Oemof
Workshop Week

Basics

Martha Hoffmann

Session I

RLI, 16.09.2019

© Reiner Lemoine Institut

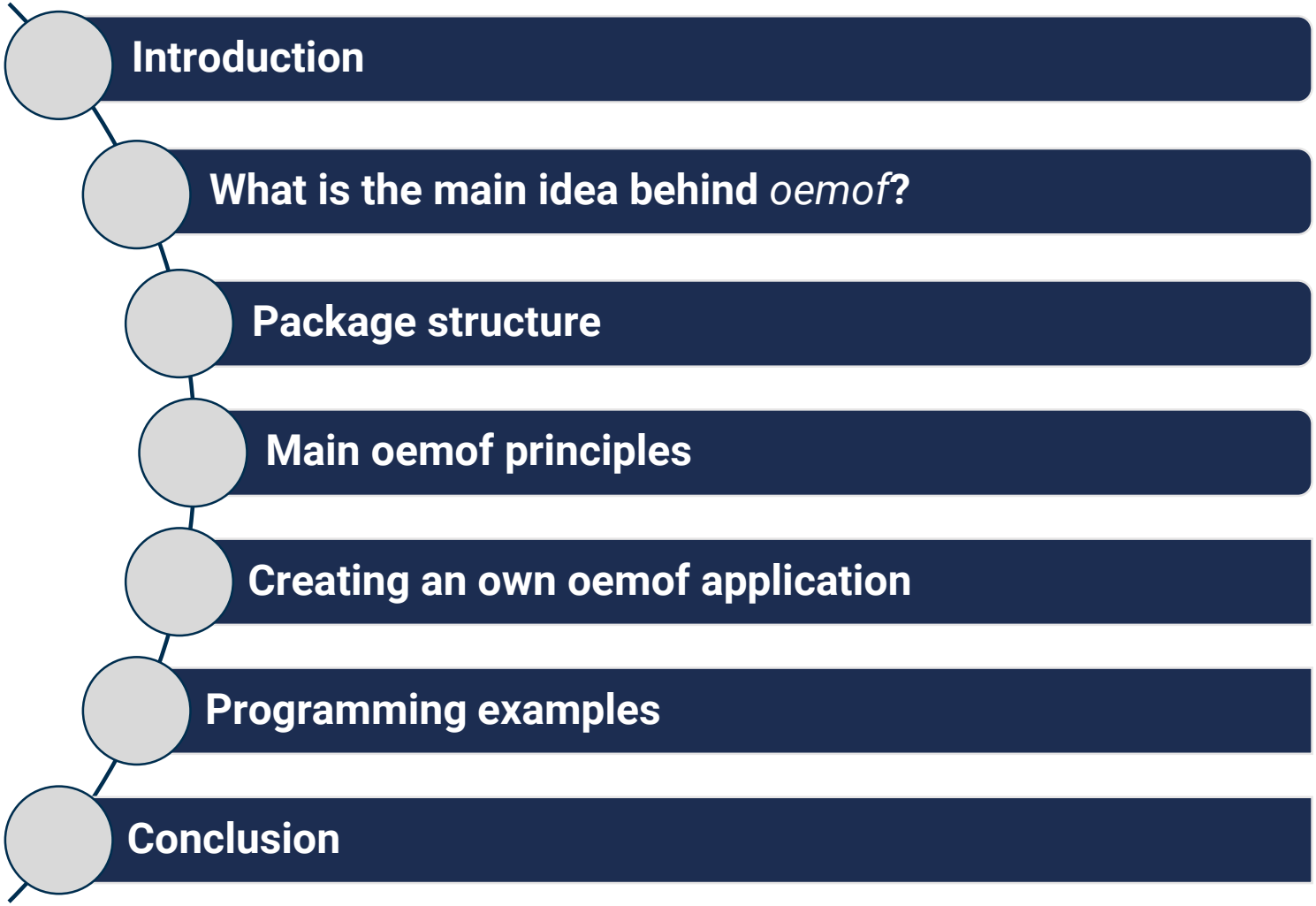
Aim of this session

REINER LEMOINE INSTITUT

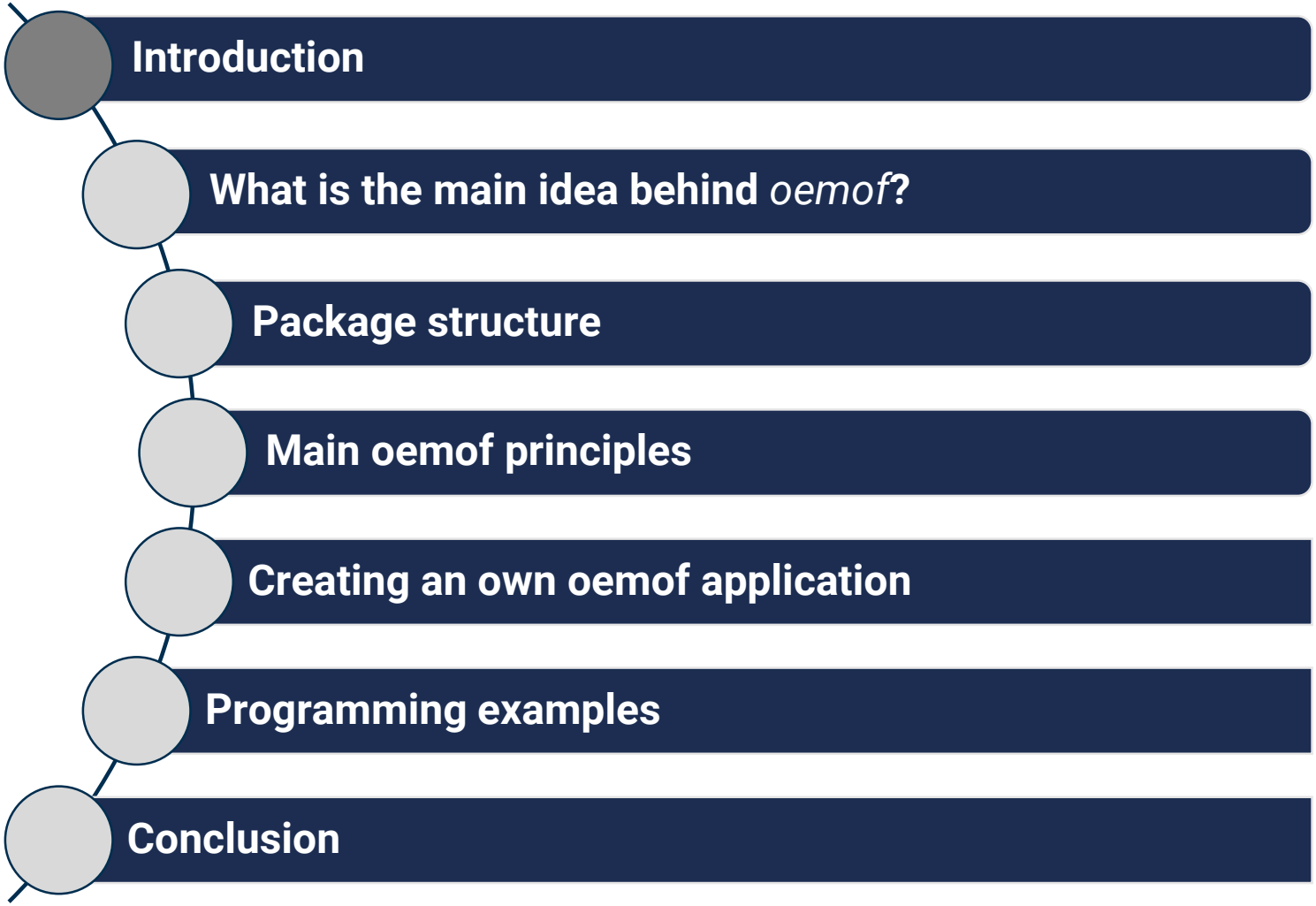
Theoretical and practical introduction to using oemof

