



## E-shape and DestinE: Use-cases on renewable energy

**Susanne Weyand, Hauke Bents, Bruno Schyska, Thomas Schmidt,  
Francesco Witte and Marion Schroedter-Homscheidt**

with thanks to DFD, IMF and IHR colleagues

Institute of Networked Energy Systems



DLR

Deutsches Zentrum  
für Luft- und Raumfahrt  
German Aerospace Center



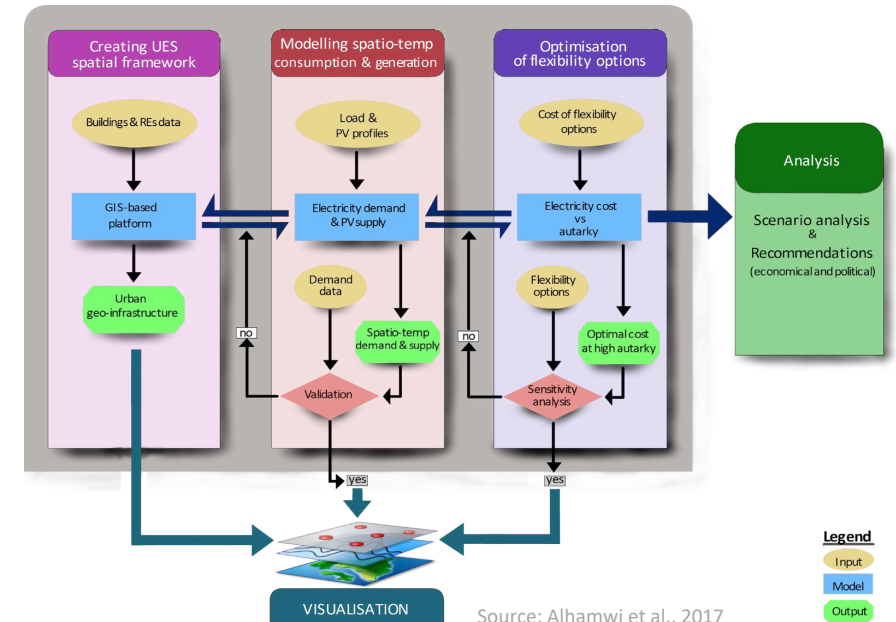
## Energy Modelling Applications

### FlexiGIS and REMix

supports potential users such as:

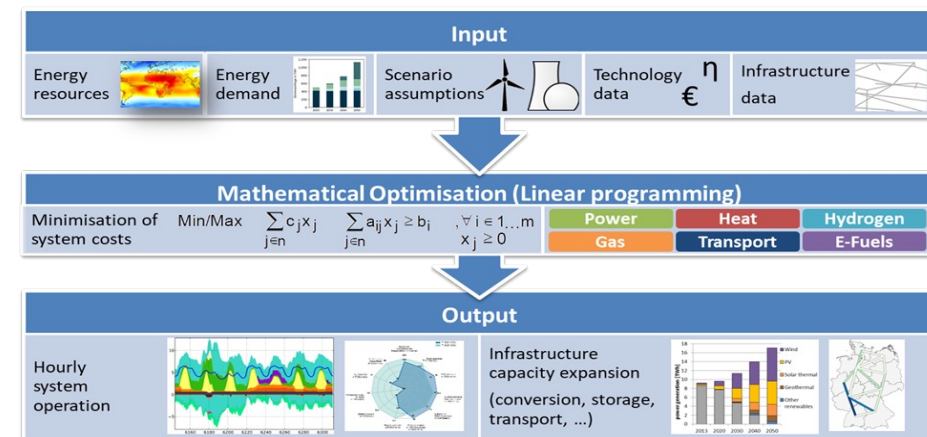
- Network and Grid Operators
- Decision-makers in urban planning
- Industry
- Aggregators for solar power trading
- Citizens
- and Researchers

