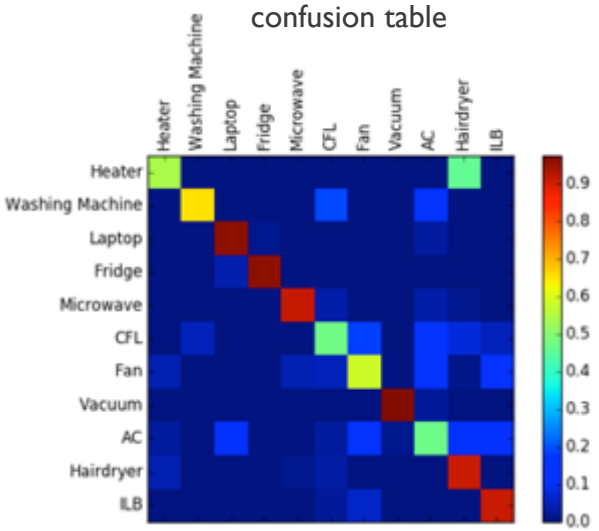
Cost-effective:
single sensor

source: http://blog.oliverparson.co.uk/2014/04/ paper-accepted-at-nilm-2014.html

- Energy efficiency
  - Electricity bill split per device → awareness → incentive to reduce
  - Identify anomalies, electricity theft, …
- Energy usage patterns
  - Advice to adapt to time-varying prices
  - Load forecasting
  - Activity recognition → e.g., healthcare apps

