

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

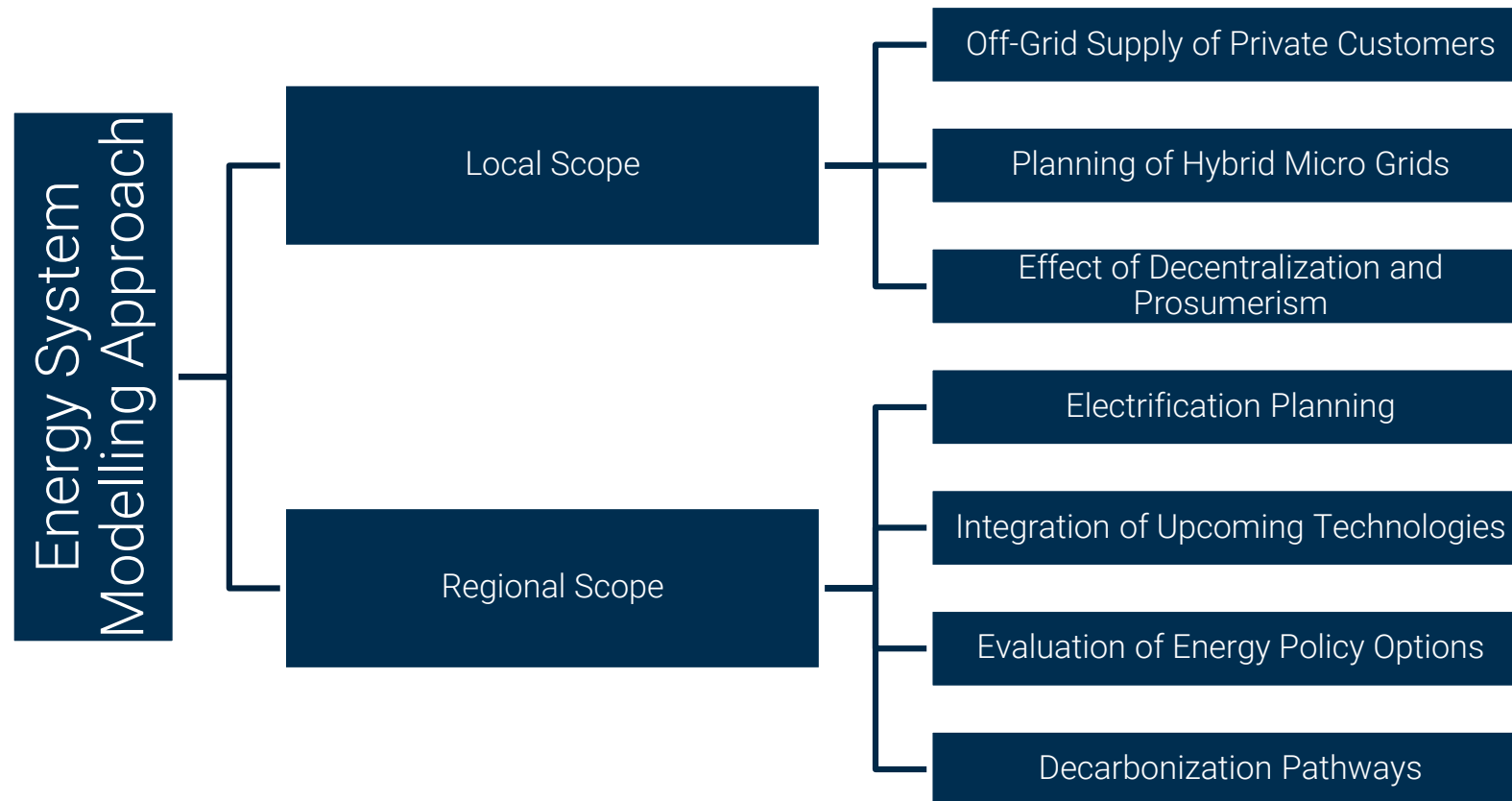
Repetition: Questions regarding sessions

