

# The iCarus Project

Forecasting Energy  
Optimizing Renewables

# Alliander

Distribution System Operator

- Electricity & gas
- 5.6 M customer connections
- 7 k employees
- 41 k km gas lines
- 90 k km electricity cables
- 99.99% service uptime



# As a DSO:

## The Observation:

1. Increasing number of Solar PV Systems.
2. Unpredictable energy flows on local grid

## The Challenge:

1. PV systems poorly registered
2. Solar energy fluctuates strongly in time
3. Solar energy fluctuates strongly in place

## The Idea:

- Can we use household PV systems as a sensor to accurately predict solar energy yield?
- And if so, how well does this solve our problems?
- And if so, who benefits besides us?

# 3500x More data using Household PV

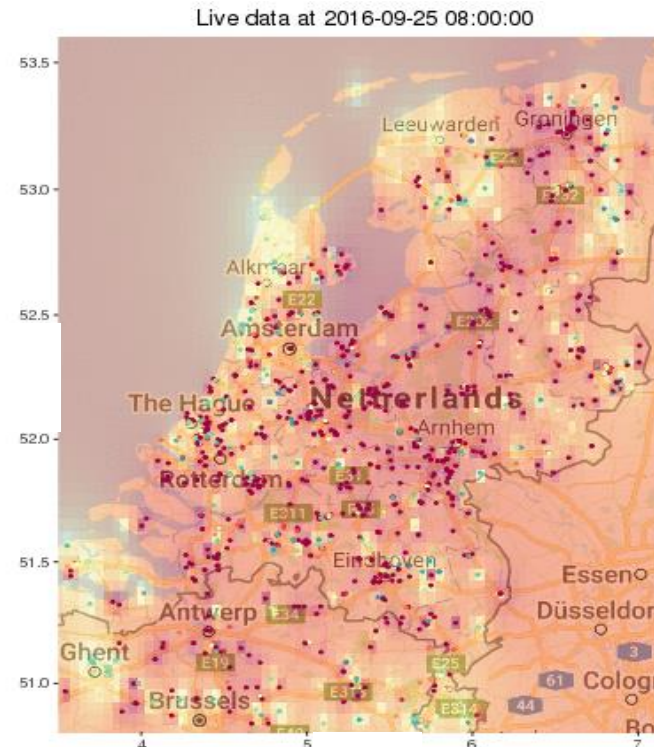


## Traditionally



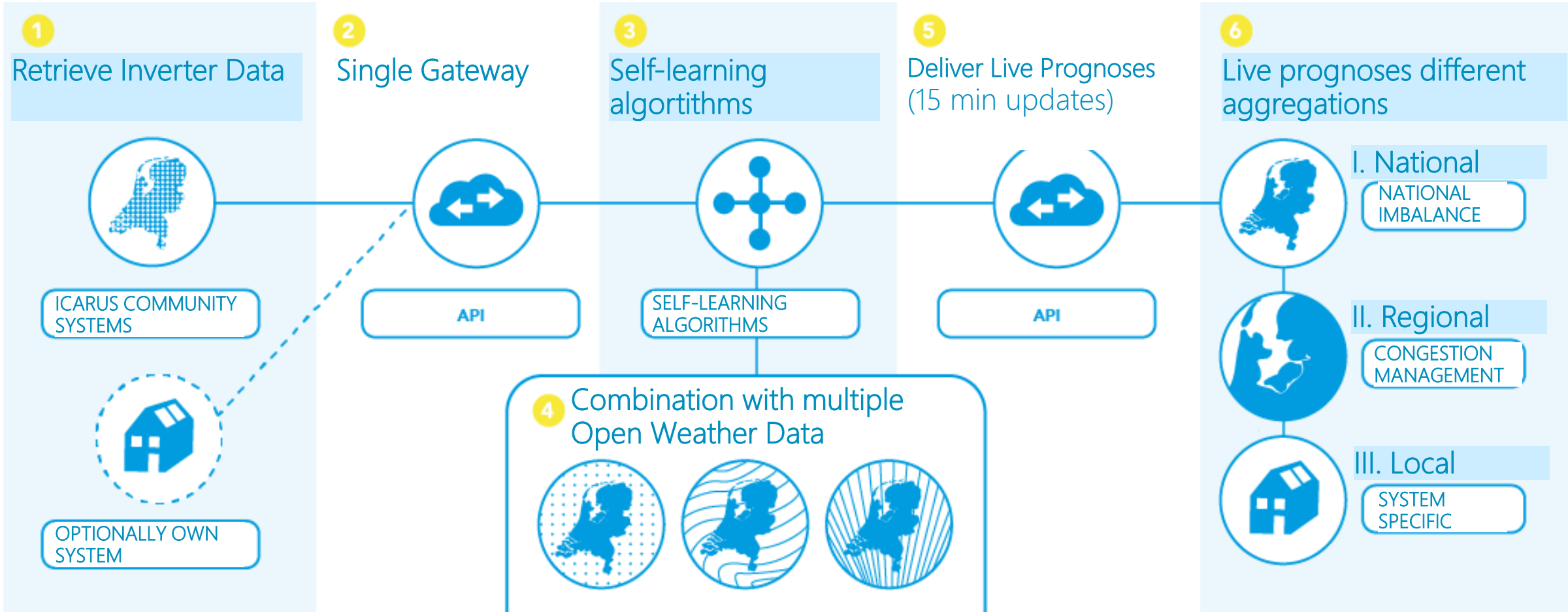
- 40 weather stations, well defined
- 6 hours data lag
- irradiance converted to solar energy