ENERGY DISAGGREGATION

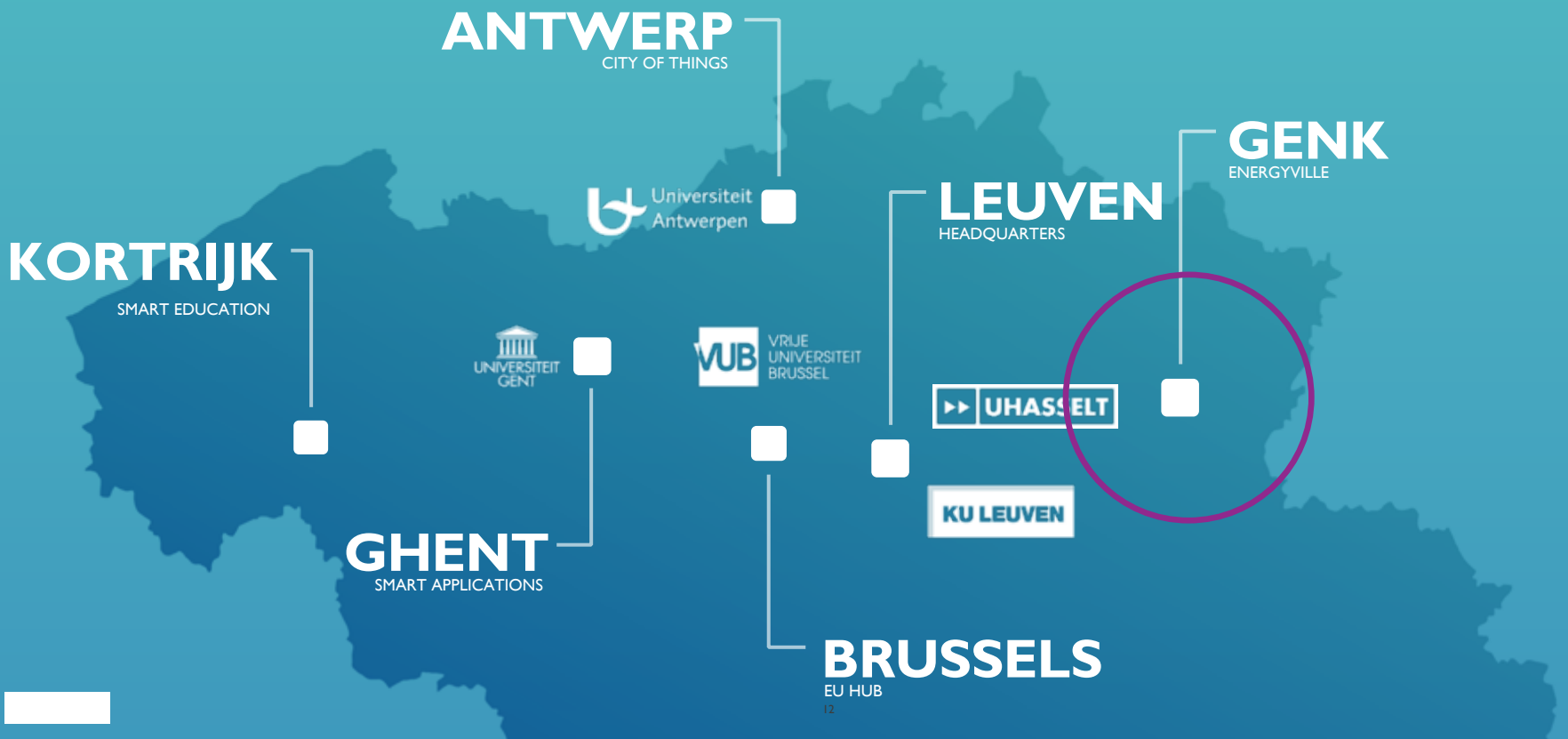




Result:

Test on public dataset (PLAID), 11 appliance types

→ 84.5% accuracy (state-of-the-art was 