Energy System Modelling and Energy Justice - Incompatible Concepts?

Session 3: Oemof-Tutorial

Workshop @ Meccanica Feminale,
Stuttgart, 18.02 – 20.2.2025

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Workshop Sessions

Day 1: Introduction to Energy Modelling			
10:00	11:30	Session 1	Basics of Energy Modelling
14:00	15:30	Session 2	Open Energy Models
16:00	17:30	Session 3	Oemof-Tutorial

Day 2: Introduction to Justice Concepts			
8:30	10:00	Session 4	Social aspects of energy systems
10:30	12:00	Session 5	Justice in energy systems
14:00	15:30	Session 6	Case Studies Development

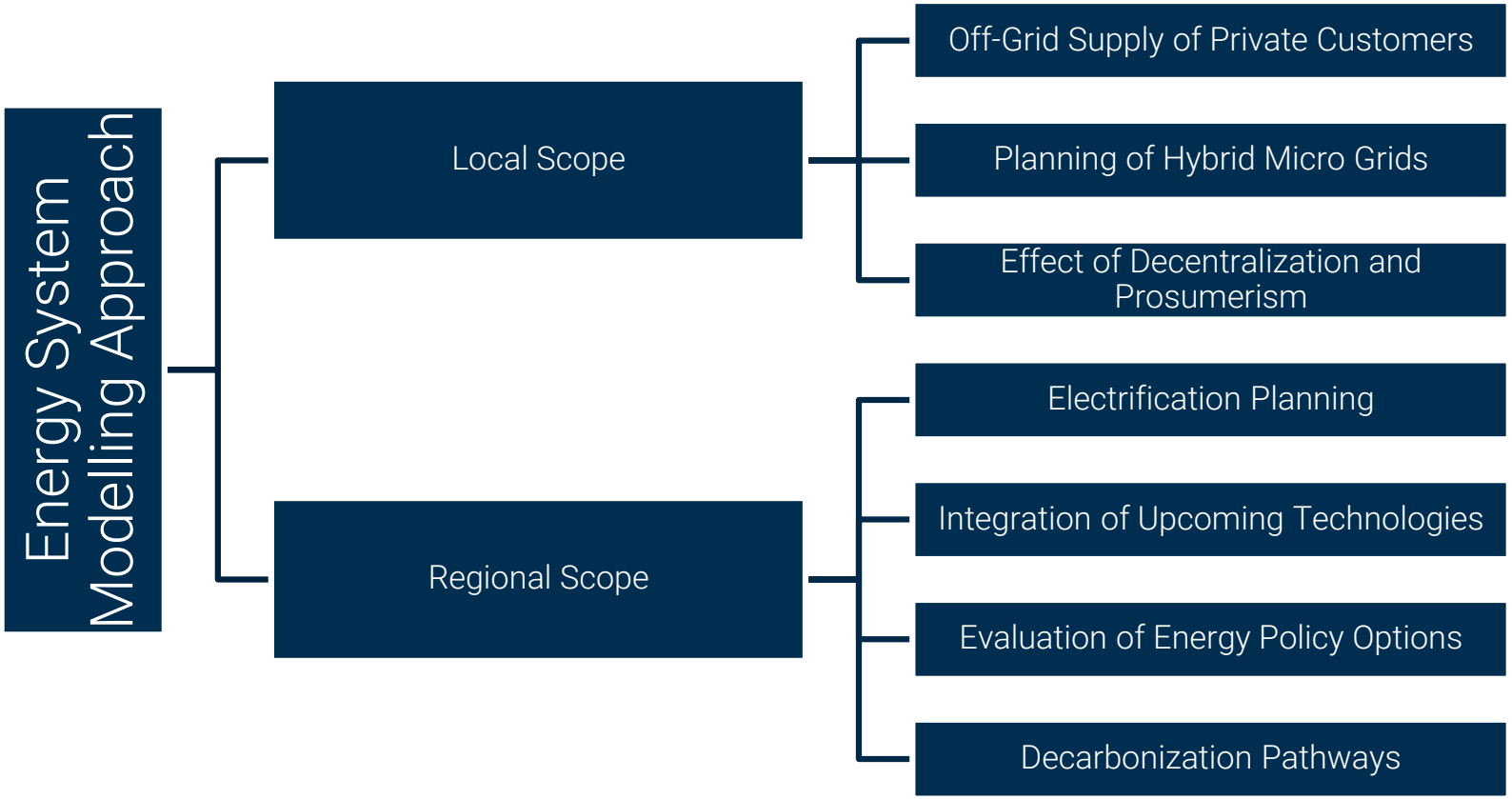
Day 3: Co-Creation at the Intersection of Energy Modelling & Justice			
8:30	10:00	Session 7	Group Work on Case Studies
10:30	12:00	Session 8	Discussion of Case Studies