All workshop contents at: https://github.com/smartie2076/oemof_workshop

Agenda


Introduction
What is the main idea behind *oemof*?
Package structure
Main oemof principles
Creating an own oemof application
Programming examples
Conclusion

Agenda

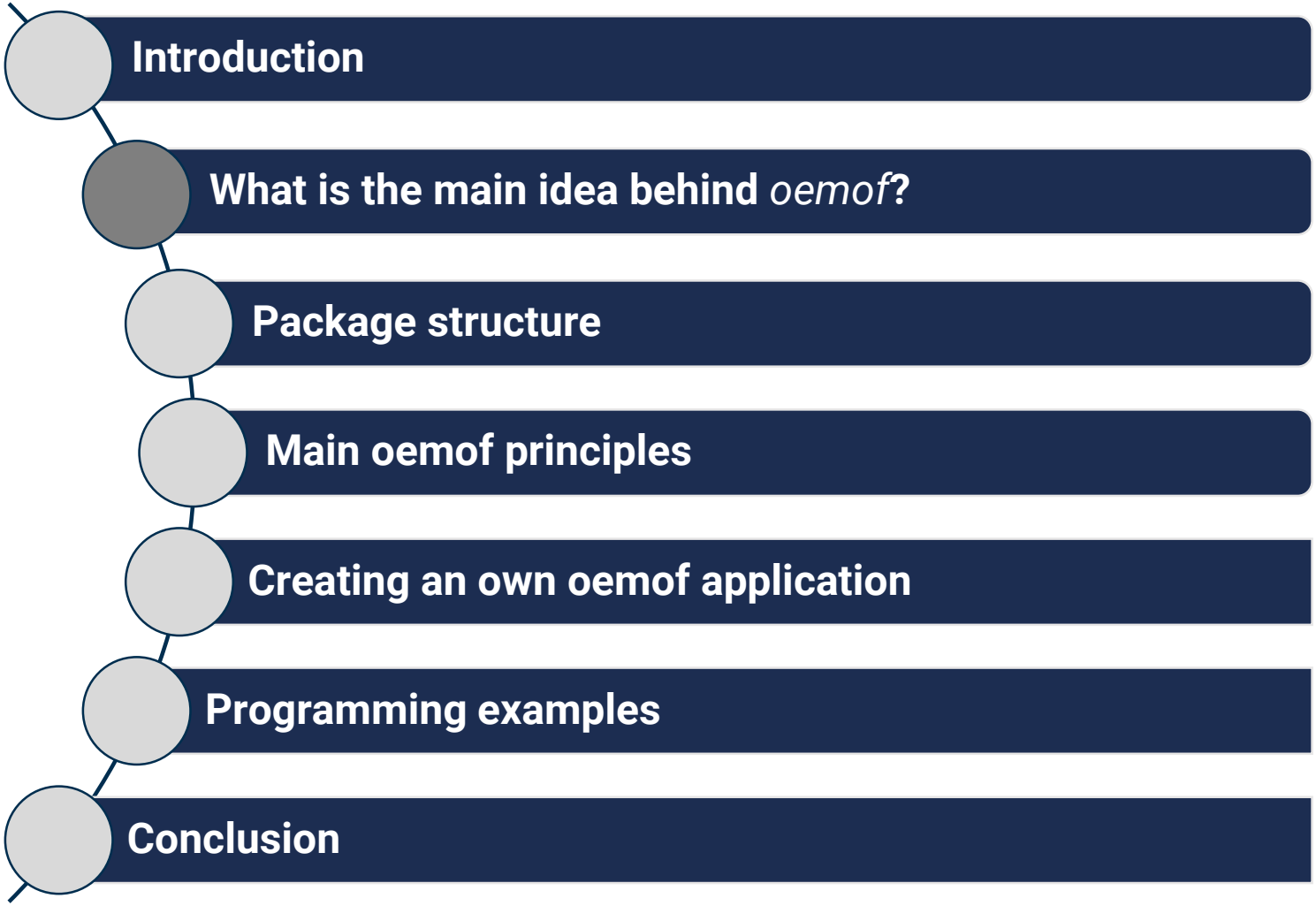

Introduction
What is the main idea behind *oemof*?
Package structure
Main oemof principles
Creating an own oemof application
Programming examples
Conclusion

Motivation for open source tools

Open source software is crucial to …

- meet scientific standards in software based research
- foster bottom-up approaches by reducing barriers associated with high license cost of proprietary software tools
- improve research quality & completeness & knowledge pooling due to collaborative modelling

Agenda


Introduction
What is the main idea behind *oemof*?
Package structure
Main oemof principles
Creating an own oemof application
Programming examples
Conclusion

What is the main idea behind *oemof*?

oemof ['ø:mɔf]

open **e**nergy **mo**delling **f**ramework

- Community-driven open-Source modelling framework initiated by:

ZNES Zentrum für nachhaltige Energiesysteme Hochschule | Europa-Universität Flensburg

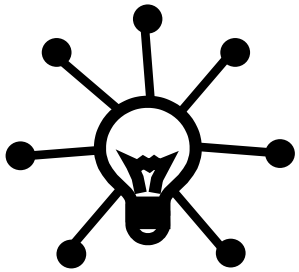
Reiner Lemoine Institut

Otto von Guericke Universität Magdeburg

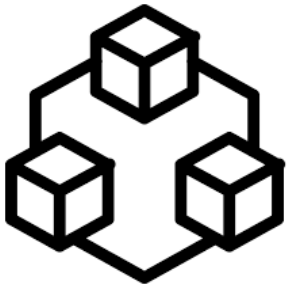
- Python package/library specifically developed for energy system modelling
- Model individual requirements/aspects in research projects, dissertations, Bachelor/-Master thesis
- Official website: http://oemof.org

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

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/

oemof ['ø:mɔf]
open energy modeling framework

KOPERNIKUS PROJEKTE
ENavi
Die Zukunft unserer Energie

oemof_heat ['ø:mɔf_'hēt]