## iCarus



- >2k inverters (potential 400k), unknown specifics
- Realtime data acquisition & analysis
- Self-learning algorithms

# Data Flow



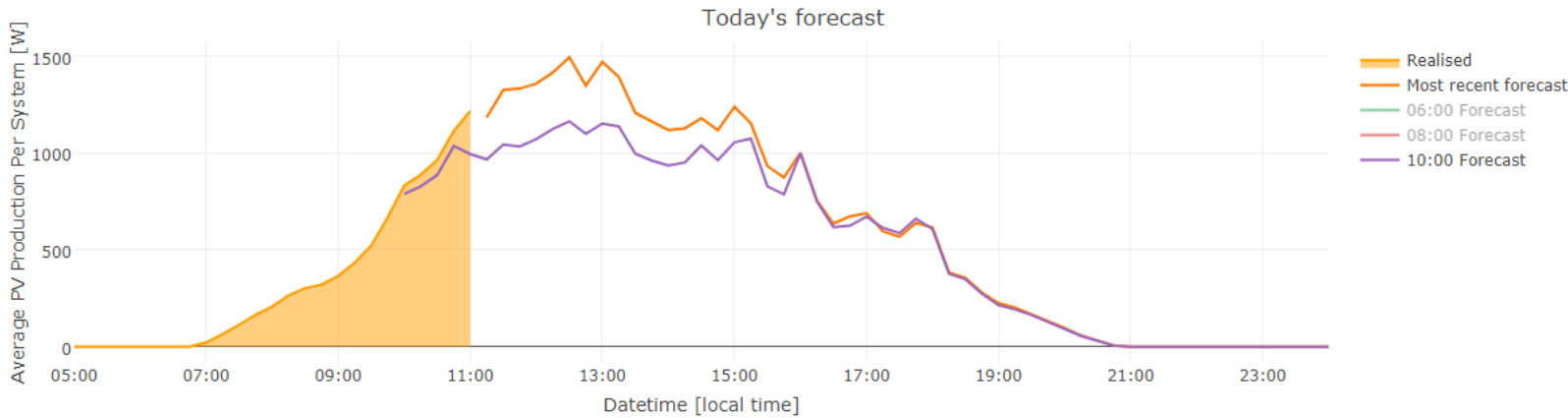
# Result: Live Dashboard PV Yield

<https://dashboard.icarus.energy>



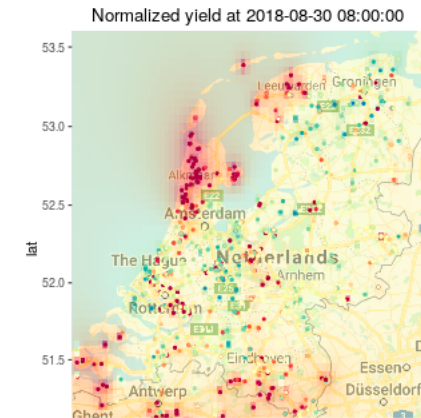