81.4%)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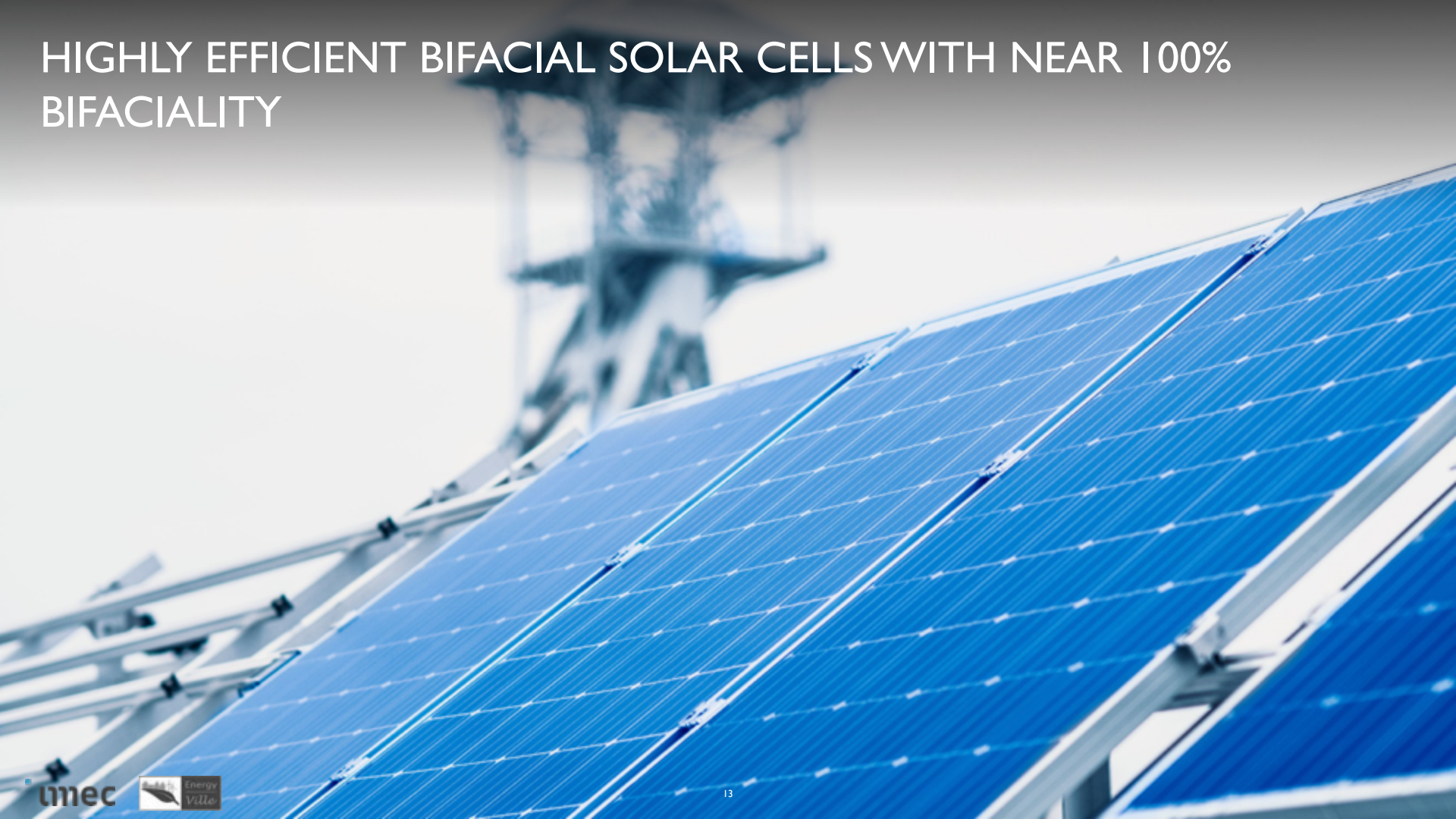
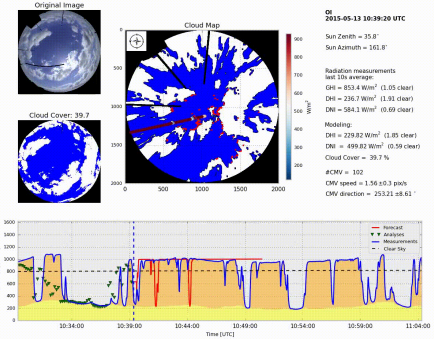
HIGHLY EFFICIENT BIFACIAL SOLAR CELLS WITH NEAR 100% BIFACIALITY