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

WINDNODE

open_BEA

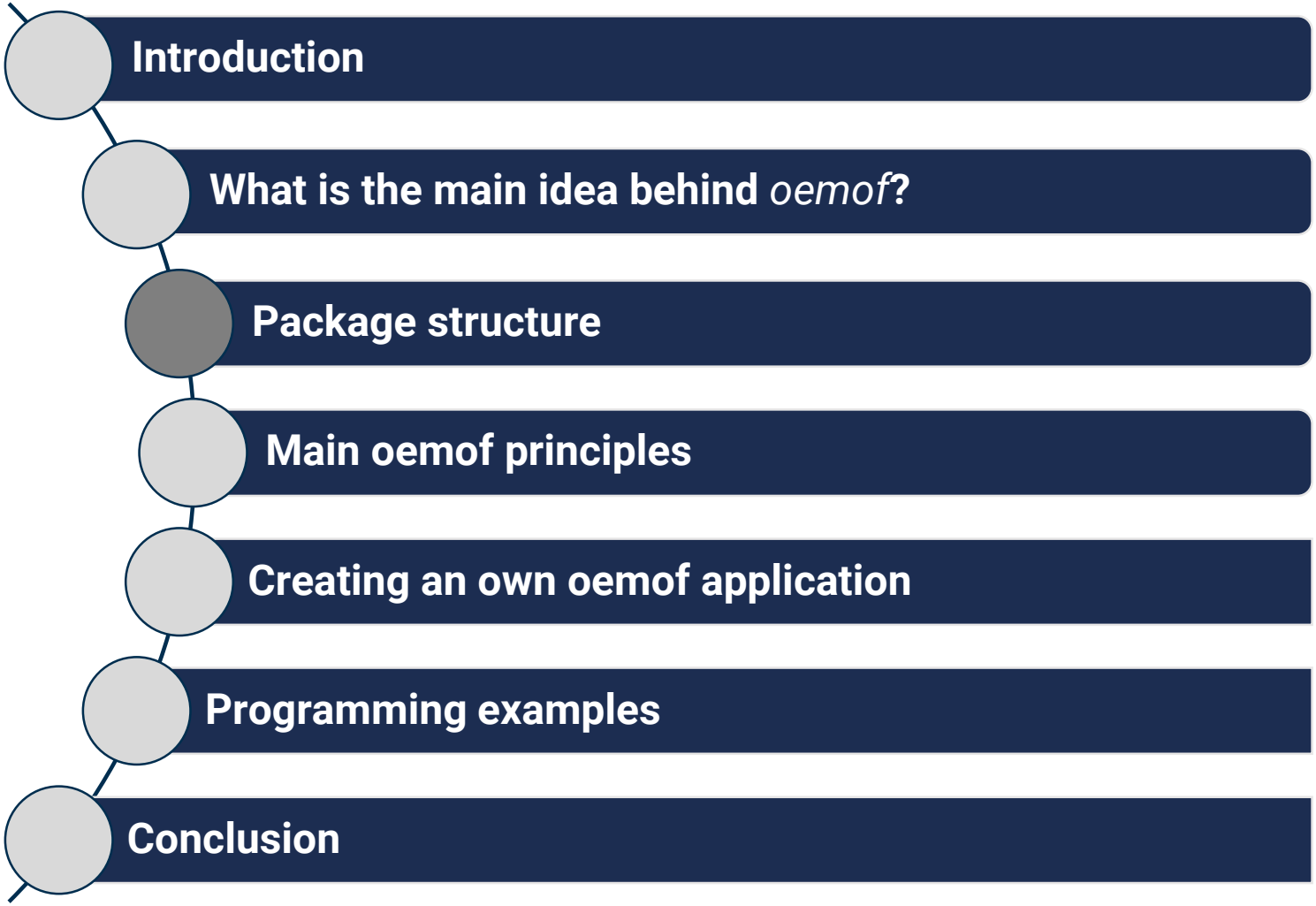
open_MODEX

Horizon 2020
European Union Funding for Research & Innovation

E-LAND

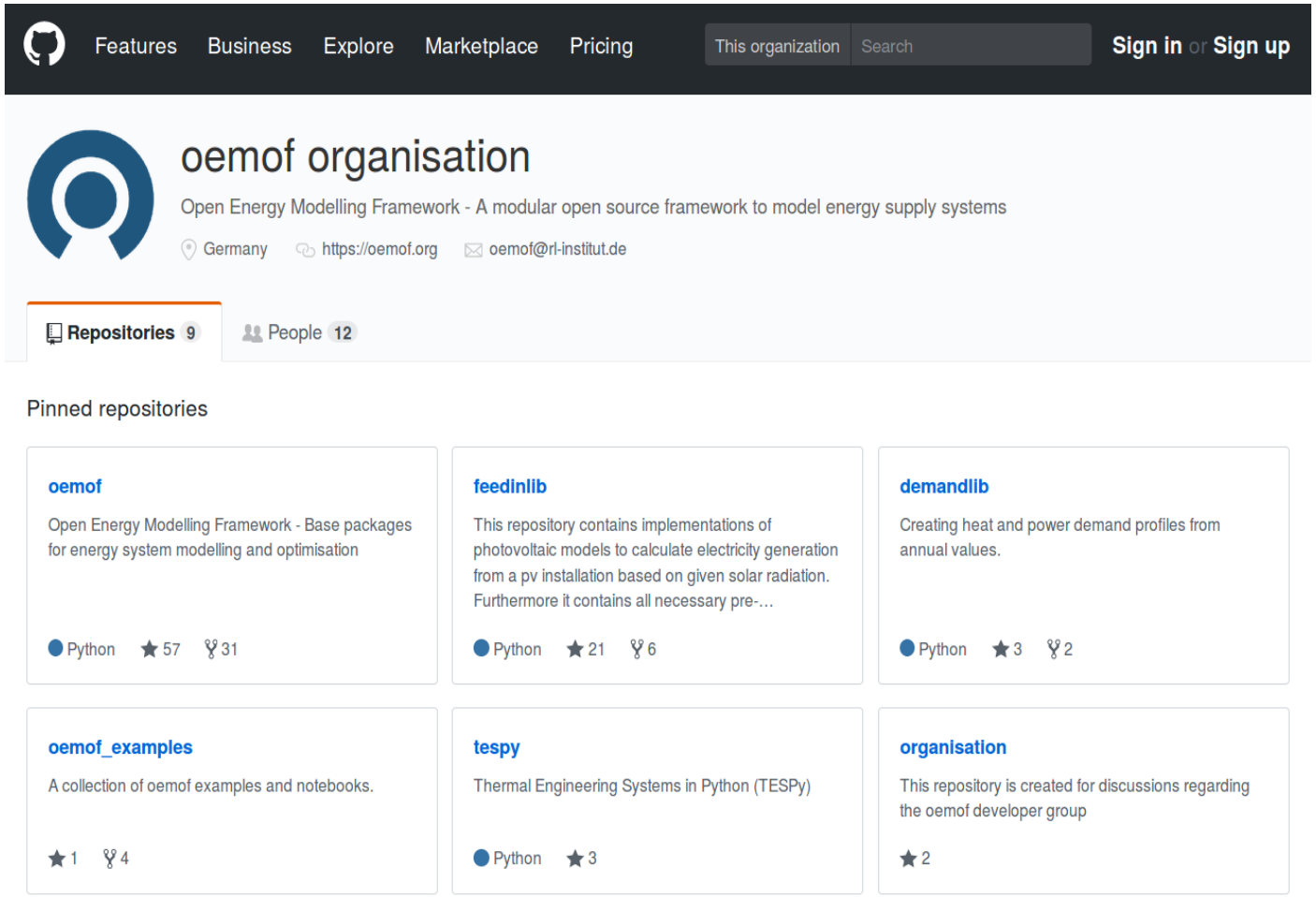
GRECO

Agenda

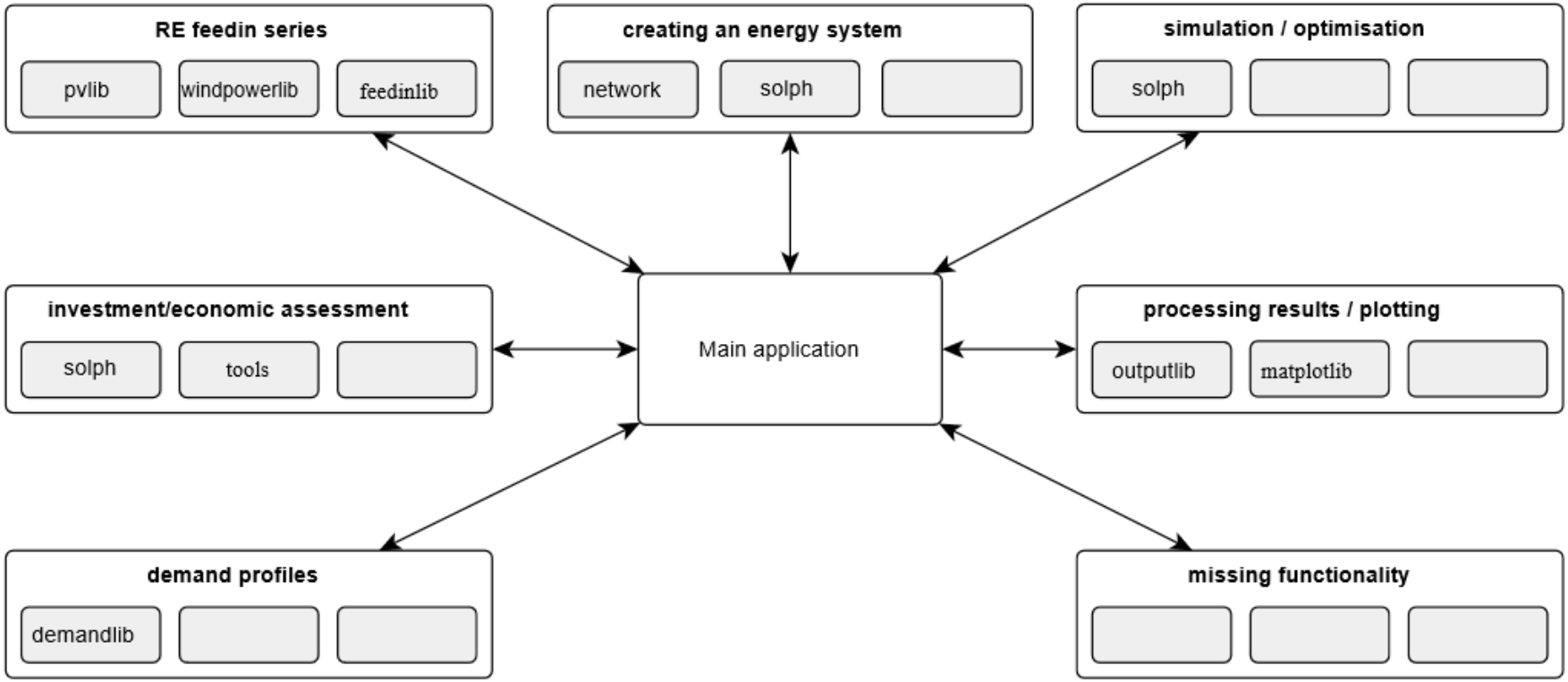