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

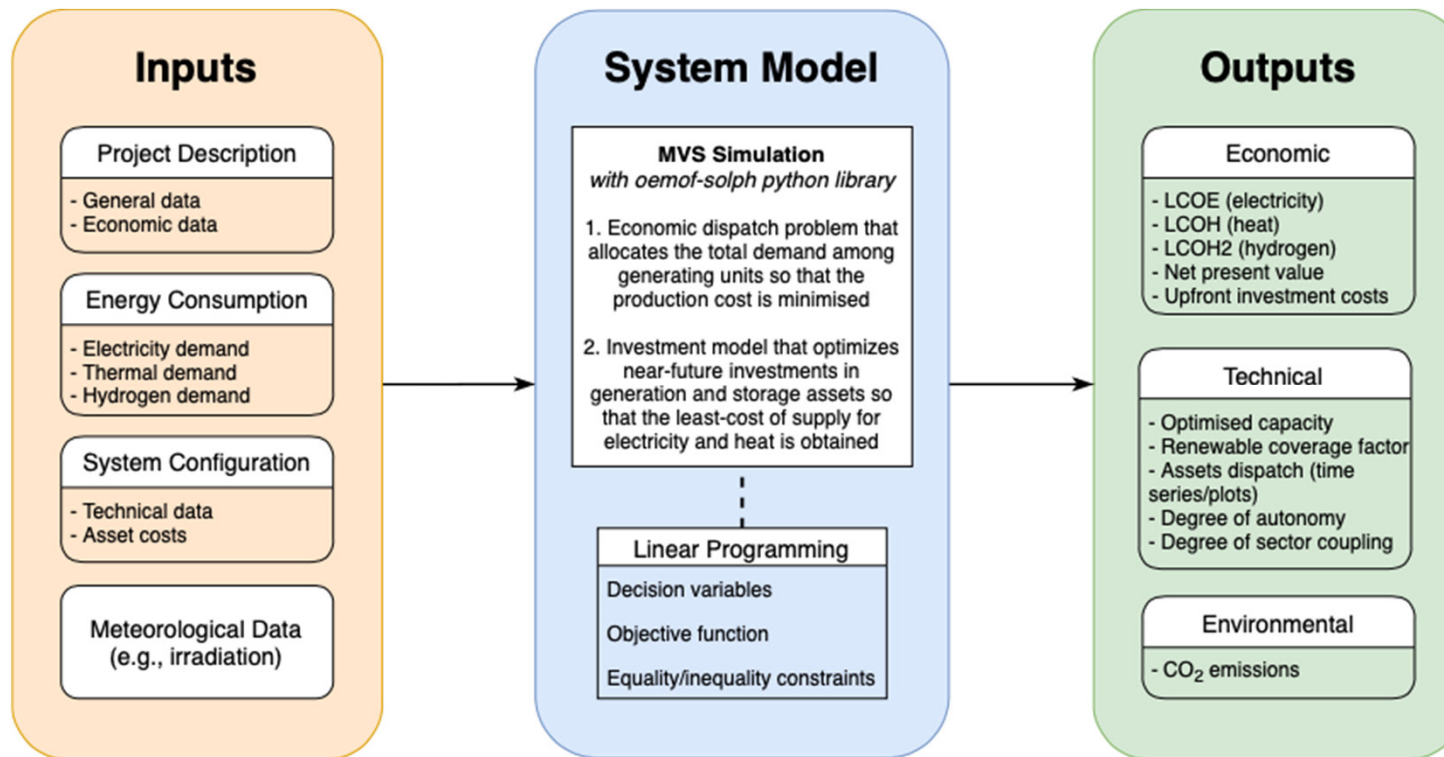


Open Questions?