Repetition: Questions regarding sessions

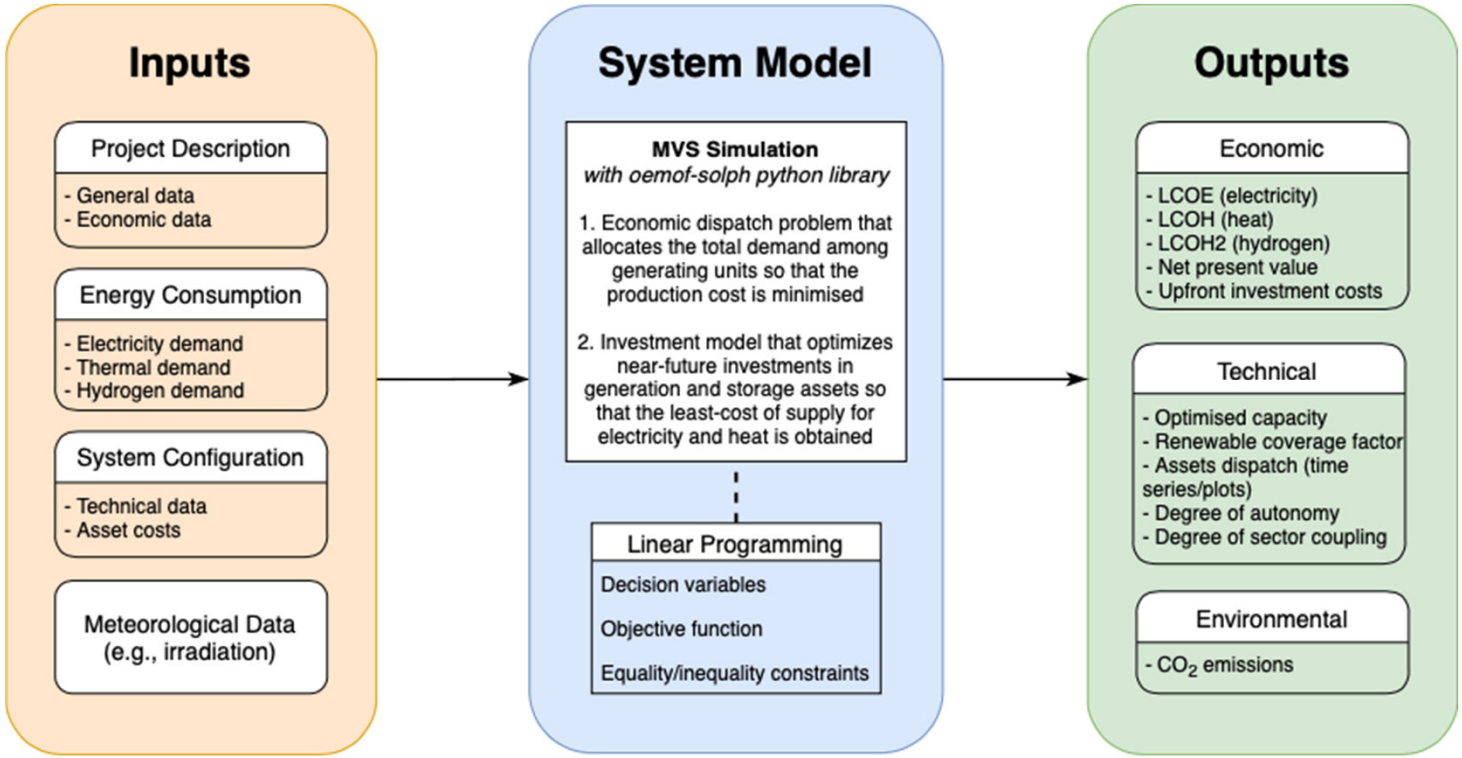
- Which of the energy modelling applications was most interesting for you?
- What are necessary inputs and where can you get them?