Introduction
What is the main idea behind *oemof*?
Package structure
Main oemof principles
Creating an own oemof application
Programming examples
Conclusion

Github reprositories of oemof

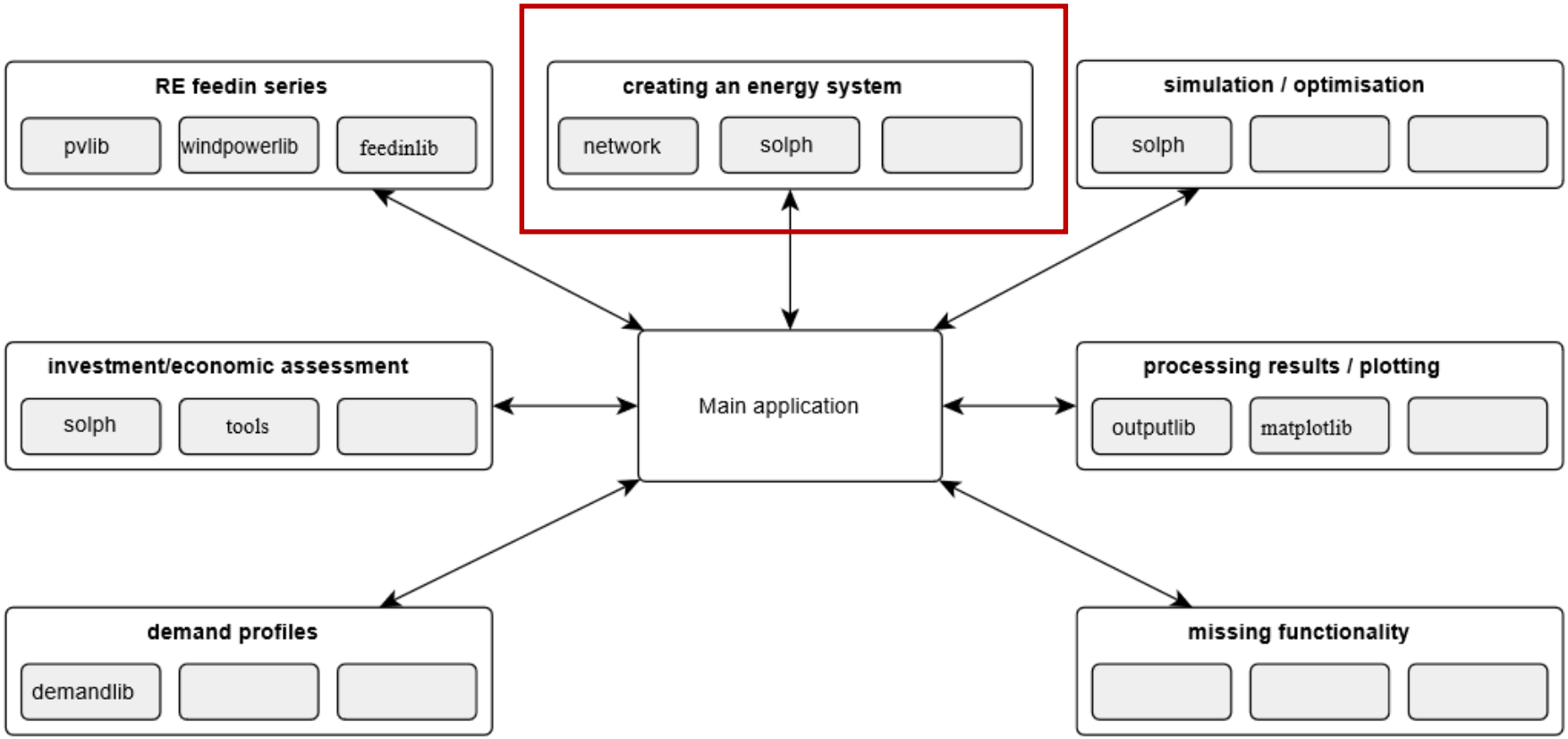
- Oemof toolbox on github: https://github.com/oemof



