



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

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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





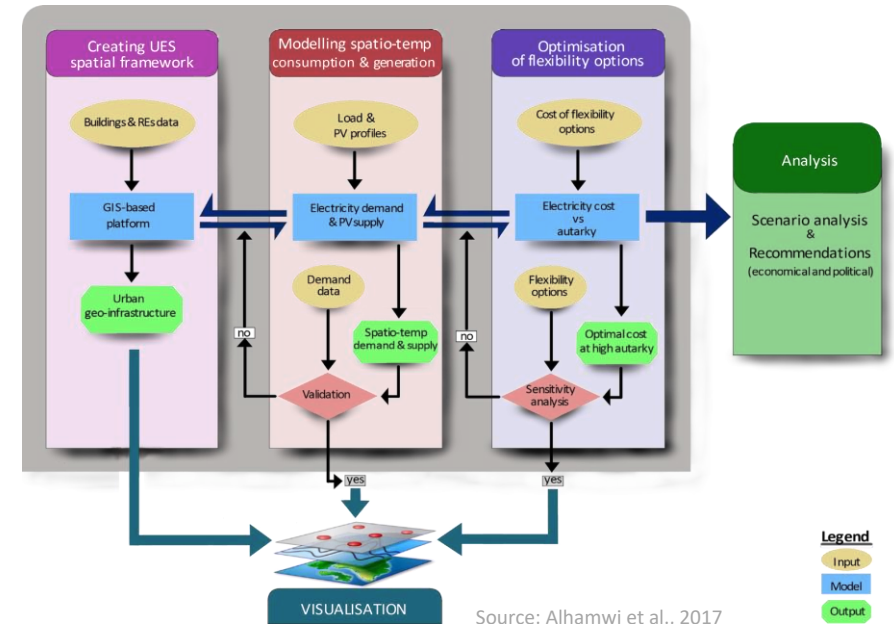
Energy Modelling Applications

FlexiGIS and REMix

supports potential users such as:

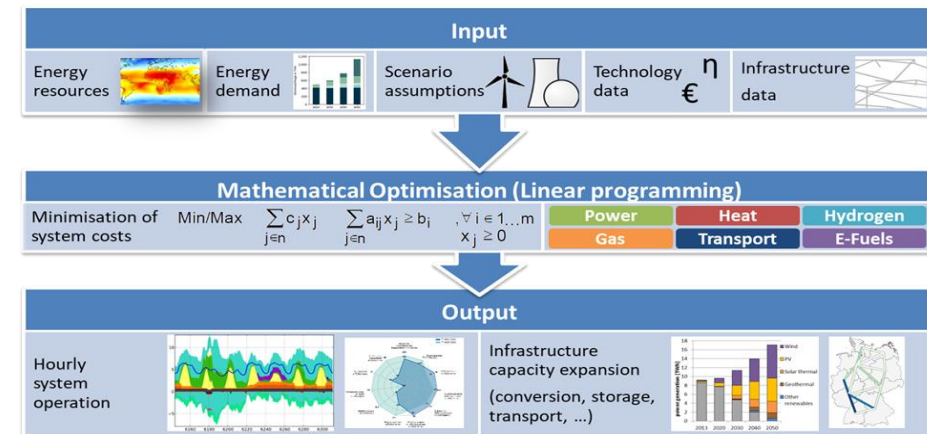
- Network and Grid Operators
- Decision-makers in urban planning
- Industry
- Aggregators for solar power trading
- Citizens
- and Researchers

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>



e-shape 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

Institute of Networked Energy Systems
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/m²)