Open Questions?

Application of ESM - Overview



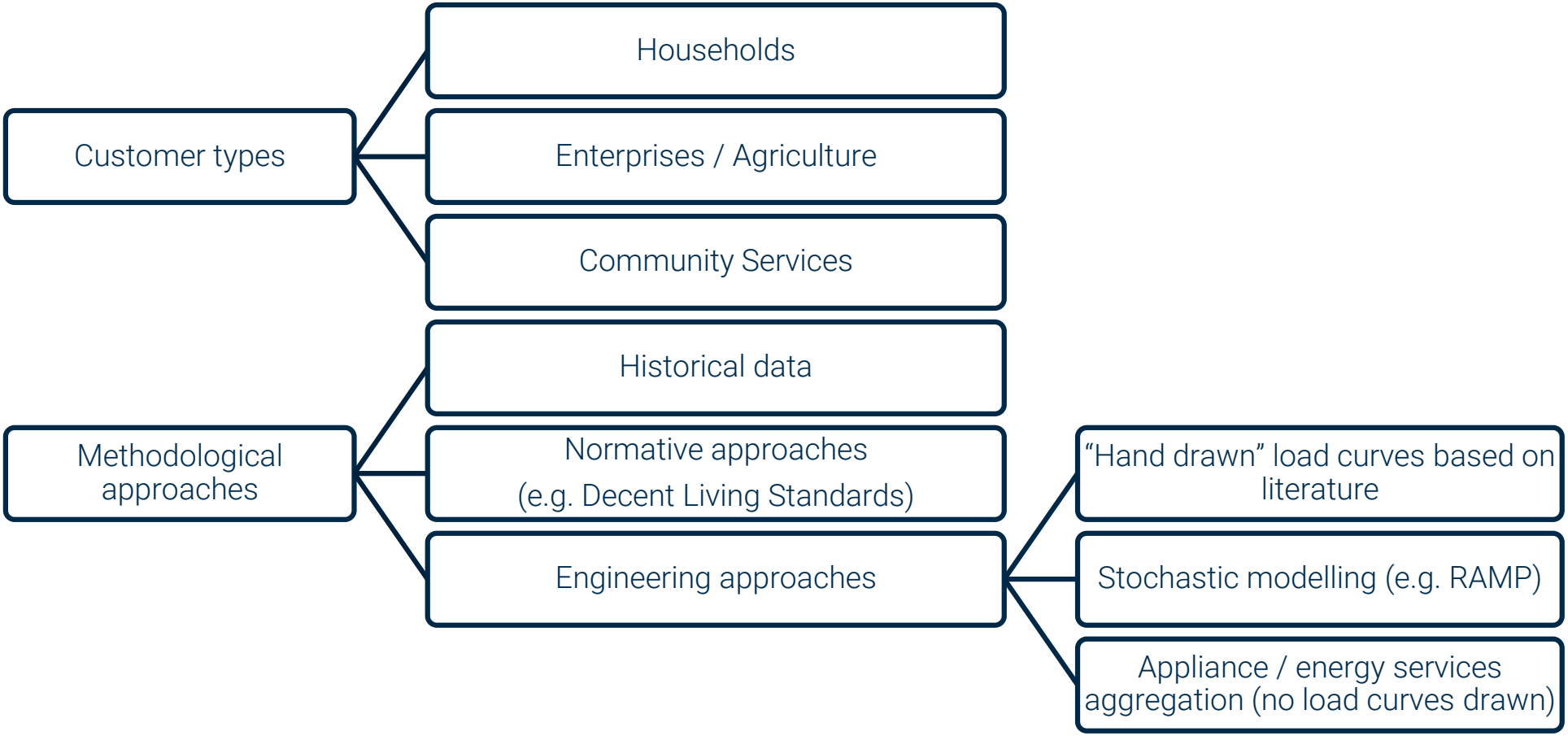
Generalizable Model Steps



Github reprository of the MVS: https://github.com/rl-institut/multi-vector-simulator