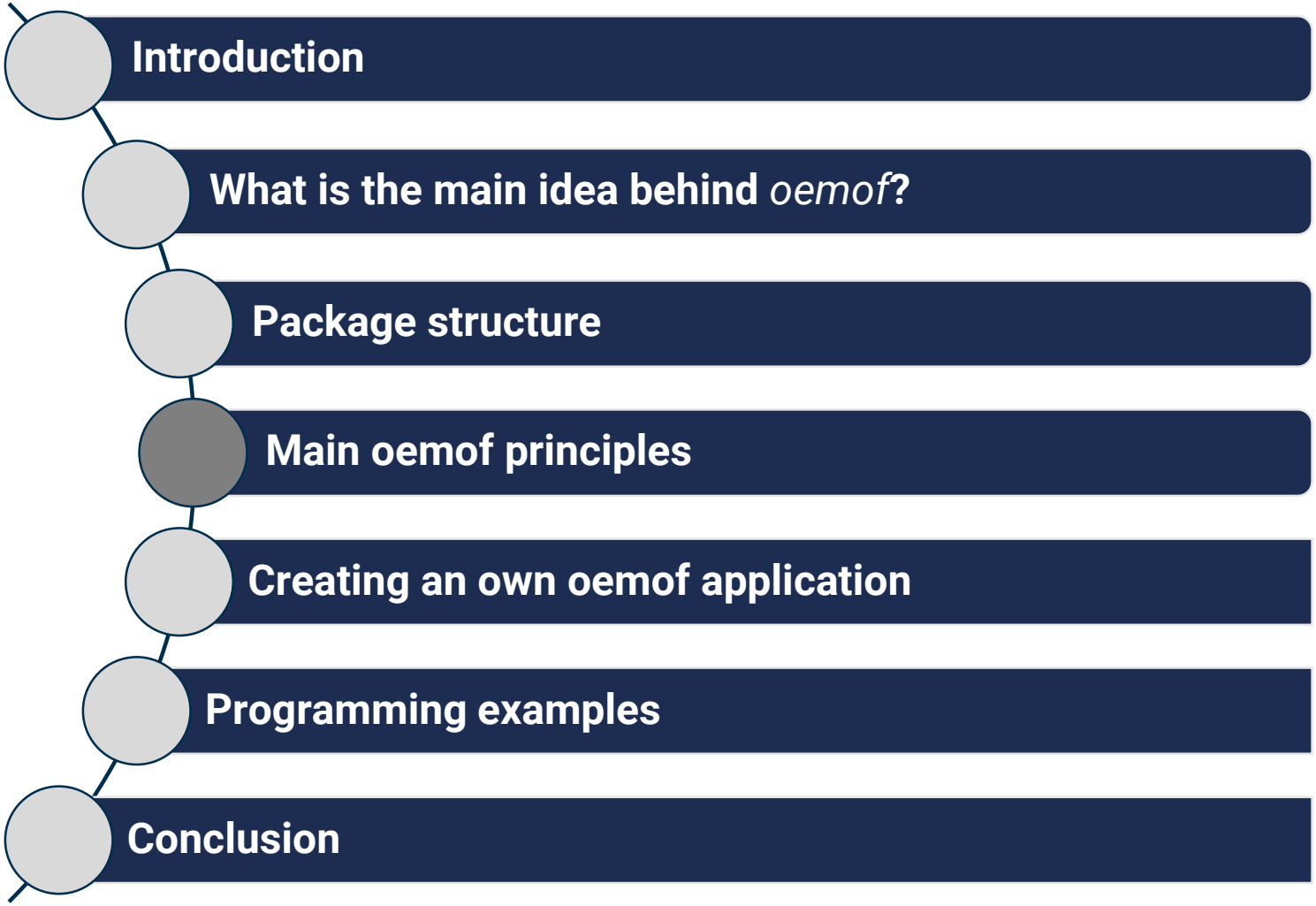
Package structure



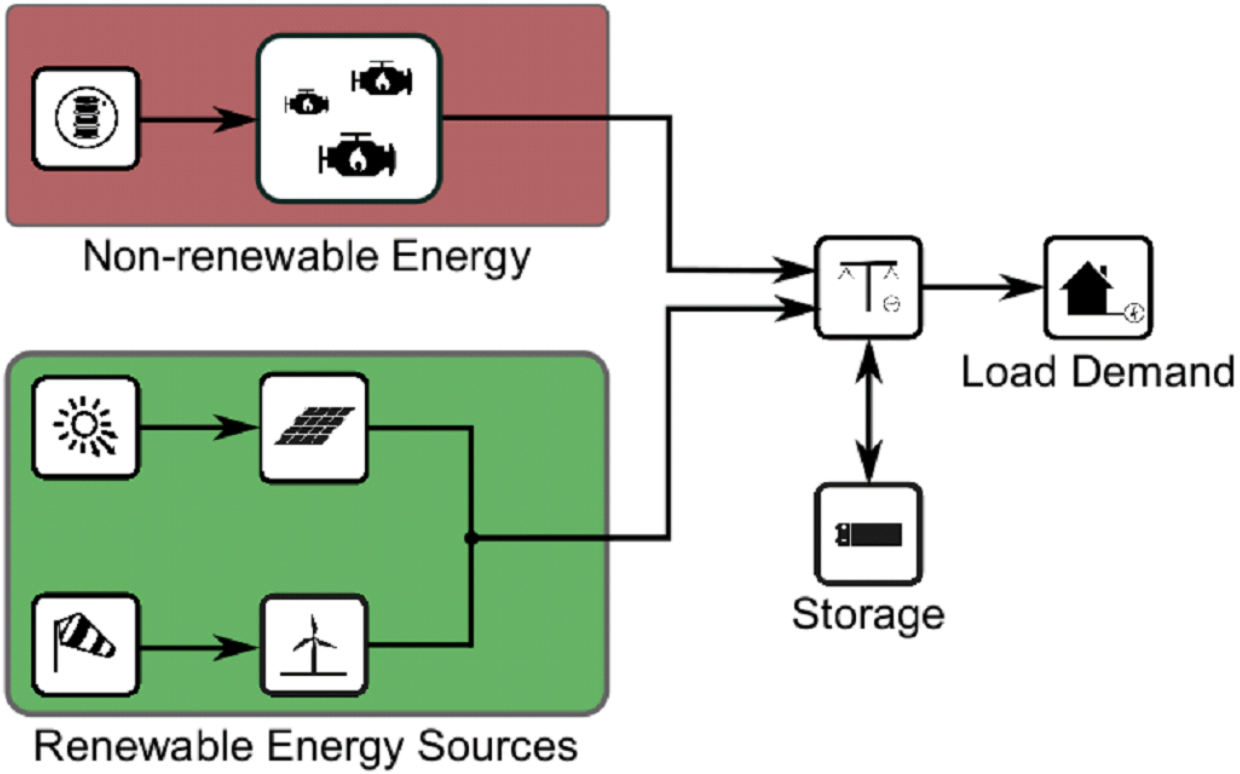
Package structure



Agenda


Introduction
What is the main idea behind *oemof*?
Package structure
Main oemof principles
Creating an own oemof application
Programming examples
Conclusion

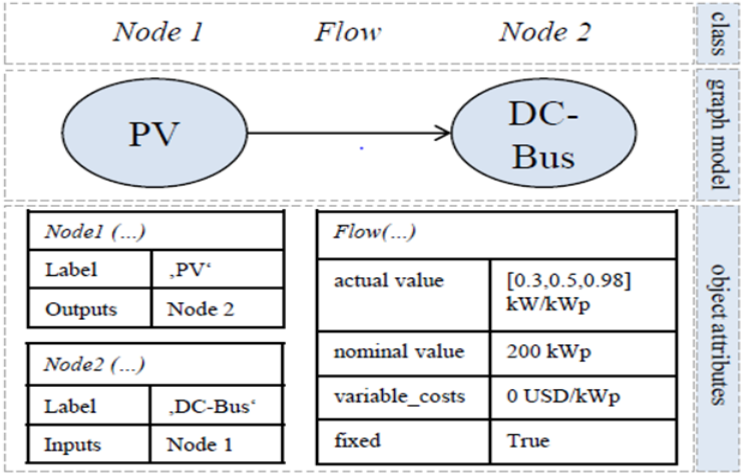
Actual energy system to be simulated



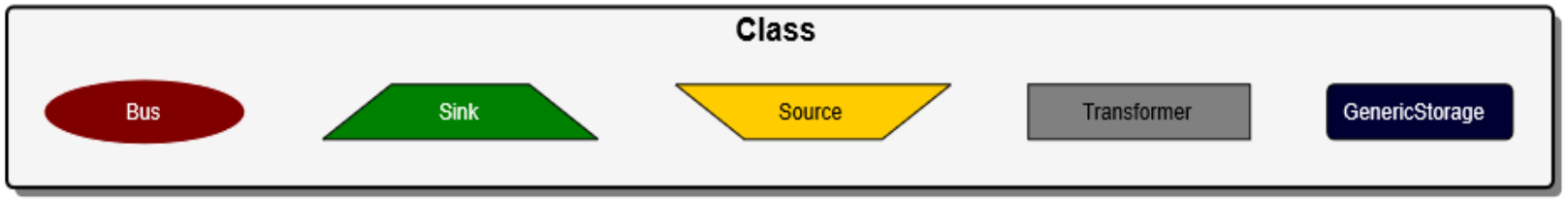
Source/Caption:

Available oemof components

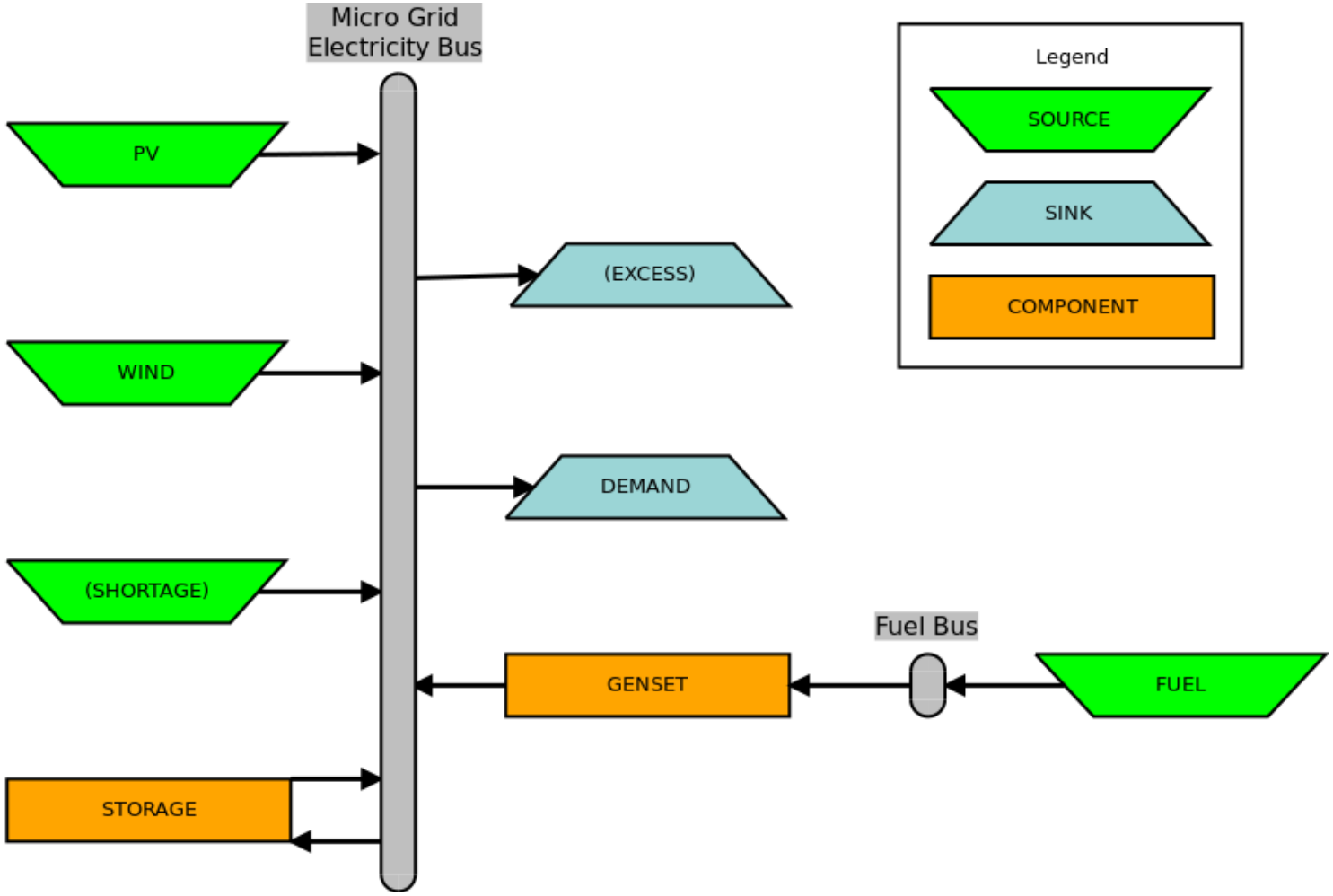
- Graph-based modelling:
  - Energy system build by Nodes, which are uni-laterally connected with Flows



- Main node classes / components:



Simplified, oemof-compatible system



Optimizing with oemof – Objective value

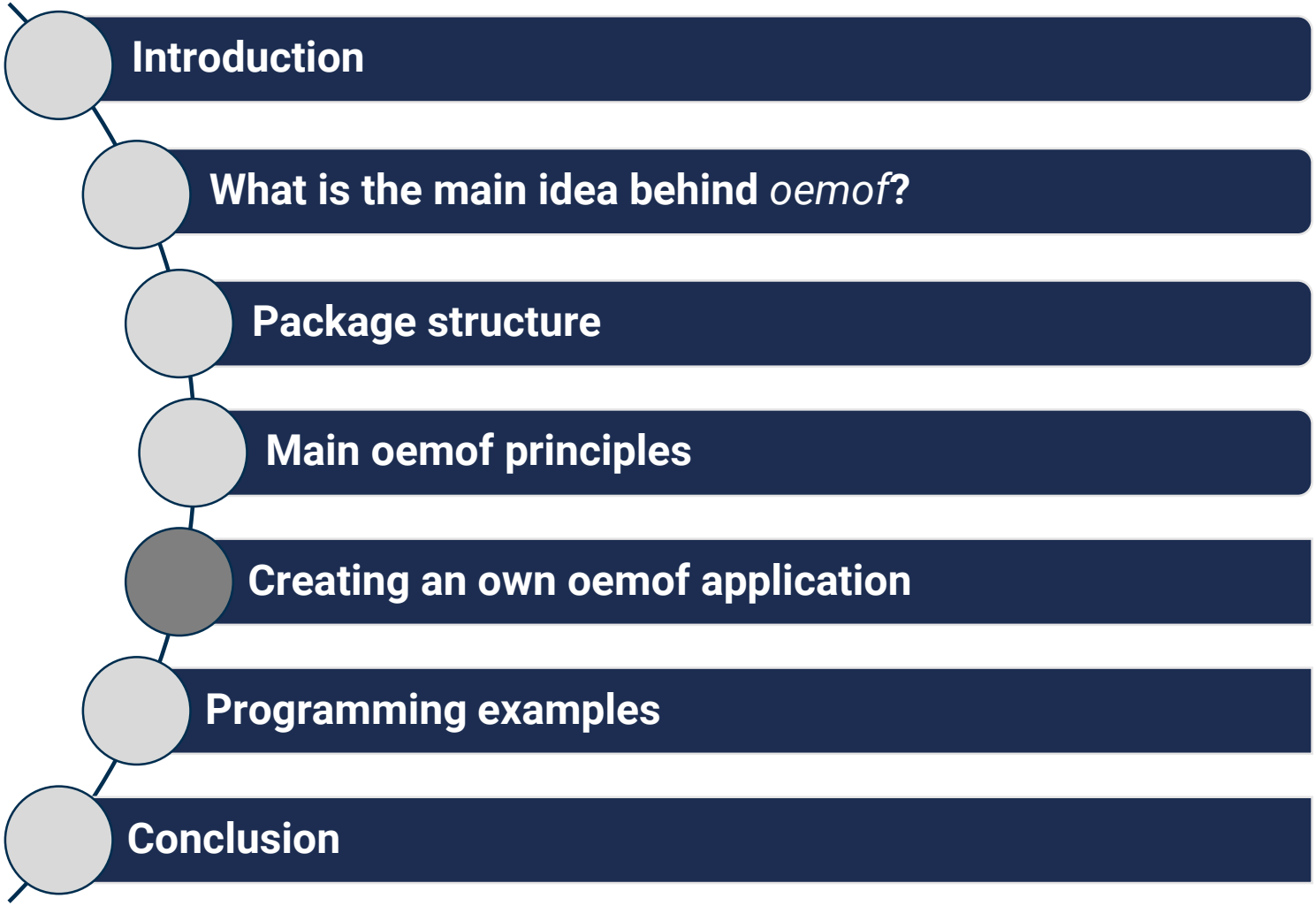
- Oemof generates a linear equation system describing the energy system model
- Solves for the minimal objective value (total costs)
- Target function:

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

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

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	-

Agenda

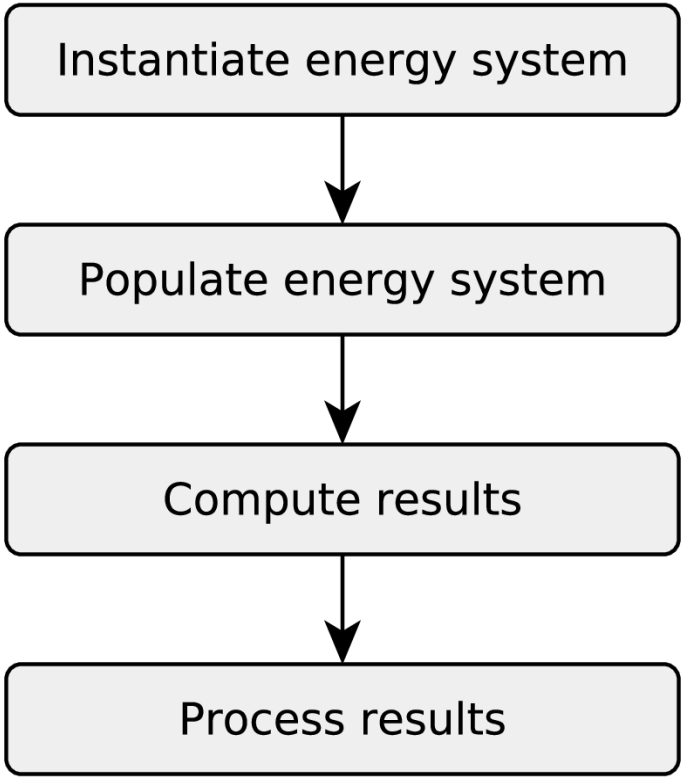

Introduction
What is the main idea behind *oemof*?
Package structure
Main oemof principles
Creating an own oemof application
Programming examples
Conclusion