FlexiGIS (e-shape): Susanne Weyand, Hauke Bents, Jethro Betcke  
 REMix (DestinE): Bruno Schyska, Thomas Schmidt, Francesco Witte



Source: Alhamwi et al., 2017  
 Online available at: <https://github.com/FlexiGIS>

### Energy system optimisation framework - Renewable Energy Mix (REMIX)



Source: <https://www.dlr.de/ve/>; Online available at: <https://gitlab.com/dlr-ve/esy/remix>





## Pilot 3.2: High photovoltaic penetration at urban scale: Energy Modeling Application - coupling to FlexiGIS

**Data Acquisition**

Nightlights  
Hyperspectral  
Optical

**Data Post-Processing**  
Extraction of Energy-Infrastructures and Building Parameter

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**Remote Sensing Technology Institute**



**PV Power-Timeseries**

Post-Processed EO-Data,  
Extracted Energy-Infrastructures  
and Building Parameter

Atmosphere  
Monitoring Service  
atmosphere.copernicus.eu

Irradiation on the tilted plans averaged over the time range (kWh/m<sup>2</sup>)

15-min PV output power (kW) over the selected period

**PSL** Centre Observation, Impacts, Energie



**EO-Data and PV Power-Timeseries  
from CAMS into Energy-Models**

Total costs 108 m€/year

Imported energy 143 GWh/year

Total storage 788 MWh/year

Electricity bus

Storage capacity  
48 MWh  
60 MWh  
65 MWh  
110 MWh  
180 MWh  
259 MWh

Grid  
PV  
Wind  
Bio  
Hydro  
Gas

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## FlexiGIS development – done in e-shape

### Timeseries process chain development:

#### Data implementation:

- **CAMS Radiation** Service to retrieve irradiation and temperature data via soda
- Airborne based **Digital Surface Model (DSM)** from DLR optical overflight 2019 (20 cm GSD)
- **Building footprints** extracted from DLR optical overflight 2019 (20 cm GSD)
- **Corine Land Cover (CLC)** data provided by DLR German Remote Sensing Data Center



#### Use

- PV location by single system
  - ERA 5 data access
  - PV modeling chain



#### Enhanced inside FlexiGIS with

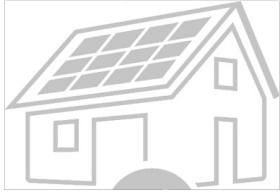
- CAMS Radiation data as well as
- PV multi location data from airborne data collection





