Welcome at Fraunhofer ISE

Christoph Kost and Patrick Jürgens
ETSAP Workshop
Freiburg, 23rd May 2022
www.ise.fraunhofer.de
Fraunhofer Institute for Solar Energy Systems ISE
Performing research for the energy transition for over forty years

The Institute in Numbers

Institute Directors:
Prof. Dr. Hans-Martin Henning
Prof. Dr. Andreas Bett

Employees: ca. 1400

Budget 2021:
Operation €104.4 million
Investment €12.3 million
Total €116.7 million

Founded in 1981
Our Business Areas

Photovoltaics
Energy Efficient Buildings
Solar Thermal Power Plants and Industrial Processes
Hydrogen Technologies and Electrical Energy Storage
Power Electronics, Grids and Smart Systems
Reserach Group Energy Systems and Energy Economics
Head of Group: Dr. Christoph Kost

Transformation and decarbonization analyses

Sector coupling issues
- Processes, buildings (e.g. WP), traffic (e.g. electromobility)
- Multiple technologies are optimized separately
- Detailed integration of sector coupling effects

Coupled expansion planning for infrastructure measures in GER/EU systems,
- storage, power plants (aggregation of data from EE)
- Gas grids, electricity grids, hydrogen

Market integration and system
- optimization of local/decentralized energy systems, properties and districts
Model based Energy System Analysis by Fraunhofer ISE
Models for our services

- Energy System Model (National Level)
  REMod
- Energy System model & Market Integration
  (Regional/Unit Level)
  DISTRICT
- Investment Decision Model
  (National Level)
  E2S
- Power System Model
  (National Level)
  ENTIGRIS
- Energy and City Model
  (Municipal/City Level)
  KomMod
- Grid Models
  Load Flow Analysis
  Distribution Grid Planning
  Power System Operation Control
Regionalization of the integrated sector coupled energy system model REMod

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Regionalization of the integrated sector coupled energy system model REMod

Agenda

1. Sector coupling in the model REMod
2. Optimization Results
3. Regionalization: Energy Exchange Function
4. Outlook: REMod-EU
Sector coupling in the model REMod

Modeling approach and scope

Geographical scope
- Germany as one node

Conversion and consumption sectors
- Inclusion of all consumption sectors
- Multiple technologies are optimized separately
- Detailed integration of sector coupling effects

Optimization
- Minimization of transformation costs
- Non-linear „Black box“ optimization of realistic simulation

Time resolution
- Simulation on hourly basis
- Including historic timeseries (demand, weather) of five years
- Optimization of transformation on yearly basis
Optimization Results

Transformation path of technologies – renewable energy sources

![Graph showing the transformation path of technologies with renewable energy sources from 2020 to 2045. The installed capacity for different energy sources is indicated for each year. The graph includes bars for Wind Offshore, PV-Open space, PV-Roof (South), Wind Onshore, and PV-Roof (East-West).]
Optimization Results
Transformation path of technologies – industry sector
Optimization Results
Transformation path of technologies – buildings sector
Optimization Results
Transformation path of technologies – transportation sector
First energy system model for all sectors on state level

Current Model
- Germany as one node
- Assumption: energy is available at any place

Regionalized Model
- Multi-node: each region simulated separately
- Simulated energy-exchange between regions
- Optimization of electricity grid and gas network
Regionalization: Simulation with Energy Exchange Function

- Calculate residual load
- Exchange between regions
- (dis)charging of energy storage
- Exchange between regions
- Flexible power plants
- Exchange between regions
- Im/export and load balancing

balance neighbouring region

balance neighbouring region
Outlook: REMod-EU

Modeling approach and scope

Data
- Development of database
- Coupling to models: renewables.ninja, GlobalEnergyGIS.jl, ...
- Coupling of public Databases: Energy-Charts, Entso-E, Eurostat, ...

Optimization and Calculation Effort
- Parallelization
- Adjust optimization algorithm
- Flexible reduction of optimization variables

Scenario Analysis
- European Green Deal & Effort Sharing
- Network Expansion (Electricity, Gas, H2)
- Role of Technologies (e.g. Nuclear, Gas)
Thank You for Your Attention!

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Thank You for Your Attention!

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