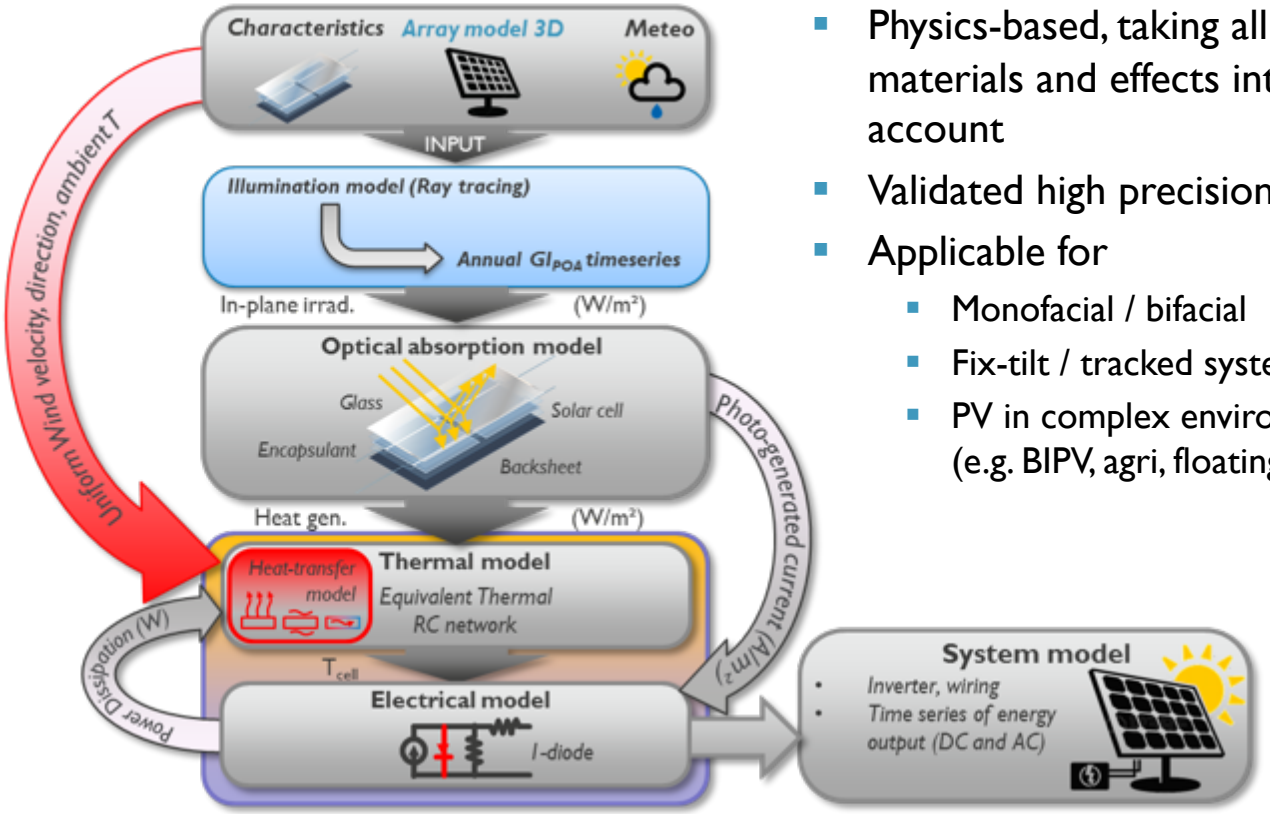


Distributed energy storage

Solid-state Li-ion batteries based on nanocomposite electrolyte for local grid battery systems

ACCURATE PV E-YIELD SIMULATION FRAMEWORK



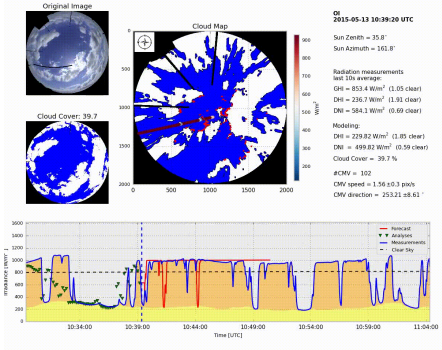


- Physics-based, taking all materials and effects into account
- Validated high precision
- Applicable for
  - Monofacial / bifacial
  - Fix-tilt / tracked systems
  - PV in complex environment (e.g. BIPV, agri, floating, ...)

E-YIELD SIMULATION APPLICATION FIELDS

- Simulation of PV production
  - More accurate than existing software for bifacial PV energy production
  - Sizing of power plants, determine anticipate output, more accurate financial return calculation, technology selection

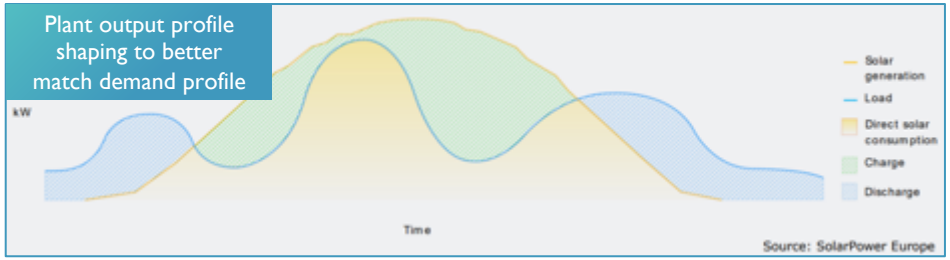
- Operation and Maintenance monitoring
  - Create accurate digital twin for fast fault detection
  - Simplified preventive PV asset maintenance