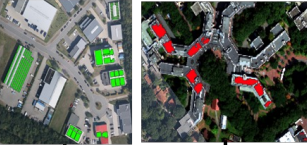
## FlexiGIS development – still ongoing

**Current**

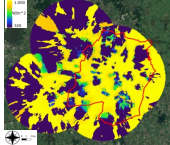


single scaled system

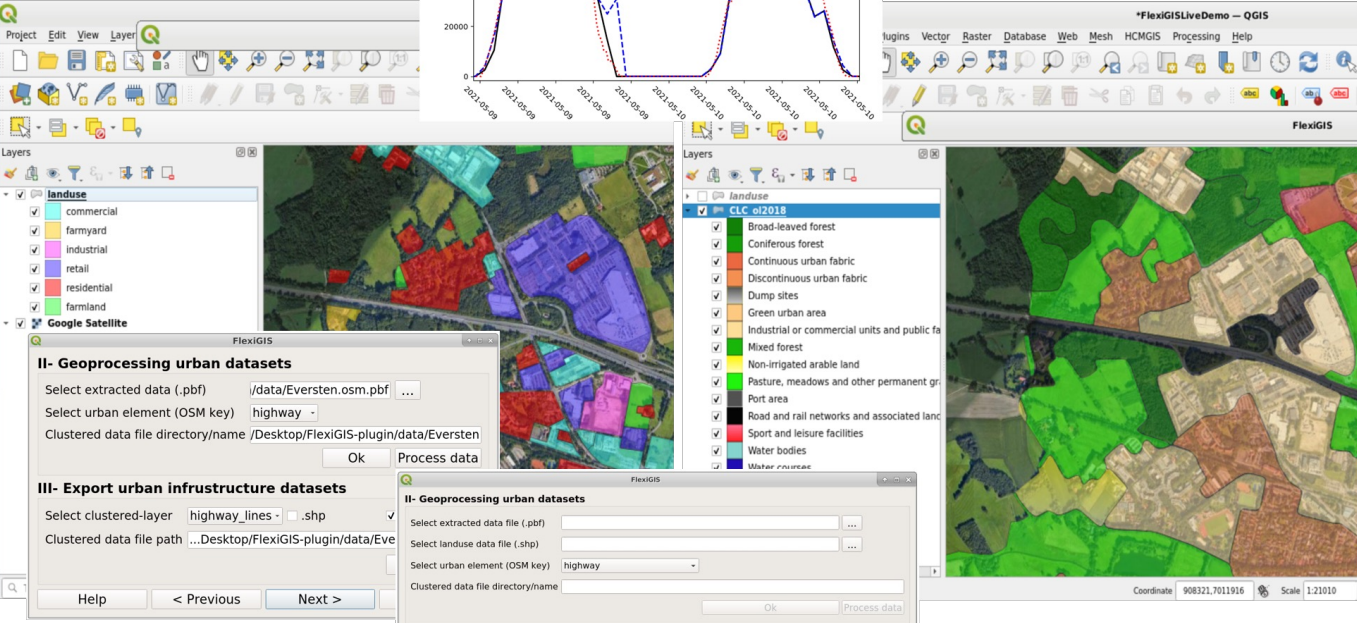
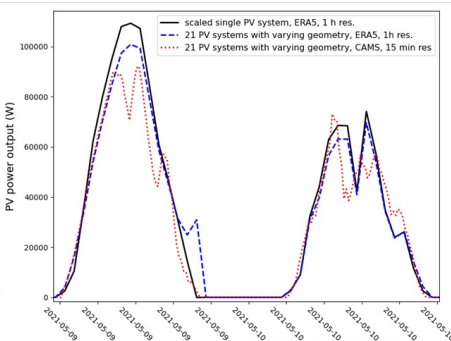
**Ongoing implementation**