Installation of oemof

- Necessary to install:
  - Python programming environment (eg. pycharm)
  - Package manager (eg. miniconda)
  - Solver (eg. coinor-cbc)
  - Python library oemof

- More information:
  - Slides: Oemof_Workshop_02_Installation.pptx
  - Youtube tutorial for Windows: https://www.youtube.com/watch?v=eFvoM36_szM

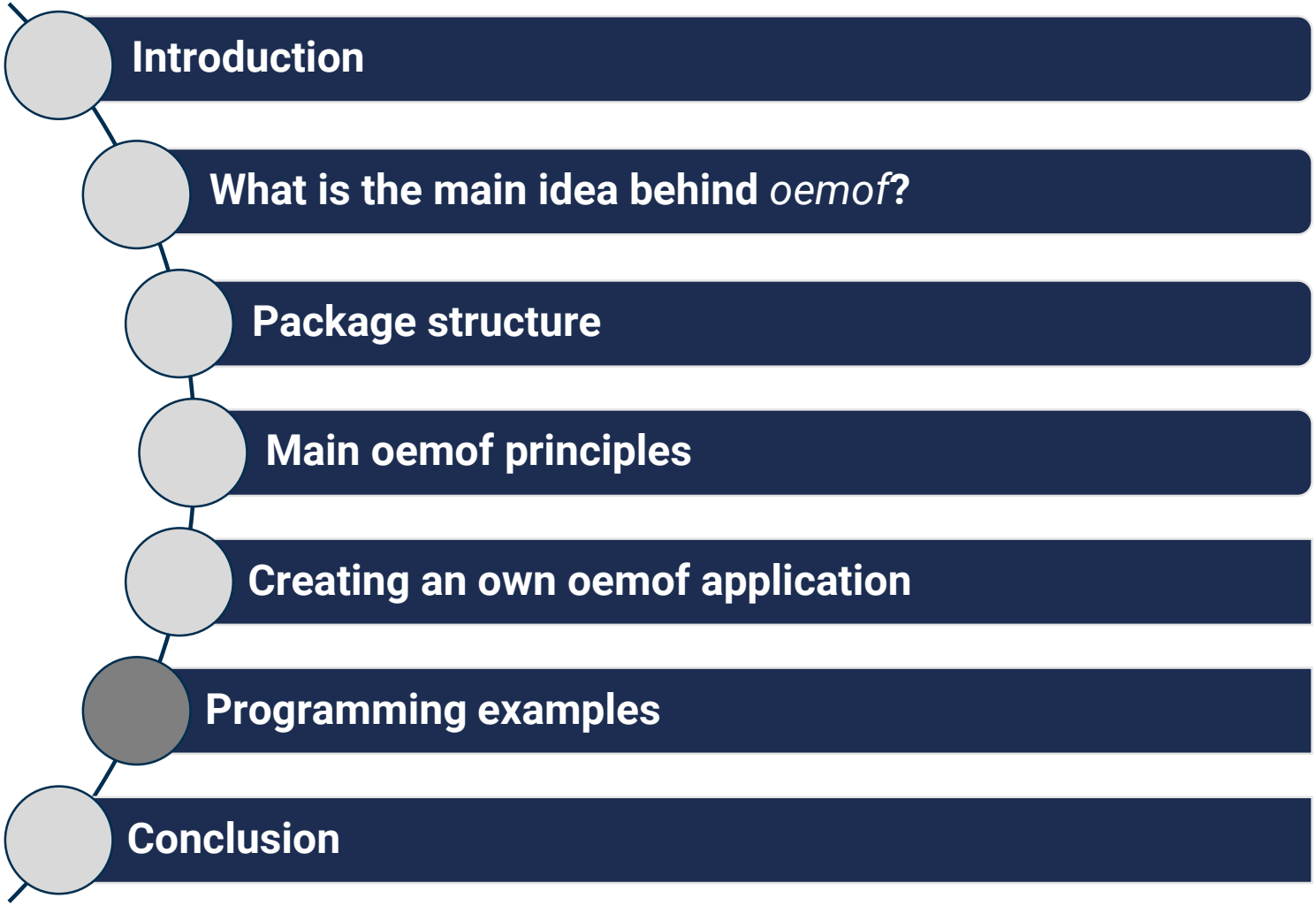
Building an own oemof application



Data requirements of an oemof model

- Economic parameters:
  - Fix and variable cost of the system components
  - For internal processing of costs: WACC, project lifetime
- Timeseries with values for each timestep:
  - Sources (non-dispatchable generation)
  - Sinks (non-dispatchable demands)
- Technical parameters:
  - Transformer (eg. generator) efficiencies
  - Technical storage parameters

Agenda


Introduction
What is the main idea behind *oemof*?
Package structure
Main oemof principles
Creating an own oemof application
Programming examples
Conclusion

Download coding examples

- Download git reprository of this workshop from git: https://github.com/smartie2076/oemof_workshop

- To execute jupyter notebooks:
  - Open terminal, move to folder /oemof_workshop
  - Create environment and install requirements

```
pip install -r requirements.txt
```

  - Execute

```
jupyter notebooks
```

Tutorials - Jupyter notebooks

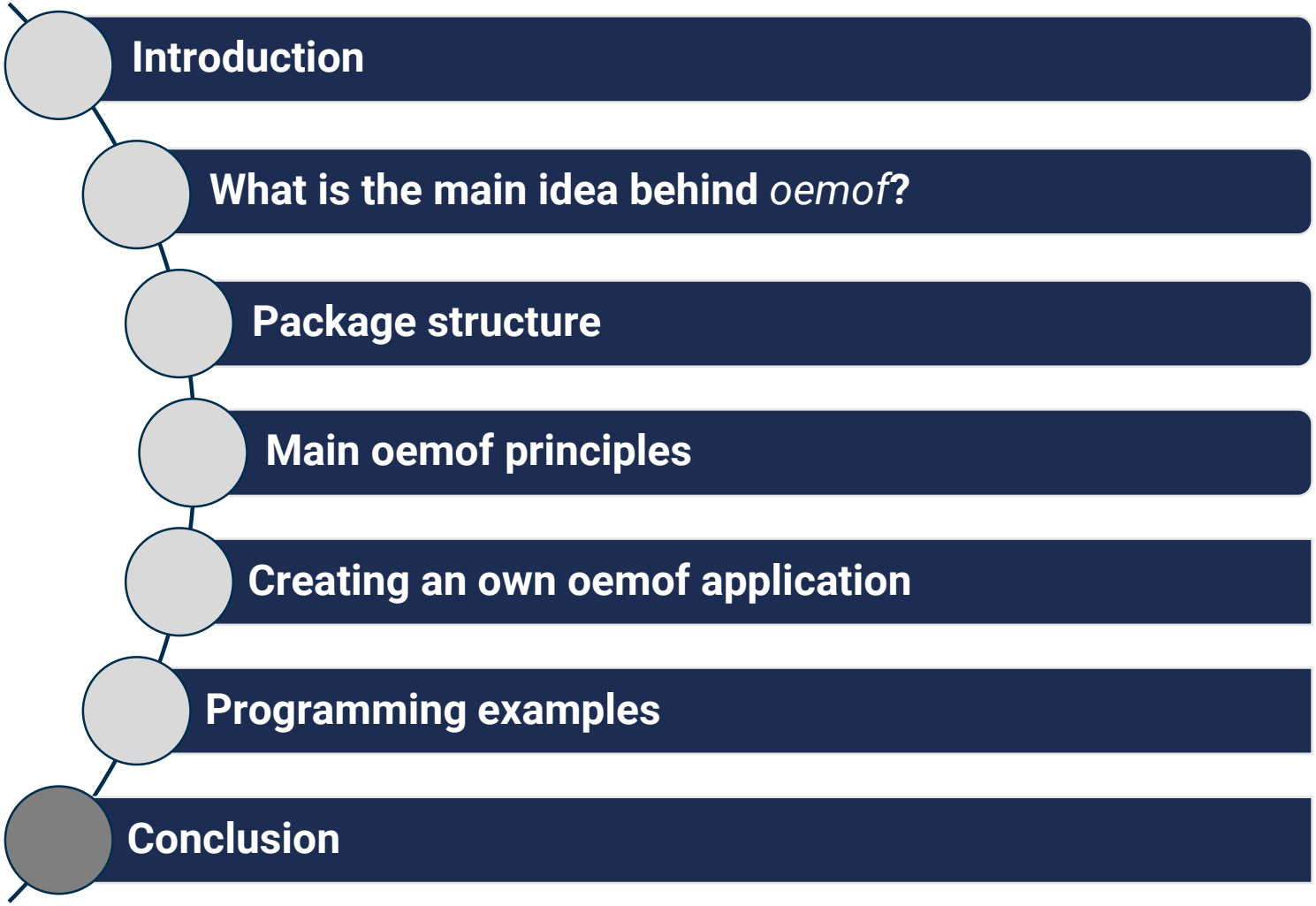
- Dispatch optimization with fixed capacities:
  ./Day_1_Oemof_Basics/1a_tutorial_dispatch.ipynb
- Investment and dispatch optimization:
  ./Day_1_Oemof_Basics/2a_tutorial_investment_optimization.ipynb