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

Institute of Networked Energy Systems



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



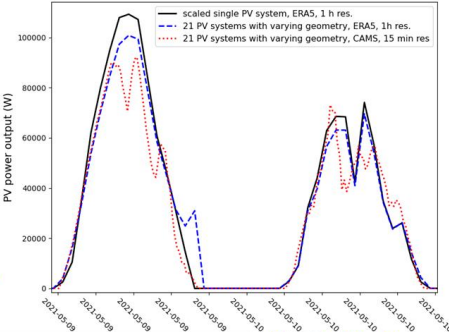
single scaled system

Ongoing implementation

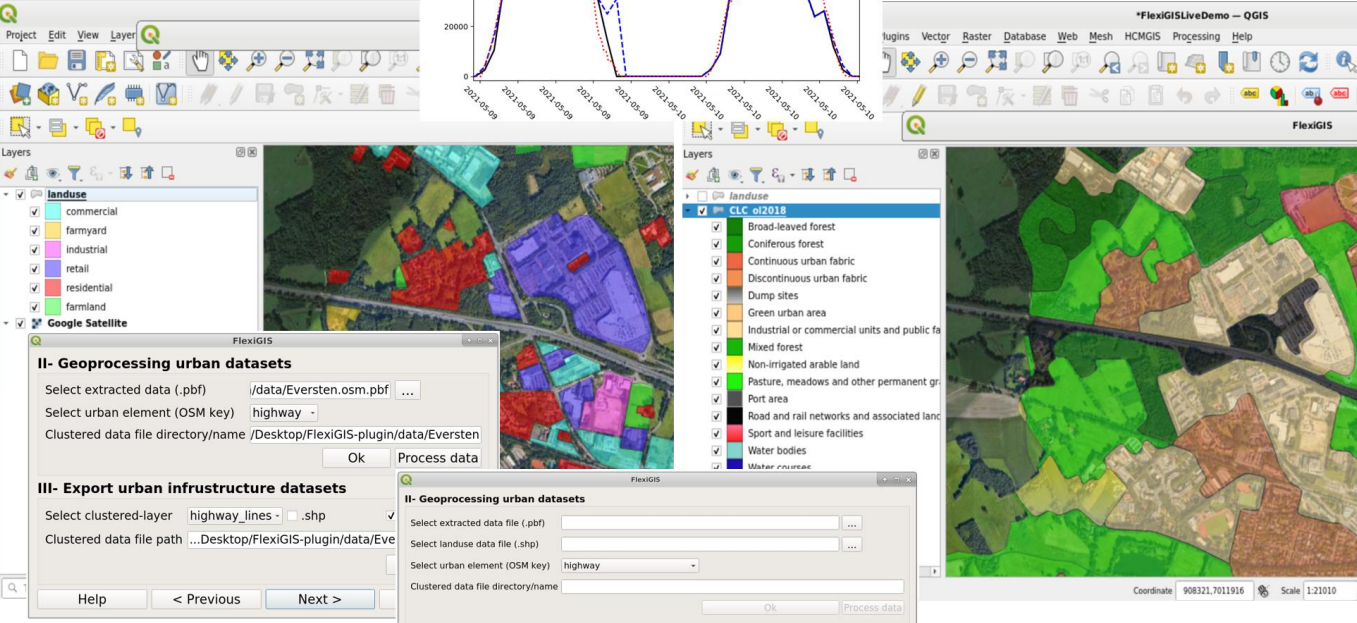


multiple systems with varying geometry

DLR- ASI Network "Eye2Sky"



Atmosphere Monitoring Service
atmosphere.copernicus.eu



II- Geoprocessing urban datasets

Select extracted data (.pbf) /data/Eversten.osm.pbf ...

Select urban element (OSM key) highway -

Clustered data file directory/name /Desktop/FlexiGIS-plugin/data/Eversten

III- Export urban infrastructure datasets

Select clustered-layer highway_lines - .shp

Clustered data file path ...Desktop/FlexiGIS-plugin/data/Eve

Layers

- landuse
- commercial
- farmyard
- industrial
- retail
- residential
- farmland
- Google Satellite