← iCarus » Dashboards POST pvdata API Get Forecast API Technical Support

Live output & forecast our office @Arnhem

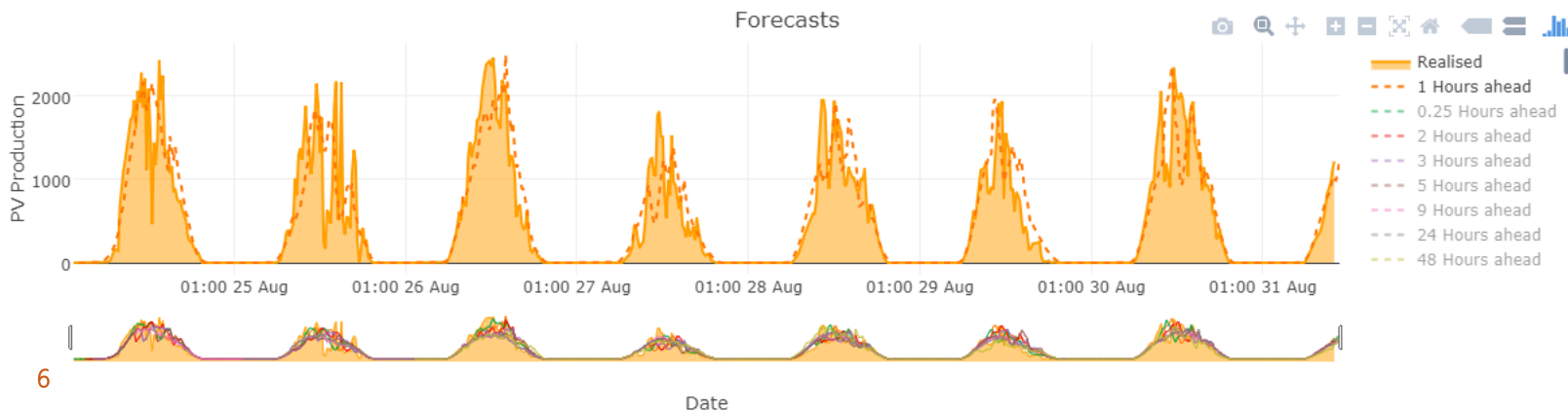


Pretty fancy, right?

Distribution PV yield yesterday

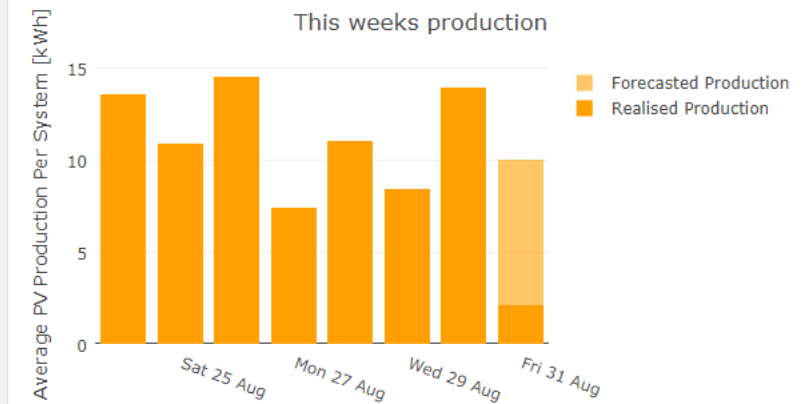


Historic PV production and forecasts our office @Arnhem



Try zooming in on a specific day!