multiple systems with varying geometry

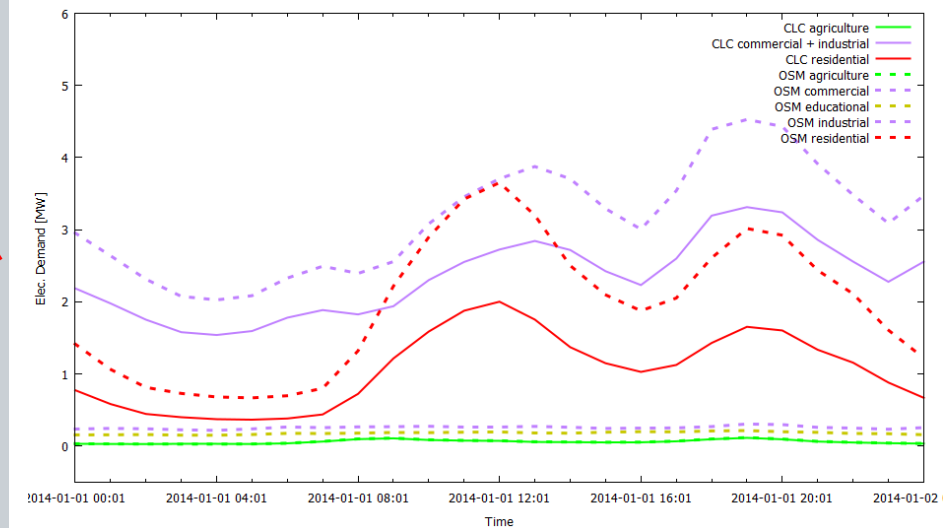
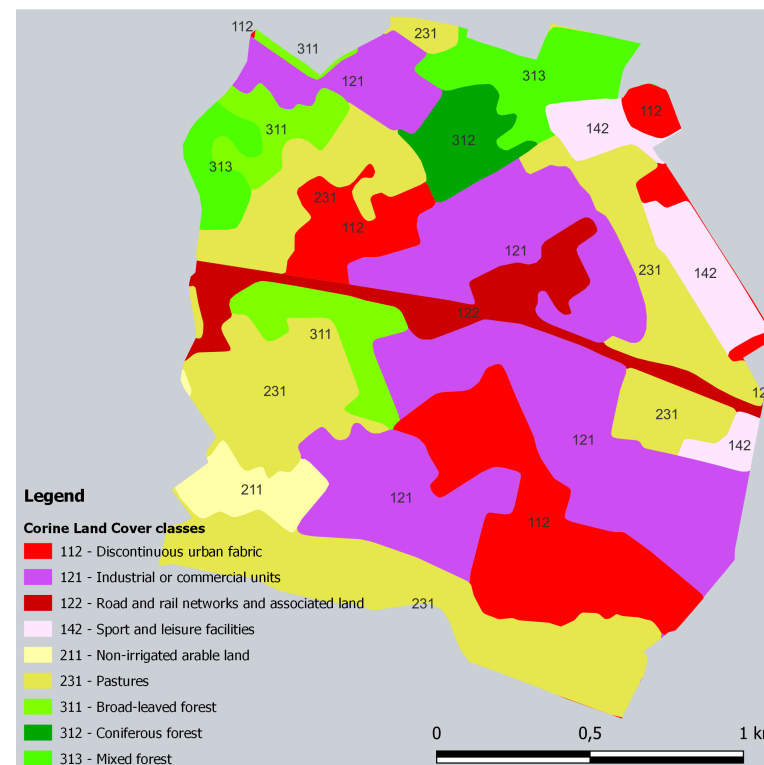
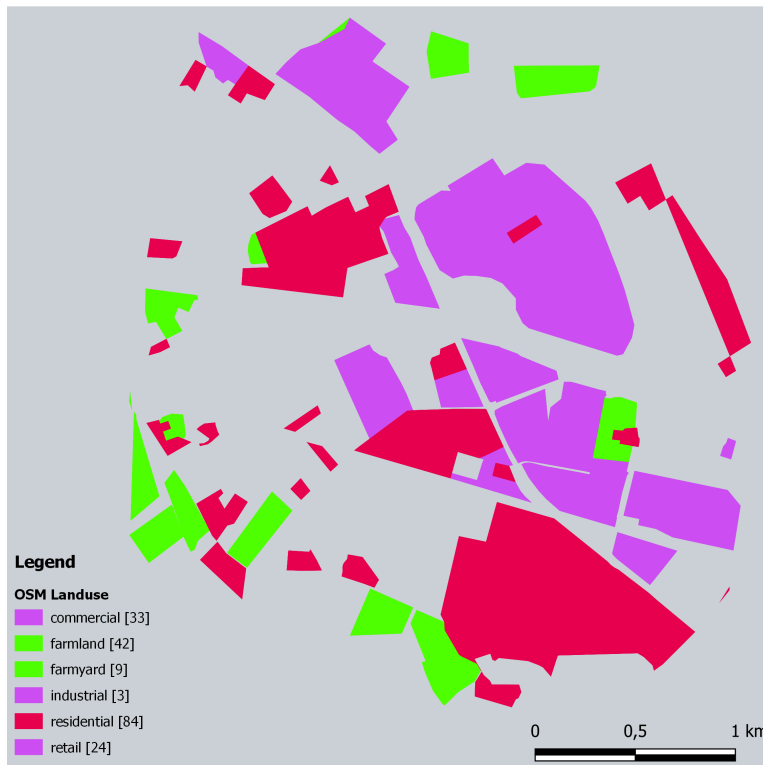


DLR- ASI Network "Eye2Sky"