Manual of the MVS: https://multi-vector-simulator.readthedocs.io

Demand estimation approaches



Supporting colloborative development: GitHub

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- Version control solution
  - History of changes
  - Reasoning behind changes
  - Public availability (can be disabled)
  - Authors
- Enables colloboration on programming projects
  - Discussion of issues
  - Validating proposed changes
  - Rights management
  - Projekt management

Further reading:
(1) Github: https://github.com/

Programming software: Python and Pycharm

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- Install python via miniconda:
  - https://docs.conda.io/en/latest/miniconda.html
- Pycharm...
  - Is a GUI for programming
  - Can process, validate and highlight many file and programming styles
  - Includes file versioning and git features
  - Install from: /https://www.jetbrains.com/pycharm/download
- Make sure you have Git installed, https://git-scm.com/book/en/v2/Getting-Started-Installing-Git or via Pycharm

Logo from: JetBrains - https://www.jetbrains.com/company/press/, Gemeinfrei, https://commons.wikimedia.org/w/index.php?curid=53185677

Installation of cbc-solver on Windows (I)

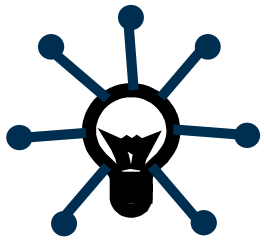
- Recommended solver for oemof is Cbc (Coin-or branch and cut): https://projects.coin-or.org/Cbc
- Download cbc-solver:
  - 64bit: http://ampl.com/dl/open/cbc/cbc-win64.zip
  - 32bit: http://ampl.com/dl/open/cbc/cbc-win32.zip
- Unzip into chosen path

  →Place into your pycharm project folder (for the quick training purpose)

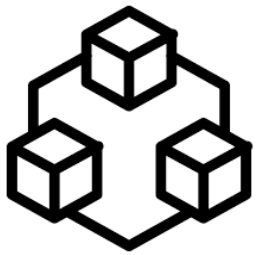
  →For future use you can also place it under system variables, as described here https://offgridders.readthedocs.io/en/latest/Installation.html

What is the main idea behind *oemof*?

- Collaborative, public development
- Recycling and expansion of existing models
- Modular structure with defined interfaces to correlate other approaches/packages
- Improved review process by the community



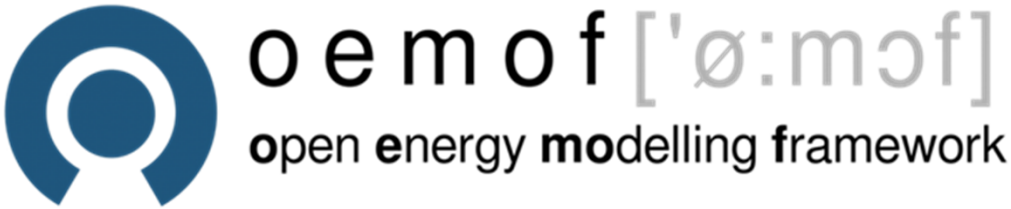
collaborative



modular

open source

What is the main idea behind *oemof*?



- Is a community-driven open-Source modelling framework initiated by:

ZNES Zentrum für nachhaltige Energiesysteme Hochschule | Europa-Universität Flensburg

RLI Reiner Lemoine Institut

Otto von Guericke Universität Magdeburg

- Python packages specifically developed for energy system modelling
- Model individual requirements/aspects in research projects