This weeks PV Production our office @Arnhem



The bar of today's production also shows how much more PV Energy will be generated!

# Result: Case specific application

## Behind the meter optimization

- Individual households
- Smart appliances

## Local Grid Balancing

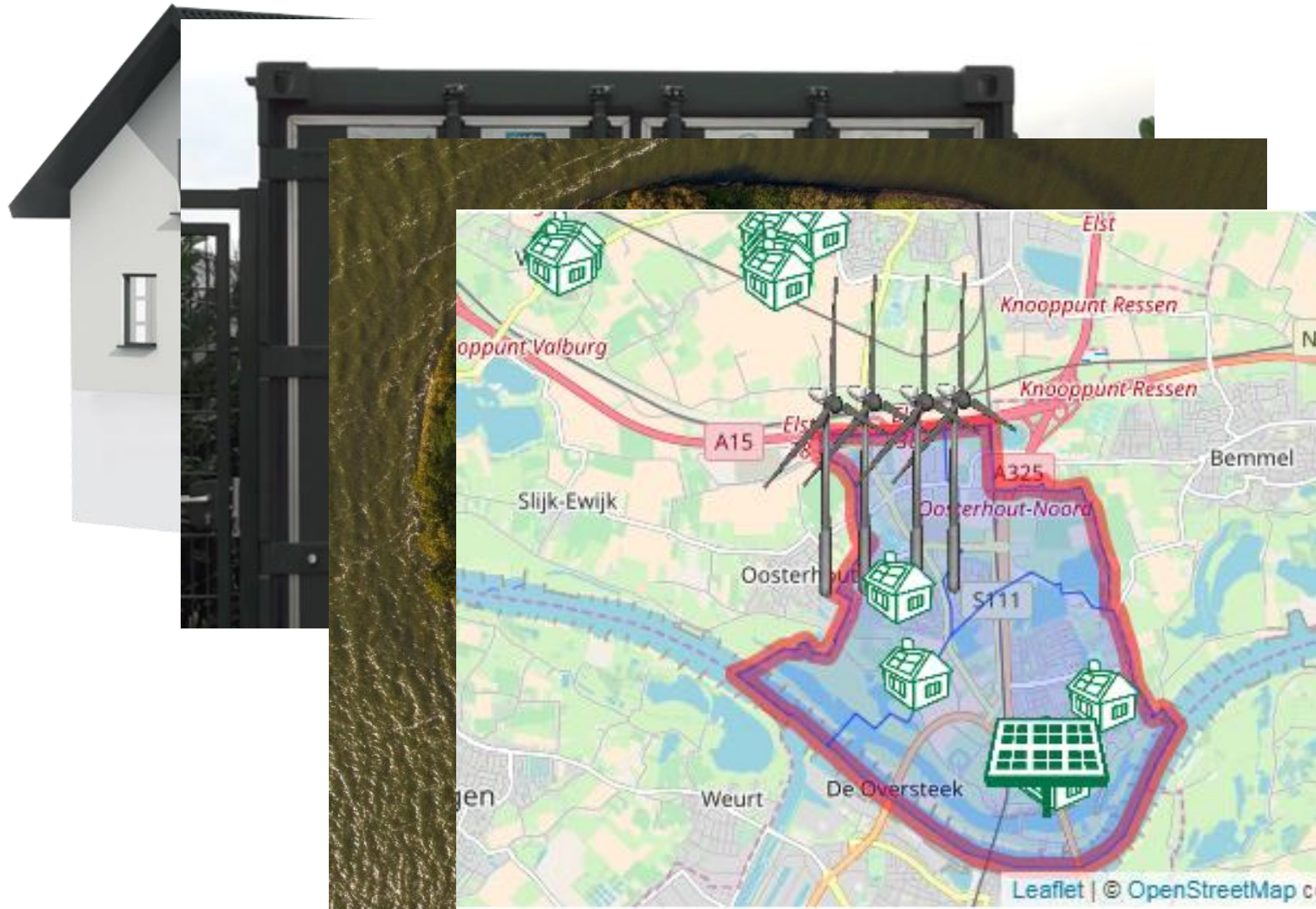
- Neighborhood battery
- 30 Households with PV