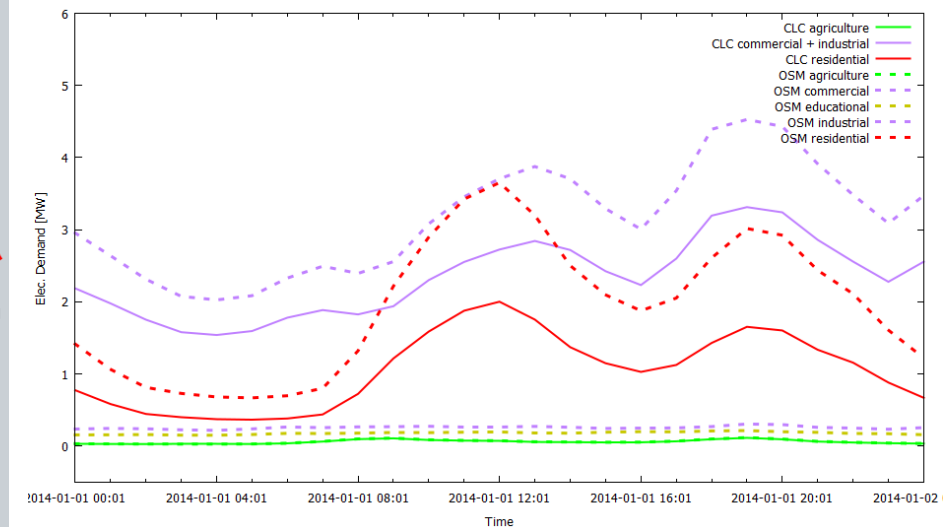
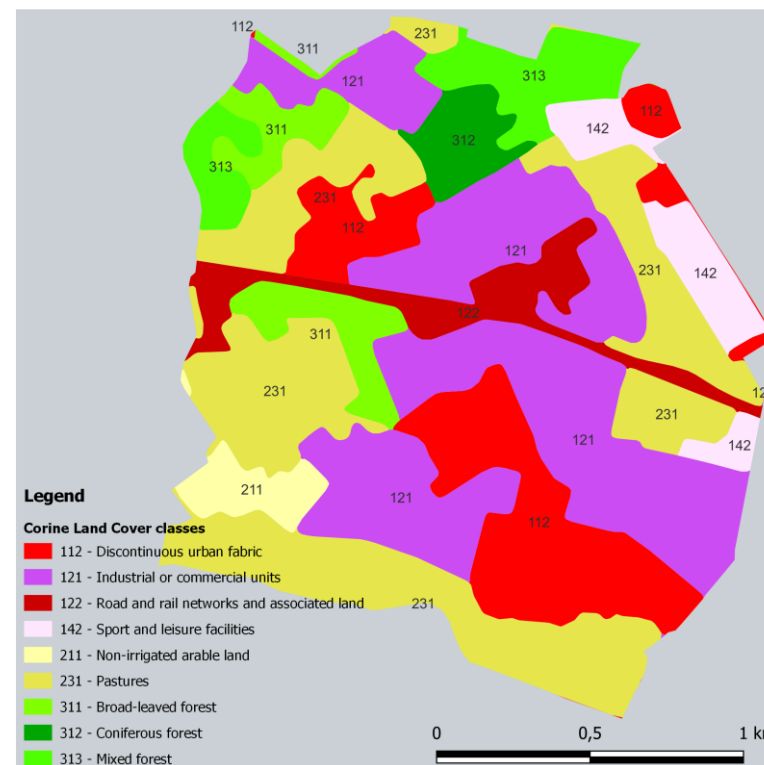
Layers

- landuse ol2018
- Broad-leaved forest
- Coniferous forest
- Continuous urban fabric
- Discontinuous urban fabric
- Dump sites
- Green urban area
- Industrial or commercial units and public fa
- Mixed forest
- Non-irrigated arable land
- Pasture, meadows and other permanent gr
- Port area
- Road and rail networks and associated land
- Sport and leisure facilities
- Water bodies
- Water courses

Coordinate 908321.7011916 Scale 1:21010



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:

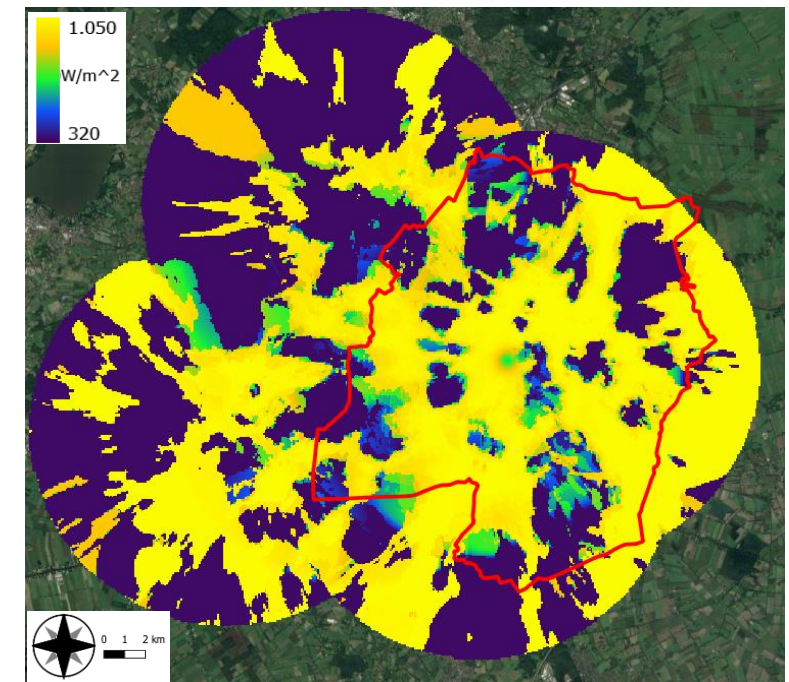
- Global, Diffuse and Direct Irradiation Components (GHI, DNI and DHI)