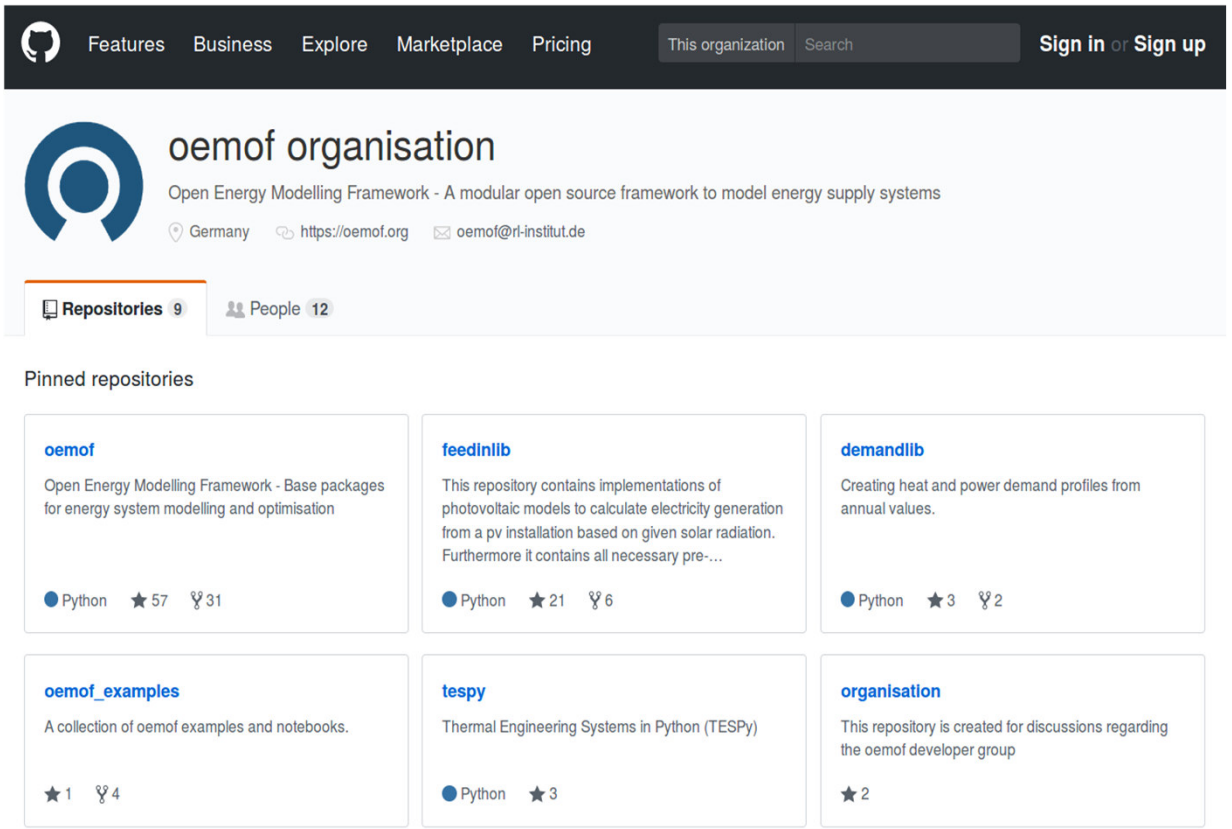
Further reading:
(1) Hilpert S, Kaldemeyer C, Krien U, Günther S, Wingenbach C, Plessmann G (2018) The open energy modelling framework (oemof)—a new approach to facilitate open science in energy system modelling. Energy Strategy Rev 22:16–25