## Micro-grid optimization

- Small Island
- Generators, PV

## Flexibility market

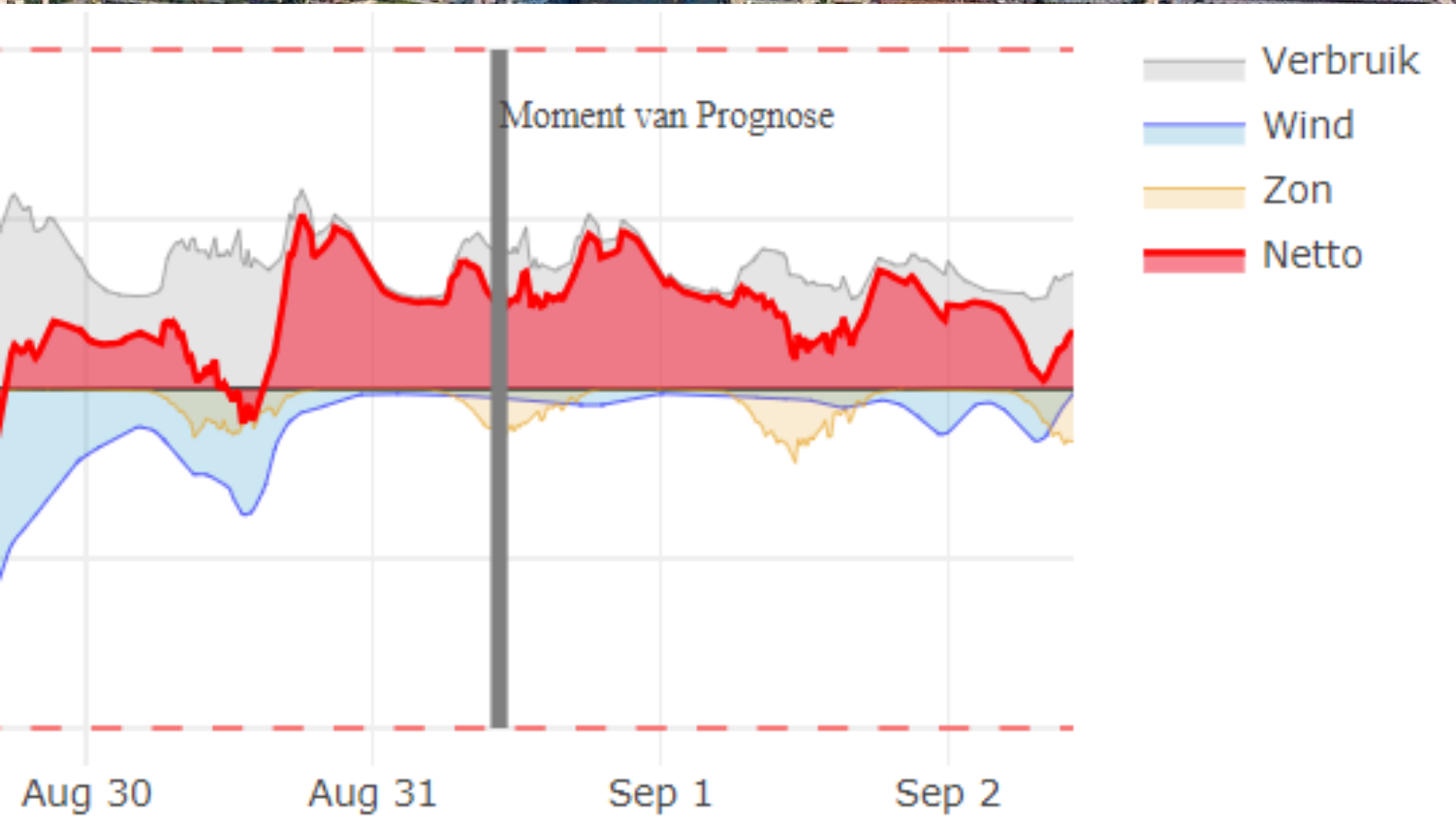