Application of ESM - Overview



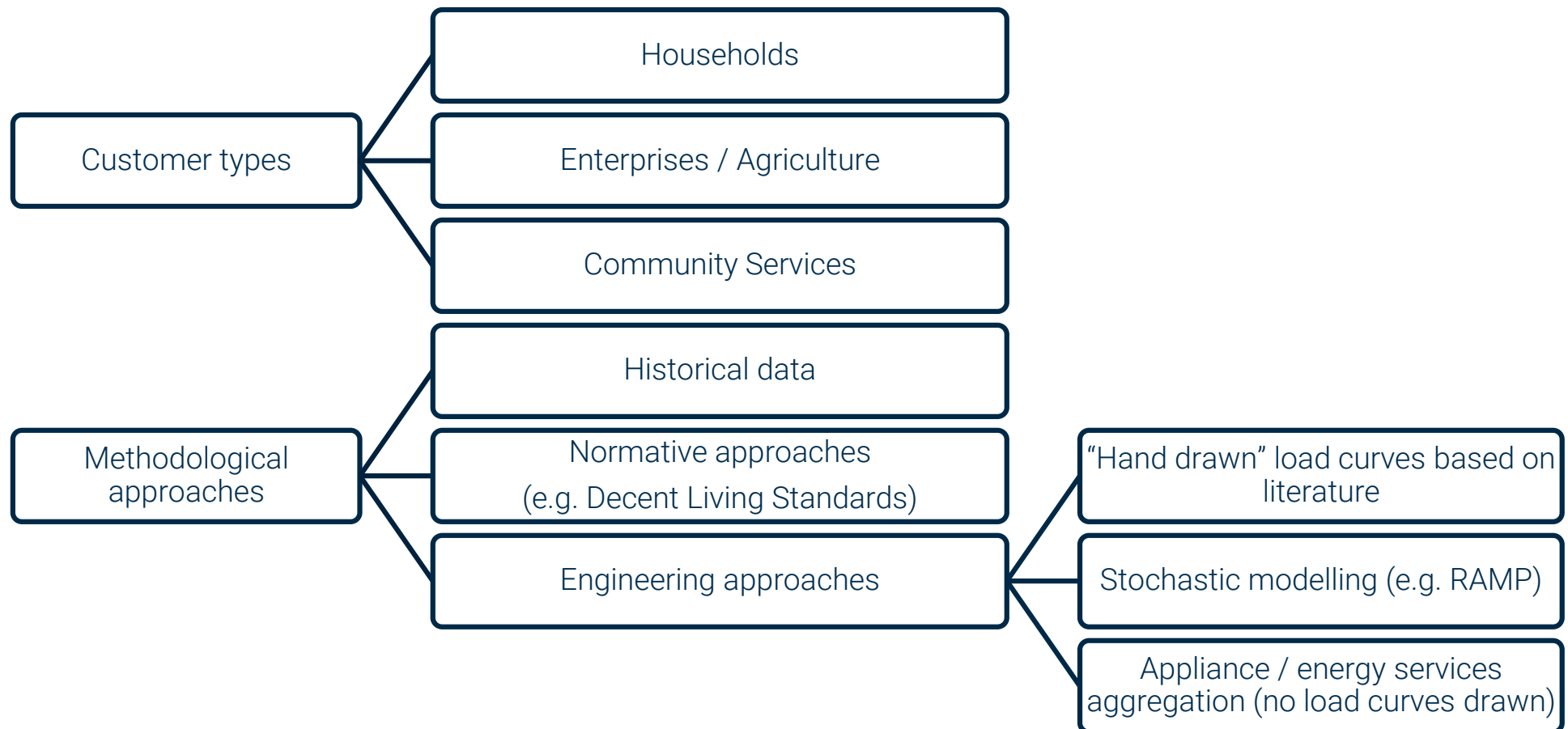
Generalizable Model Steps



Github repository 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 collaborative development: GitHub

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



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Further reading:

(1) Github: <https://github.com/>

Programming software: Python and Pycharm

- 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



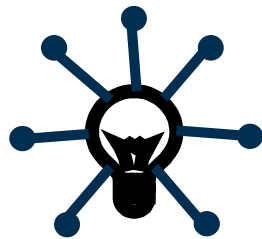
Logo from: JetBrains -
<https://www.jetbrains.com/company/press/>, Gemeinfrei,
<https://commons.wikimedia.org/w/index.php?curid=5318567>
7

Installation of cbc-solver on Windows (I)

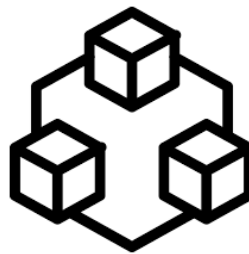
- Recommended solver for oemof is Cbc (Coin-or branch and cut): <https://projects.coin-or.org/Cbc>
- Download cbc-solver:
 - 64bit: <http://ampl.com/dl/open/cbc/cbc-win64.zip>
 - 32bit: <http://ampl.com/dl/open/cbc/cbc-win32.zip>
- Unzip into chosen path
 - Place into your pycharm project folder (for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