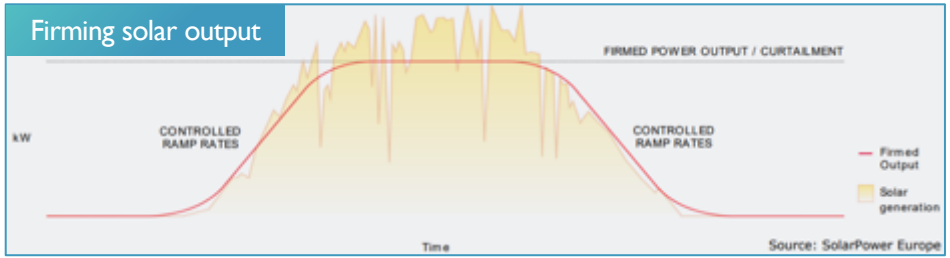


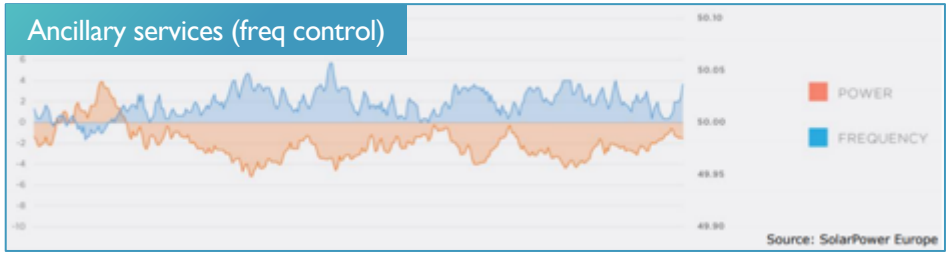
- PV forecasting
  - Better short-term forecasting taking into account local actual weather effects
  - Can be linked with energy management systems (chose to store, consume, put on grid, take from grid, ...) depending on electricity cost

HYBRID PV PLANTS
VIRTUAL POWER PLANTS

- PV plants becoming dispatchable assets thanks to the addition of cost-effective storage solutions.
- The use of advanced forecasting techniques and proactive power plant control will further boost the penetration potential of PV in next generation grid and power system architectures.







ONGOING RESEARCH PROJECTS ON ENERGY COMMUNITIES

CITY DISTRICT 'NEW SOUTH' IN ANTWERP

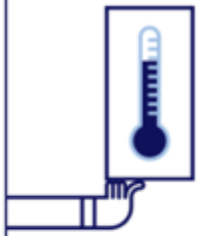
UIA Circular South (2018-2021)

- Demonstration project on circular economy
- Monitoring of energy and waste consumption of inhabitants
- Motivation of participants to adopt a sustainable behavior via nudging techniques and incentivizing via blockchain based circules.

>400 Housing units+ City complex (schools, sports infrastructure etc.)

City district ‘The New Docks’ in Ghent

Smart Multi-Energy District



Energy

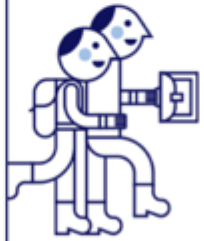
4de gen. heat network
(waste heat Christeyns)
rooftop PV
Smart Grid appliances

Water

Local sanitation
Reuse as process water
(Christeyns)

Waste

Source separation
e.g. vacuum systems
Waste collection
Water treatment
Nutrient recovery



Mobility

Electric bikes
Electric sharing cars
& charging stations

DuCoop

imec partner technical week

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RESEARCH PROJECTS

H2020 InterConnect (2019-2023)
Improve interoperability between buildings and energy grids via the design of an interoperable marketplace toolbox and IoT reference architecture using SAREF as data model.

H2020 RENergetic (2020-2024)
Optimization of different energy vectors (electricity, heat, waste) in urban districts to improve energy efficiency and self-sufficiency

Flux50 ICON ROLECS (2019-2021)
Design and demonstration of local energy communities in Flanders via 10 pilots from a technical, user, economical and regulatory perspective

H2020 BRIGHT (2020-2023)
Design of digital twins and demand response services for residential users and energy communities.

embracing a better life

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