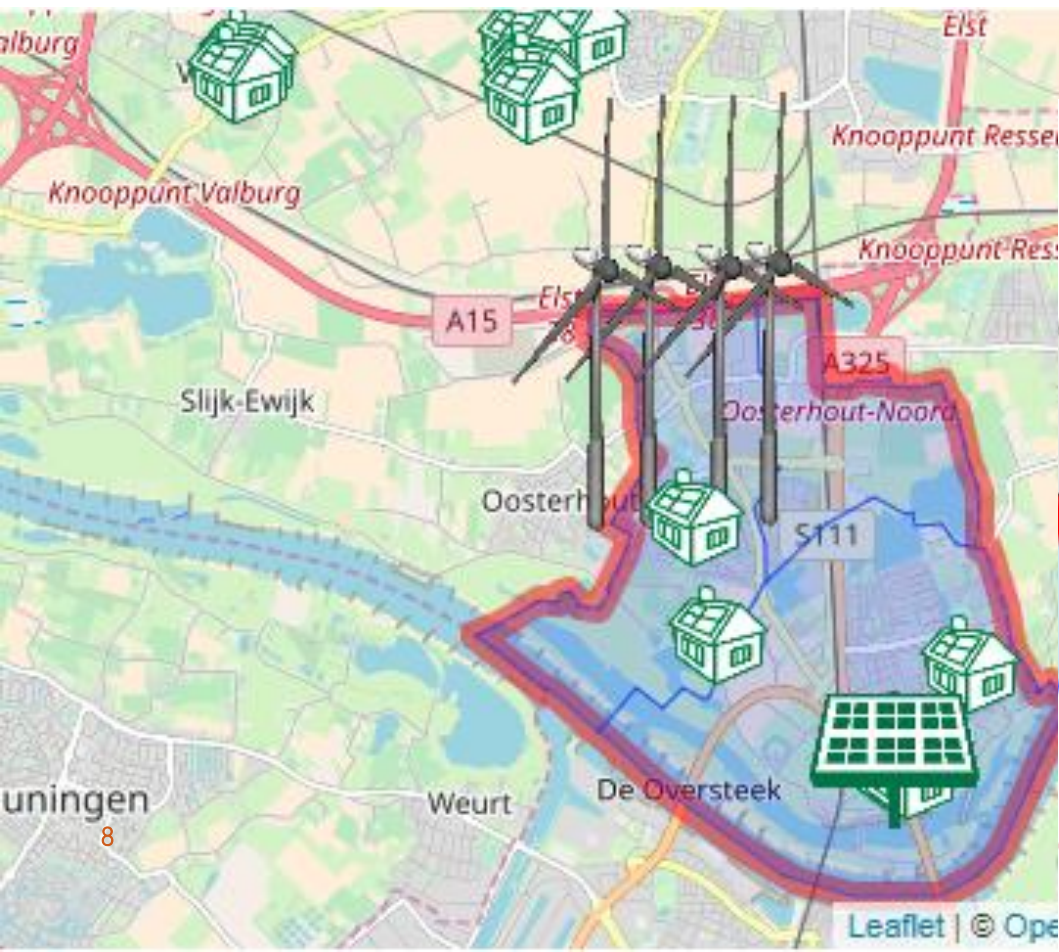
- 8000 households
- 2.5 MWp distributed PV
- 10MWp Windfarm