## Data impact on demand simulation – OSM vs. CLC



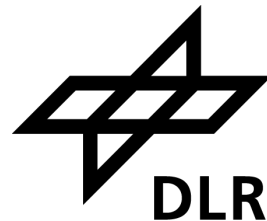
Electric demand calculation by FlexiGIS on SLP for OSM and CLC input data sets



## DestinE - Use Case Energy Systems: Adapting Energy Systems to a changing Climate

- Demonstrator development for climate information use in energy system applications.
- Ground-based validation of DestinE Digital Twin Climate Adaptation by DLR's unique Eye2Sky network.
- Comparison of several meteorological data-sets and model sensitivities quantification.
- Tools and method development for climate scenarios integrate into energy system workflows.
- Collaboration between European grid operators, public authorities and stakeholders .

Joint activity of



AARHUS  
UNIVERSITY

Renewables   
Grid Initiative



## DLR Eye2Sky – All-Sky Imager Network

### Solar irradiance measurement:

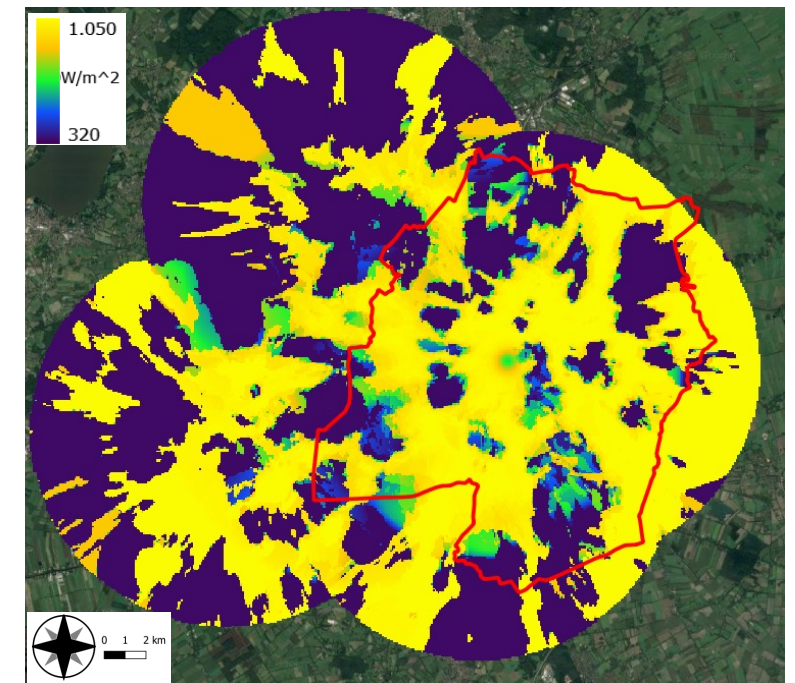
- Global, Diffuse and Direct Irradiation Components (GHI, DNI and DHI)

### Weather data:

- Temperature
- Relative Humidity

### Cloud monitoring and forecasting (generate irradiance maps)

- high temporal (30 sec) and spatial resolution (e.g. 5 m x 5 m).
- high accuracy for the next 20 minutes and overall lead times of up to 2 hours