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





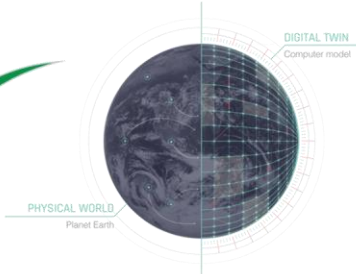
Demonstrator development

Current data input

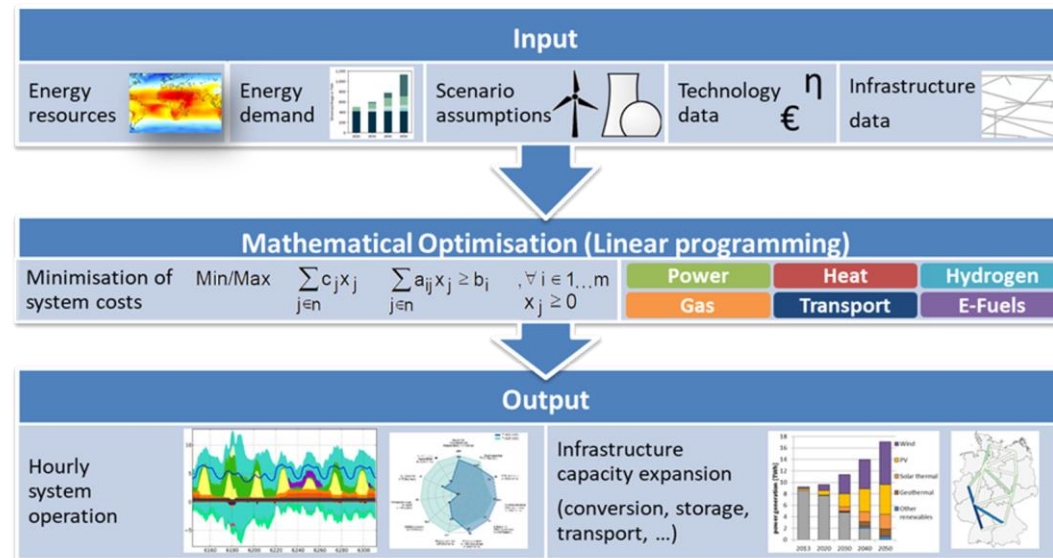


Existing open source databases

Ongoing Implementation



REMix Model

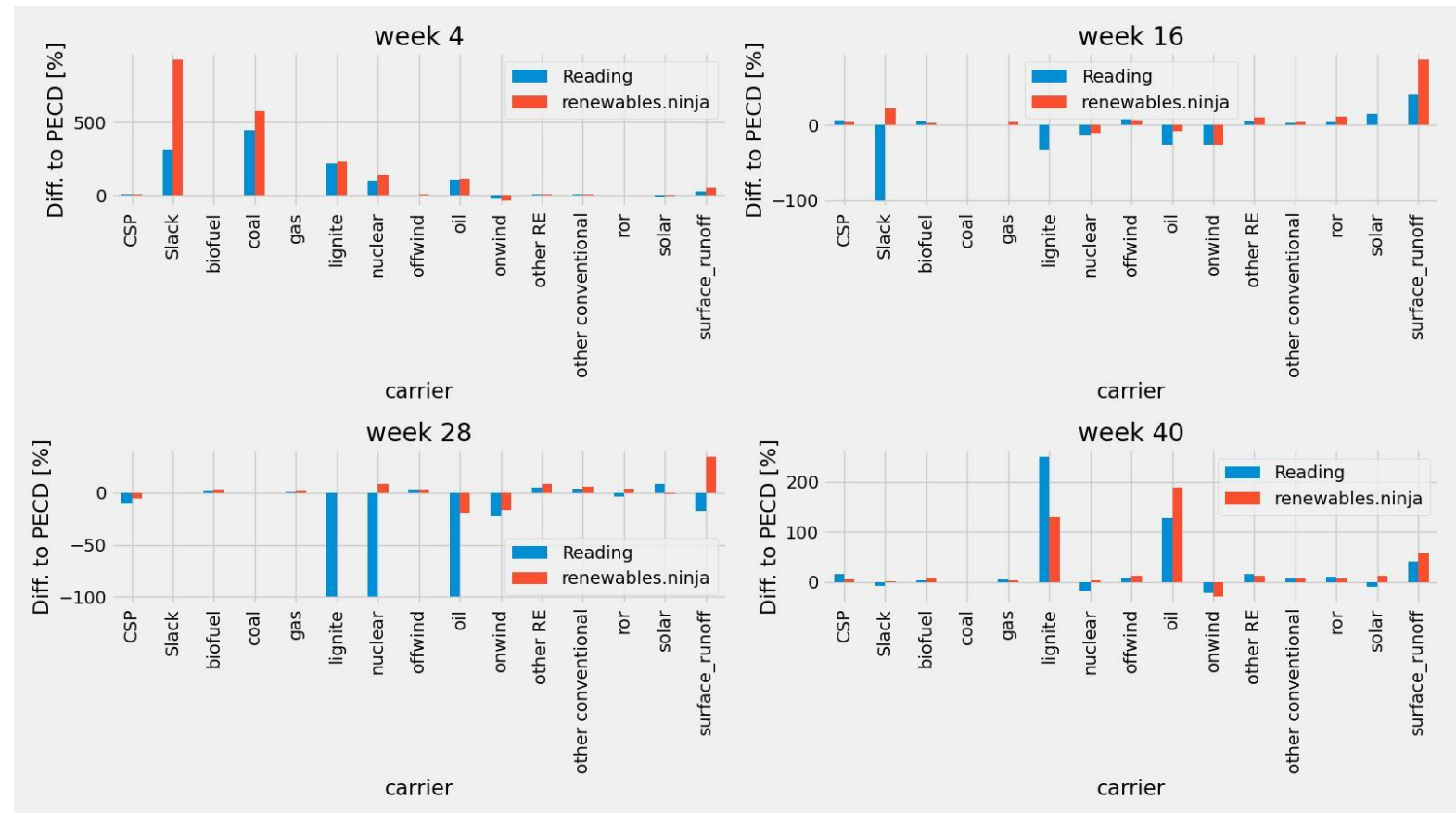




First results

- REMix simulation output based on the Pan-European Market Modeling Data Base¹
- Differences in electricity market clearings of four weeks in 2010 based on Pan-European Climatic Data Base (PECD)¹, University of Reading² and renewable.ninja data³

Differences in electricity dispatch compared to PECD



References: ¹ ENTSO-E: <https://www.entsoe.eu/outlooks/eraa/2022/eraa-downloads/>; ² Bloomfield et al. [2022] <https://doi.org/10.17864/1947.000321>; ³ 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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