Result: There's more on the grid than just solar!

Live case: <https://dashboard.icarus.energy/NijmegenNoord/>

alllander





# Learnings and discussion

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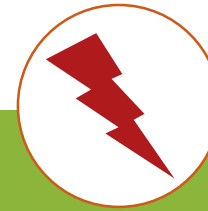
### Success:

- Large scale household PV data acquisition and cleaning
- Real-time analytics
- Accurate-enough forecasts



### Success:

- Enabling optimum use of renewable energy
- Single method, multiple external partners & projects



### Barriers:

- Many brands
- Inverter-specific data pathway
- Difficult for households
- PV alone not sufficient



### Additional Benefit:

- Forecasting Capability
- Large-scale, autonomous AI models

# Partners during the project

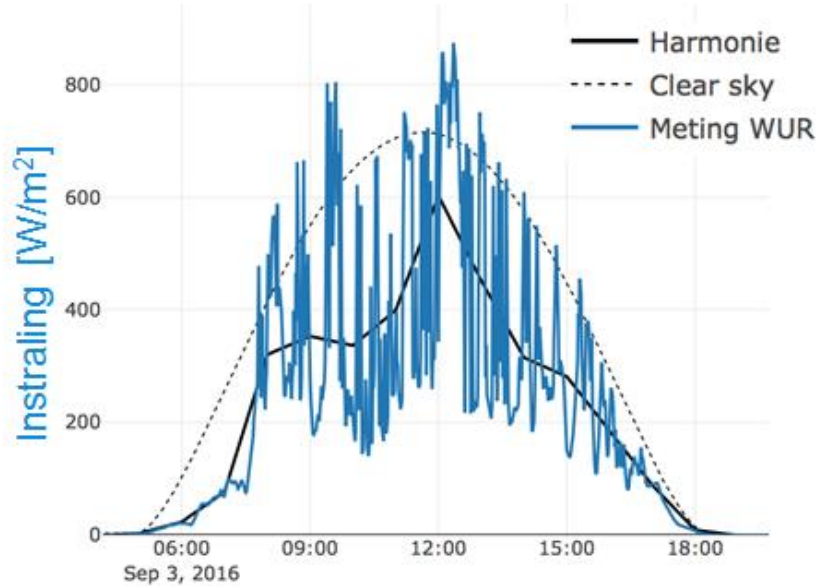


# Spin Off Projects

And Future work



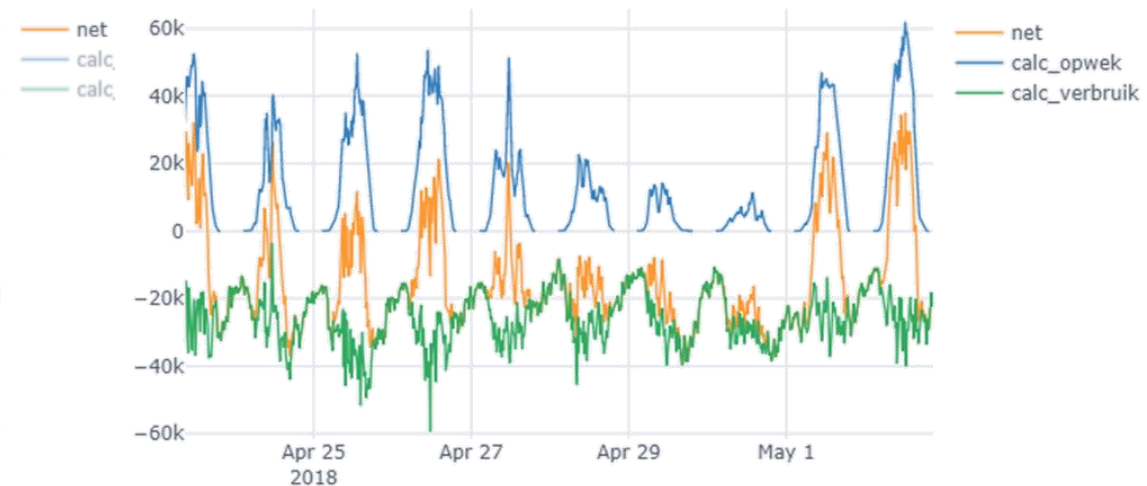
PhD Project PV:  
 - Grid management + Meteorology  
 - Accurate forecasts solar PV households



Present State of the Art Reference



Disaggregating Grid load into Household consumption and PV generation





alliander

Thank  
You!