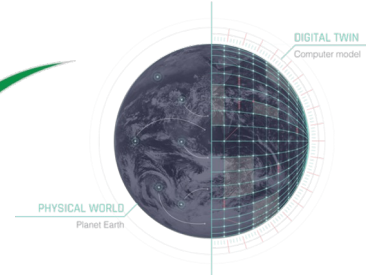
## Demonstrator development

Current data input

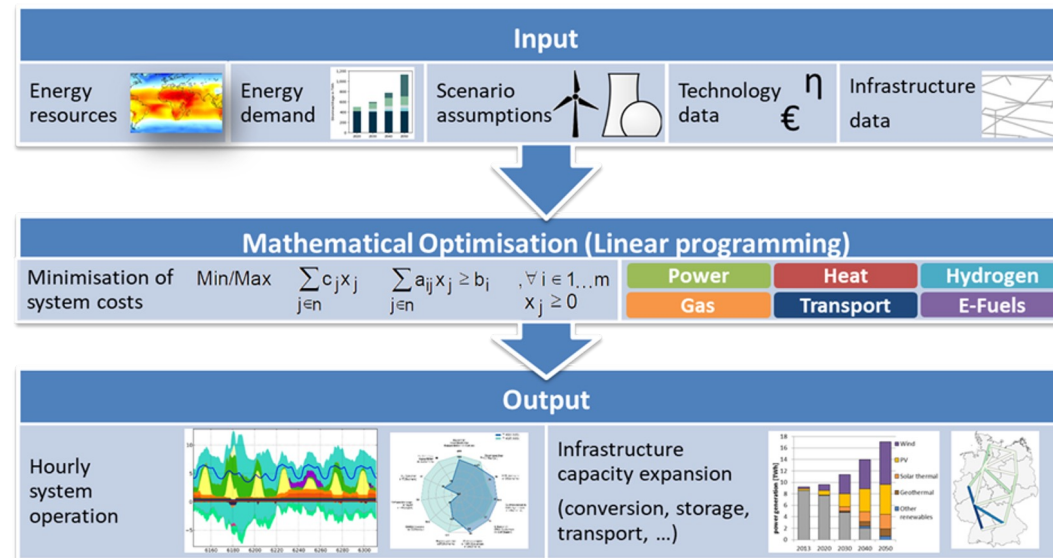


Existing open source databases

Ongoing Implementation



REMix Model

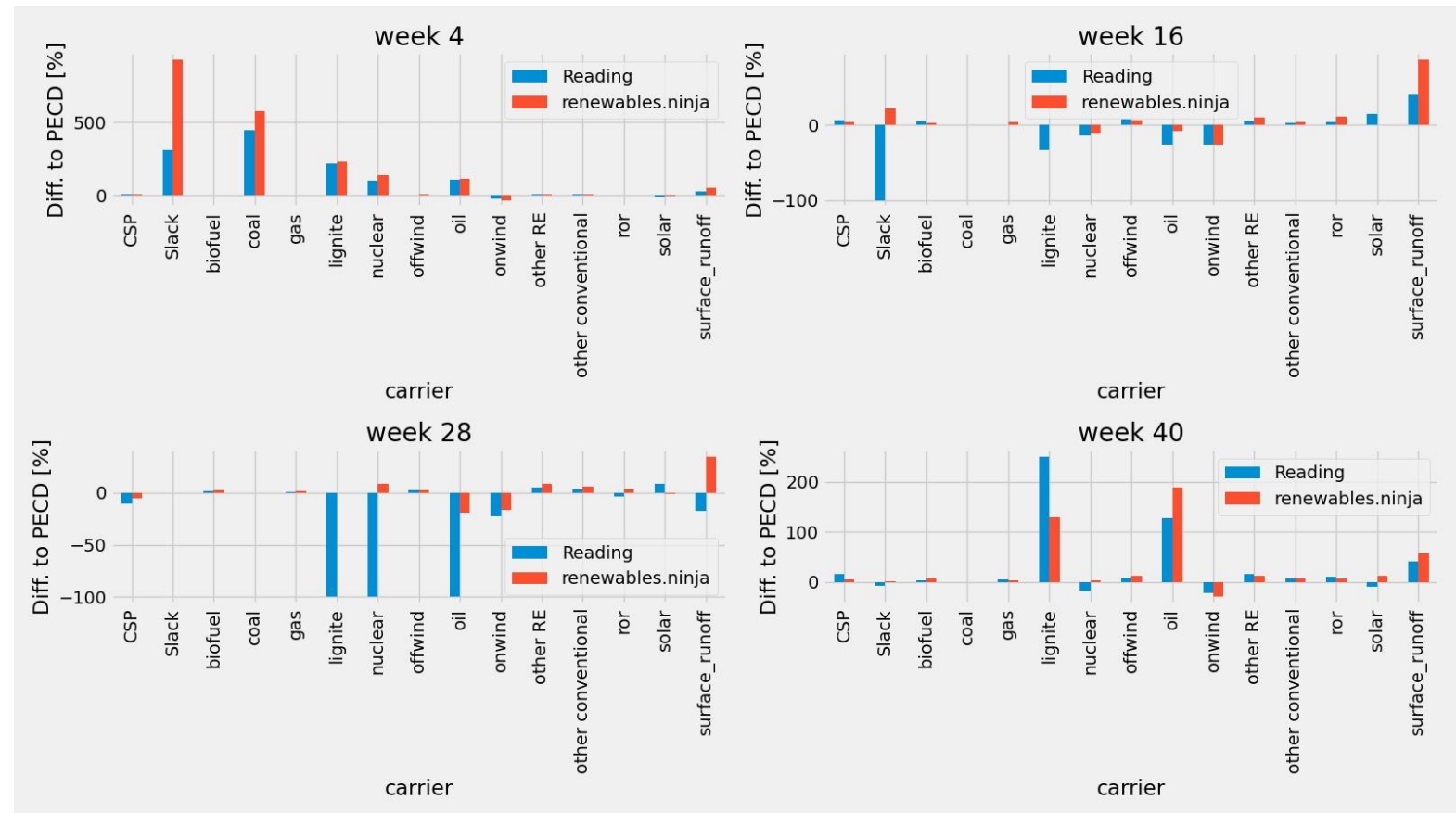




## First results

- REMix simulation output based on the Pan-European Market Modeling Data Base<sup>1</sup>
- Differences in electricity market clearings of four weeks in 2010 based on Pan-European Climatic Data Base (PECD)<sup>1</sup>, University of Reading<sup>2</sup> and renewable.ninja data<sup>3</sup>

Differences in electricity dispatch compared to PECD



References: <sup>1</sup> ENTSO-E: <https://www.entsoe.eu/outlooks/eraa/2022/eraa-downloads/>; <sup>2</sup> Bloomfield et al. [2022] <https://doi.org/10.17864/1947.000321>; <sup>3</sup> renewable.ninja developed by Imperial College London and TU Delft, Steffell & Pfenninger [2016] and Pfenninger & Staffell [2016] [doi: 10.1016/j.energy](https://doi.org/10.1016/j.energy).