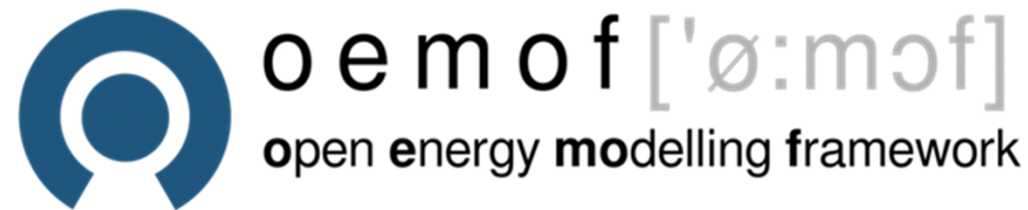


modular



open source

What is the main idea behind *oemof*?



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



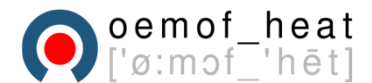
- ▶ Python packages specifically developed for energy system modelling
- ▶ Model individual requirements/aspects in research projects

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/>



Gefördert durch:



Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages



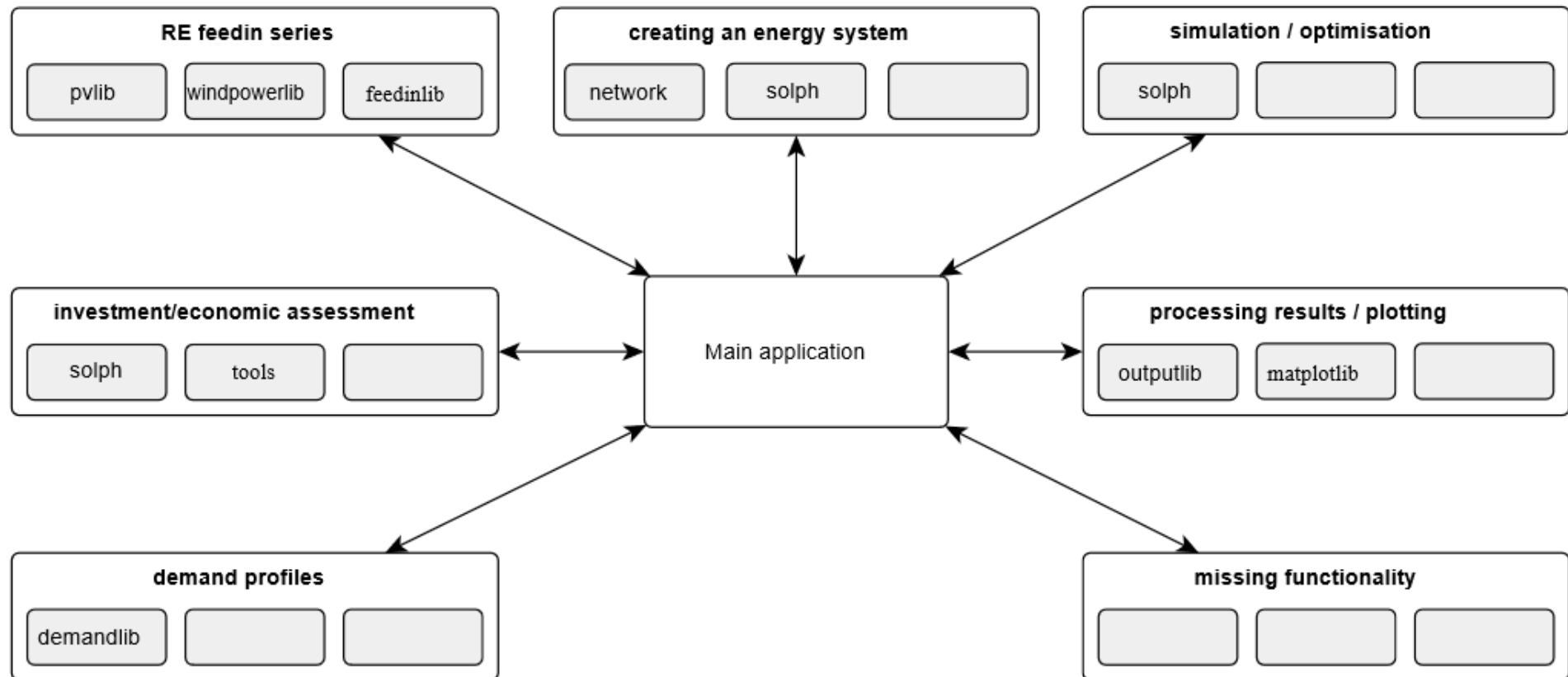
Github repositories of oemof

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

The screenshot shows the GitHub profile of the 'oemof organisation'. The header includes navigation links like 'Features', 'Business', 'Explore', 'Marketplace', and 'Pricing', along with a search bar and 'Sign in' or 'Sign up' buttons. The profile section displays the 'oemof organisation' name, a description 'Open Energy Modelling Framework - A modular open source framework to model energy supply systems', location 'Germany', website 'https://oemof.org', and email 'oemof@rl-institut.de'. Below this, it shows '9 Repositories' and '12 People'. The 'Pinned repositories' section lists six repositories:

Repository Name	Description	Language	Stars	Forks
oemof	Open Energy Modelling Framework - Base packages for energy system modelling and optimisation	Python	57	31
feedinlib	This repository contains implementations of photovoltaic models to calculate electricity generation from a pv installation based on given solar radiation. Furthermore it contains all necessary pre-...	Python	21	6
demandlib	Creating heat and power demand profiles from annual values.	Python	3	2
oemof_examples	A collection of oemof examples and notebooks.		1	4
tespy	Thermal Engineering Systems in Python (TESPy)	Python	3	
organisation	This repository is created for discussions regarding the oemof developer group		2	

Package structure



Packages of *oemof*

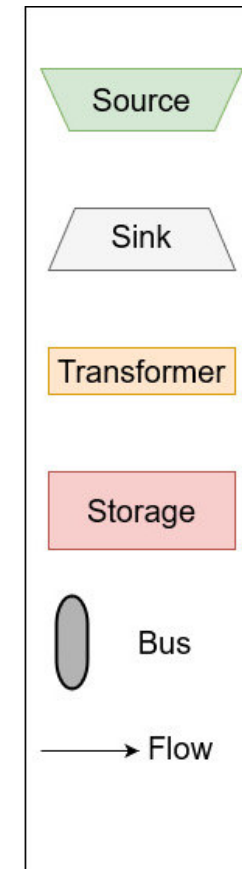
- *oemof-solph* – Energy model generator