oemof projects at RLI

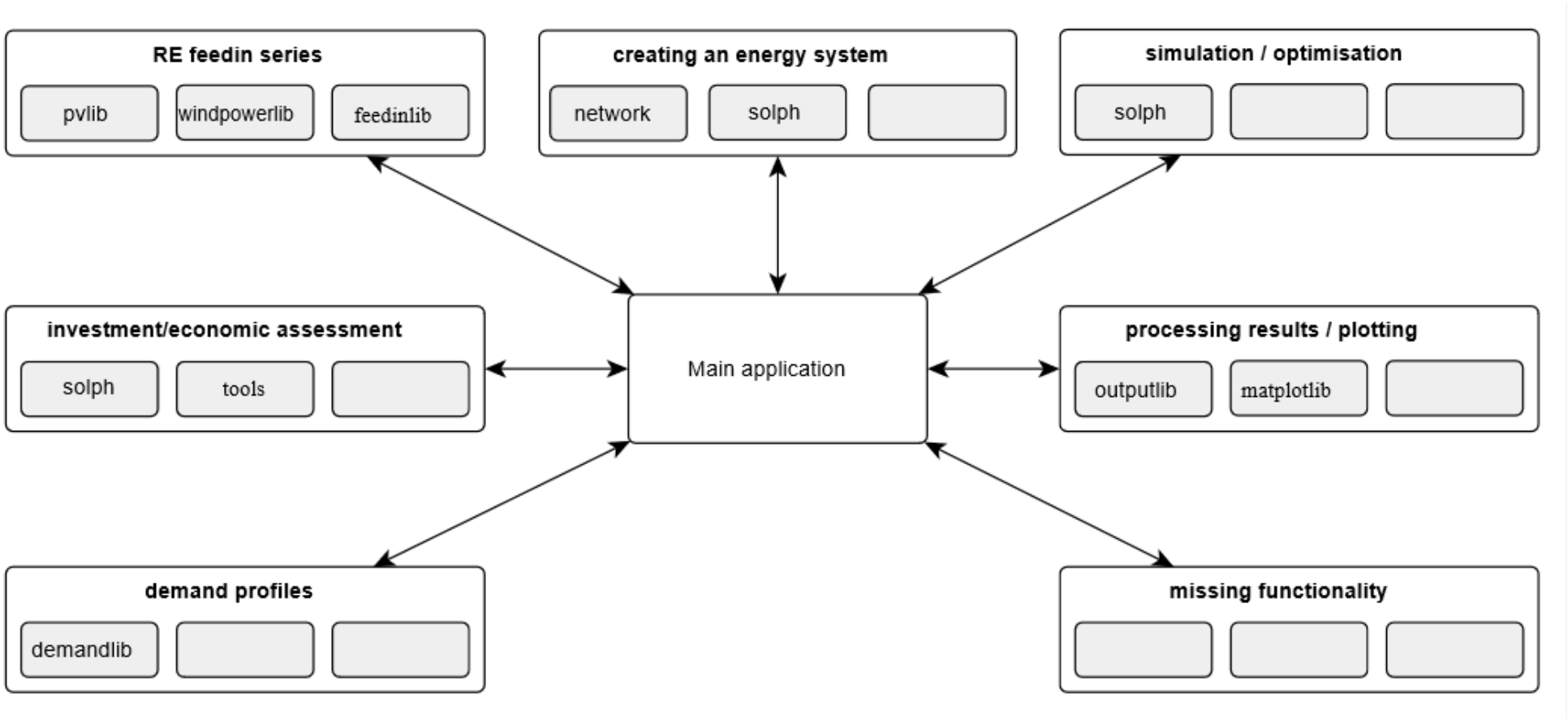
- Research projects
  - Publicly funded by EU, BMWI, BMWF
- Research studies
- Contract work
  - Model development
  - Workshops
  - Web-applications
- General oemof uses: https://oemof.org/projects/

Github reprositories of oemof

- Oemof toolbox on github: https://github.com/oemof



Package structure



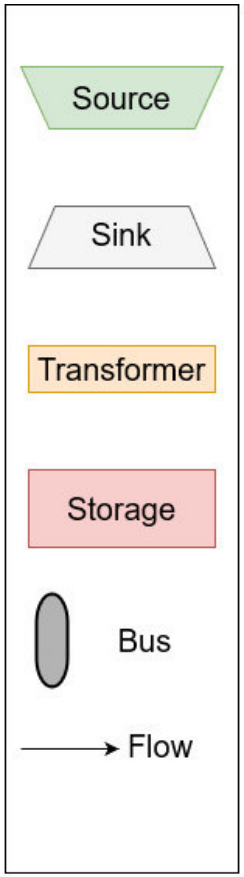
Packages of *oemof*

- *oemof-solph* – Energy model generator
- *TESPy* – Modelling of thermal engineering systems
- *feedinlib* – PV potential
- *demandlib* – Head and power demand profiles
- *oemof-thermal* – Thermal energy components
- *DHNx* – District heating optimization
- *cydets* – Cycle detection
- …and some more programming-related packages

Further reading:
(1) Oemof repositories: https://github.com/orgs/oemof/repositories?q=&type=&language=&sort=stargazers

Component models of *oemof-solph*

- Basic components:
  - Sink
  - Source
  - Transformer
  - Storage
  - Bus
- Advanced components:
  - Thermal storage
  - CHP (Combined Heat and Power)
  - Heat pump
  - Generator with efficiency curve



Objective Function of *oemof-solph*

- Optimization goal: Minimize annual energy supply costs
  - Decision variables: Asset capacities and their dispatch

Costs of components

Costs of dispatch

$$min \sum_{i} \left(Capex(i) * CRF(i) + Opex_{fix}(i) \right) * P_{inst}(i) + \sum_{i} \sum_{t} Opex_{var}(i) * E_{gen}(i,t)$$