## Conclusion

- Intensive co-design with application and library developers initiated.
- Several code adaptations deep inside FlexiGIS code.
- FlexiGIS: several EO data implemented -> CAMS radiation, Corine Land Cover, building footprints and still ongoing - PV system information.
- Both energy model tools show:  
Simulation output impact by:
  - EO data usage (or in combination with OSM data) (FlexiGIS)
  - and geophysical data usage (DestinE)
- Further application and data evaluations ongoing.

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# EUROGEO WORKSHOP 2023



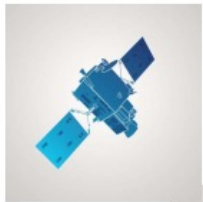
**BOLZANO 2-4 OCTOBER 2023**



## Next Generation Weather and Climate Models

200m

MSG, next generation satellites MTG



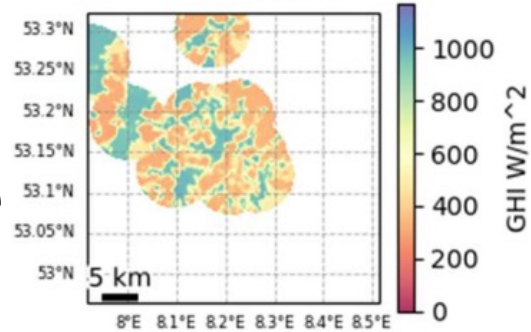
1000m



4000m

ICON – D2  
Weathermodel

GHI Map



GHI Gradient