- *TESPy* – Modelling of thermal engineering systems
- *feedinlib* – PV potential
- *demandlib* – Head and power demand profiles
- *oemof-thermal* – Thermal energy components
- *DHNx* – District heating optimization
- *cydets* – Cycle detection
- ...and some more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

$$\min \sum_i \left(\overbrace{Capex(i) * CRF(i) + Opex_{fix}(i)}^{\text{Costs of components}} \right) * P_{inst}(i) + \sum_i \sum_t \overbrace{Opex_{var}(i) * E_{gen}(i,t)}^{\text{Costs of dispatch}}$$

$i \in \{WEA, PV, BHKW, Speicher\}$

$t \in \{1...8760\}$

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

Files Running Clusters

Select items to perform actions on them.

☐ 0 ▾

/

- ☐ figures
- ☐ timeseries
- ☐ 1_dispatch.ipynb
- ☐ 2_investment_optimization.ipynb
- ☐ 3_micro_grid_basic_lp_file.ipynb
- ☐ 4_micro_grid_custom_constraint_renewable_minimum.ipynb
- ☐ demandlib.ipynb
- ☐ cbc.exe
- ☐ micro_grid_basic.lp
- ☐ micro_grid_custom_renewable_minimum.lp
- ☐ README.md
- ☐ requirements.txt



Open Questions?

Exercise: Oemof – Dispatch and Capacity Optimization


Files


Running


Clusters


Select items to perform actions on them.


☐ 0 ▾


 /


☐  figures


☐  timeseries


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☐  2_investment_optimization.ipynb


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☐  4_micro_grid_custom_constraint_renewable_minimum.ipynb


☐  demandlib.ipynb

☐  cbc.exe

☐  micro_grid_basic.lp

☐  micro_grid_custom_renewable_minimum.lp

☐  README.md

☐  requirements.txt



Open Questions?

Excercise: Oemof – Linear Equation System


Files













Running

Clusters

Select items to perform actions on them.

☐ 0 ▾

 /

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- ☐  README.md
- ☐  requirements.txt



Open Questions?

Learnig Outcomes of this Session

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



Thank you for your participation 😊



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