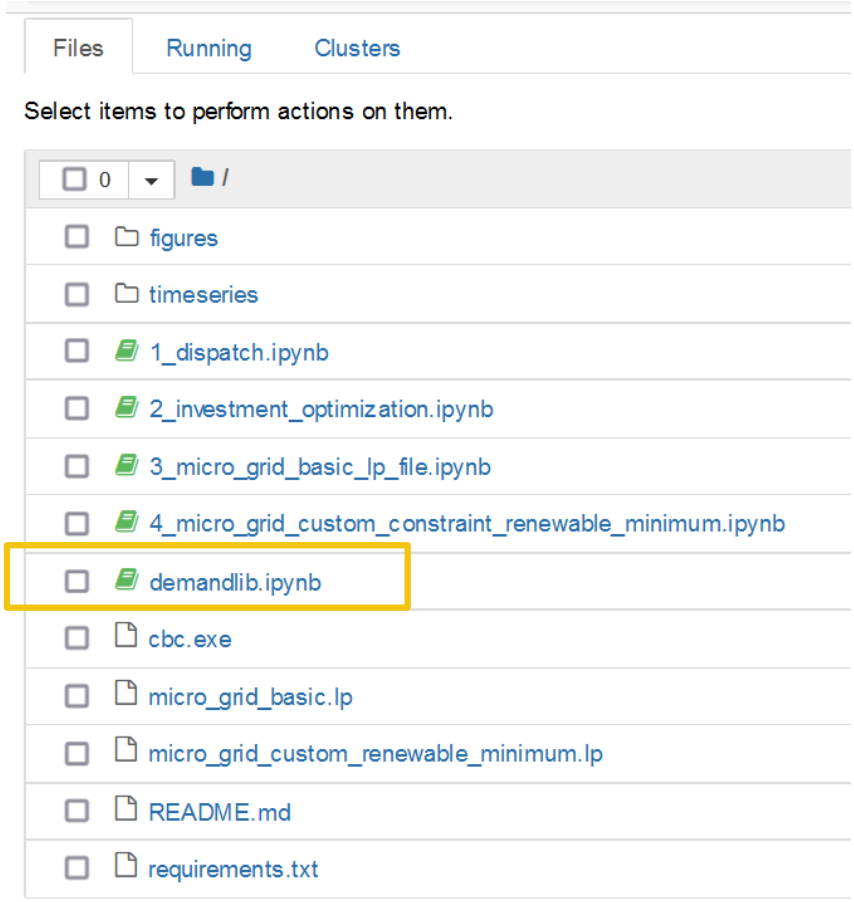
$$i \in \{WEA, PV, BHKW, Speicher\}$$
$$t \in \{1...8760\}$$

Capex	Capital expenditure	EUR/kW
CRF	Capital recovery factor	-
$Opex_{fix}$	Fixed operational expenditure	EUR/(kW*a)
$Opex_{var}$	Variable operational expenditure	EUR/kWh
P_{inst}	Capacity of component	kW
E_{gen}	Generated electricity per timestep	kWh
i	Index of system components	-
t	Index of time steps	-