Tasks - Jupyter notebooks

- Dispatch with fixed capacities:
  ./Day_1_Oemof_Baoptimizationsics/1b_task_dispatch.py
- Investment and dispatch optimization:
  /Day_1_Oemof_Basics/2b_task_investment_optimization.py

→ Solutions are provided

Agenda


Introduction
What is the main idea behind *oemof*?
Package structure
Main oemof principles
Creating an own oemof application
Programming examples
Conclusion

Working with oemof

- Download and use oemof
- Register on and post and discuss issues on: https://forum.openmod-initiative.org/tags/c/qa/oemof
- Indicate or post own projects/coding examples via mail or github
- Find documentation on: http://oemof.readthedocs.io/en/stable/
  - Register errors in documentation via mail or issue or pull request (github)
- Find oemof examples on: https://github.com/oemof/oemof_examples

Helping oemof develop

- Documentation
  - Register or correct spelling and grammar mistakes
  - Re-write sections that are unclear
  - Add missing explainations
- Code
  - Register or fix bugs
  - Fix docstring or code layout
  - Create and submit own components or constraints
  - Add own features or implement requested features
- When developing: Fork/clone oemof reprository: http://github.com/oemof/oemof

Oemof user&developer meetings

- Yearly user&developer meetings

- Half-yearly developer meetings
  - Next meeting: 4. to 6.12.2019, Berlin
  - Register and develop agenda on: https://oemof.org/2019/09/11/oemof-turns-5-anniversary-developer-meeting-in-december-2019/

THANK YOU FOR YOUR ATTENTION !

REINER LEMOINE INSTITUT

How to follow Oemof's activities?

Website: https://oemof.org/
Github: https://github.com/oemof
Or join our mailing list!

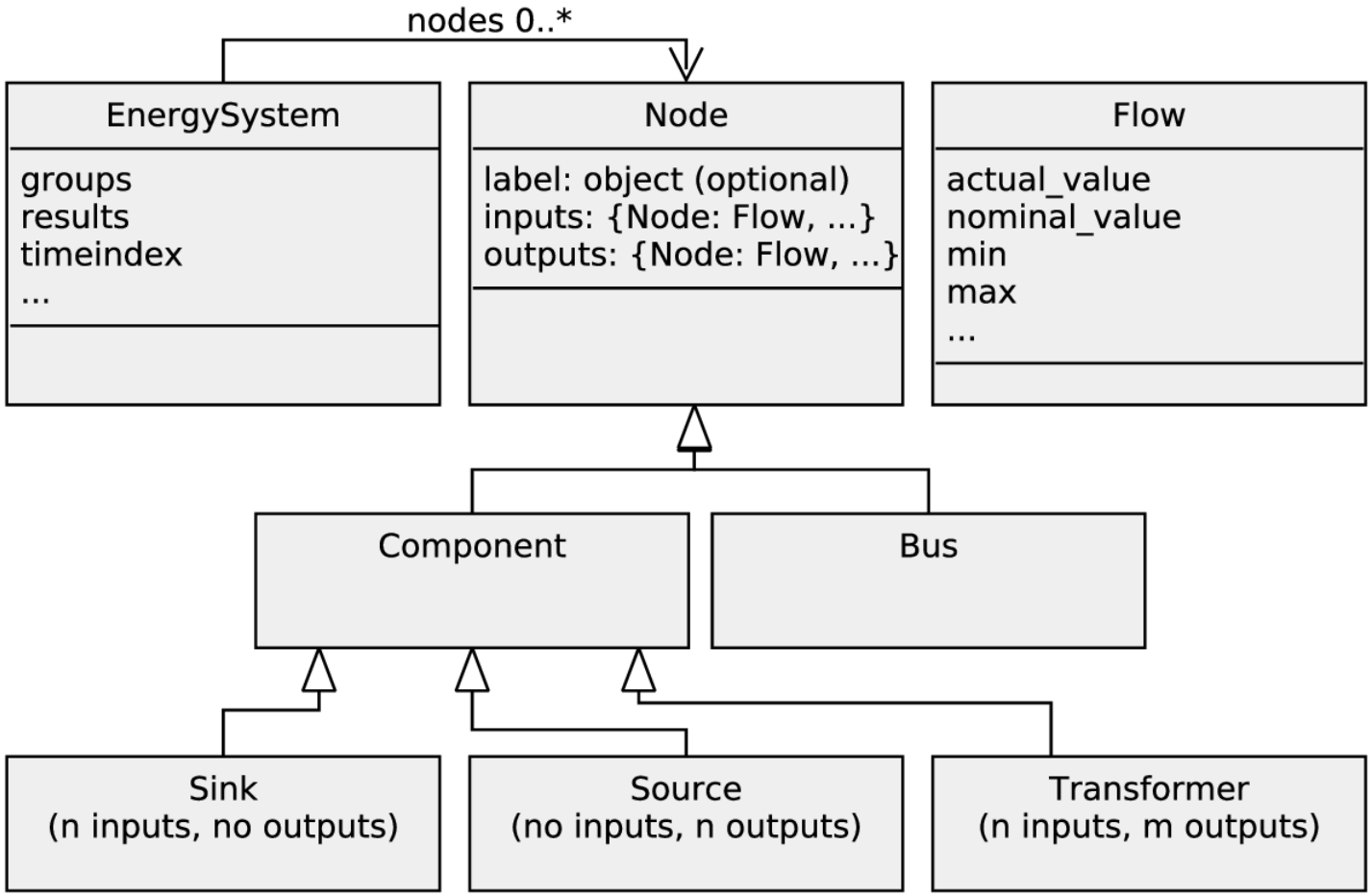
License

Except where otherwise noted, this work and its content (texts and illustrations) are licensed under the Attribution 4.0 International (CC BY 4.0)

See license text for further information.

Tel: +49 (0)30 1208 434 88
E-Mail: martha.hoffmann@rl-institut.de
Web: http://www.rl-institut.de
Twitter: @rl_institut

Please quote as: "PRESENTATION TITLE" © Reiner Lemoine Institut | CC BY 4.0


nodes 0..*
EnergySystem
groups
results
timeindex
...
Node
label: object (optional)
inputs: {Node: Flow, ...}
outputs: {Node: Flow, ...}
Flow
actual_value
nominal_value
min
max
...
Component
Bus
Sink
(n inputs, no outputs)
Source
(no inputs, n outputs)
Transformer
(n inputs, m outputs)