Limitations

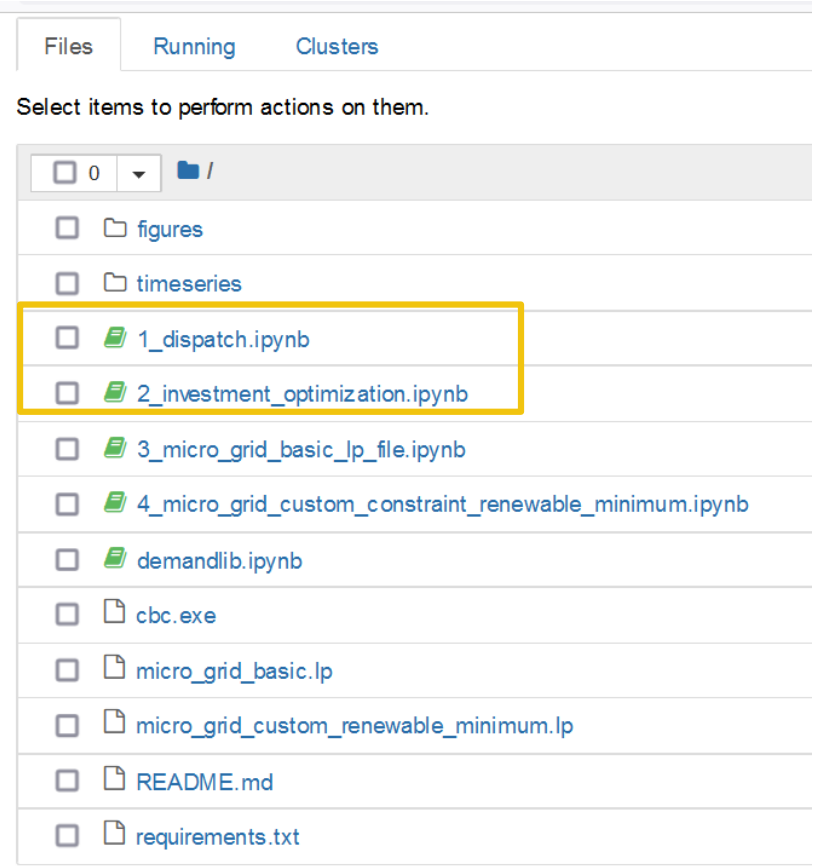
- Component models limited to linear representations
  - No generator efficiency curve
  - No charging efficiency dependent on SOC
- Assuming that the system operation constant over project lifetime
  - Replacing pre-existing capacity as they exist (brownfield)
  - No price changes (fuel, investment cost) included
  - No degradation of efficiencies over the lifetime
- Perfect foresight
- No power flow analysis

Excercise: Demand profiles with demandlib



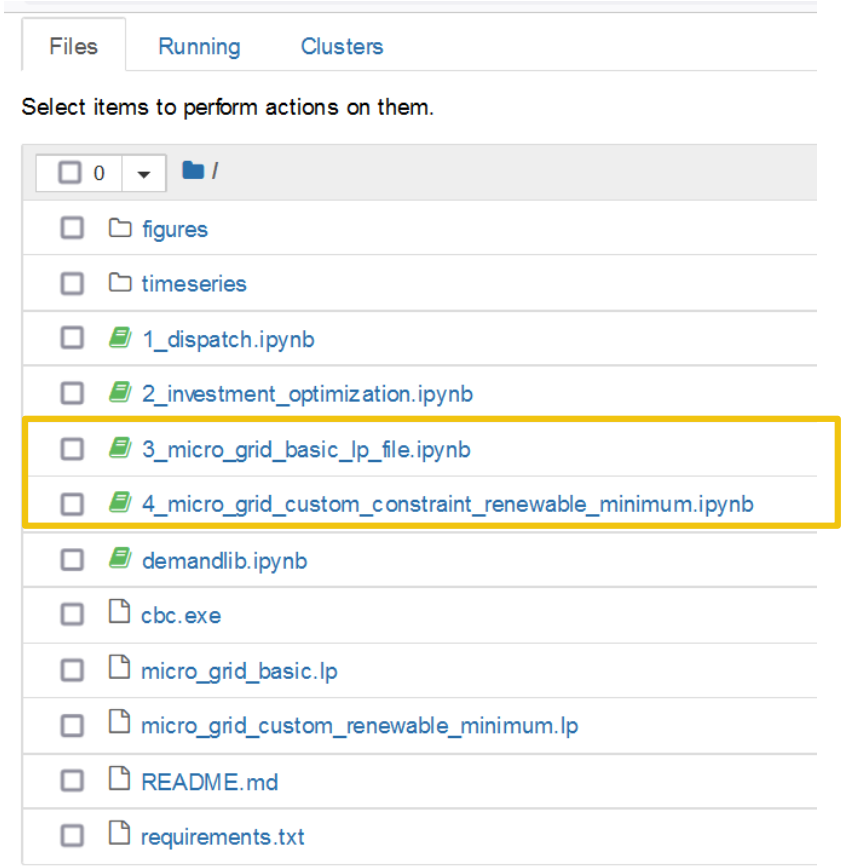
Open Questions?

Excercise: Oemof – Dispatch and Capacity Optimization



Open Questions?

Excercise: Oemof – Linear Equation System



Open Questions?

Learnig Outcomes of this Session

- Oemof packages, oemof.solph
- Objective function
- Limitations

Thank you for your participation ☺

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