NFDI4Energy:
National Research Data Infrastructure for Interdisciplinary Energy Systems Research
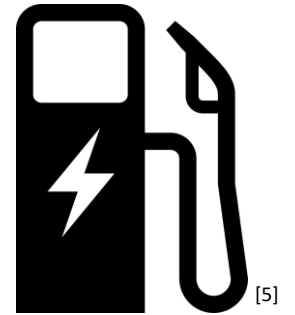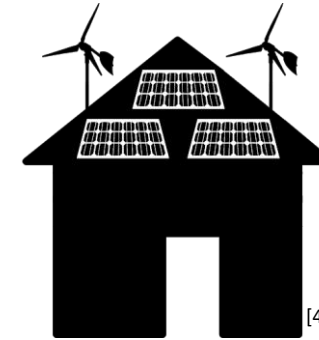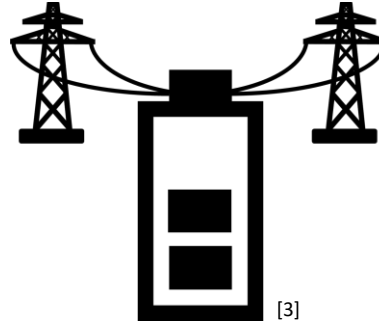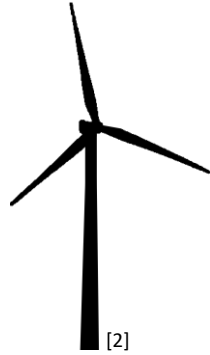
Stephan Ferenz

OFFIS & Carl von Ossietzky Universität Oldenburg

Motivation
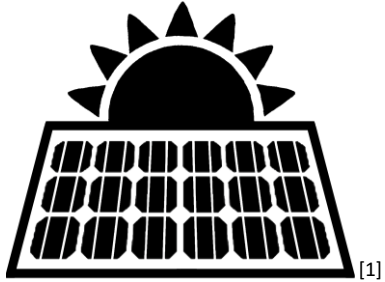
Why create a research data infrastructure for energy system research?
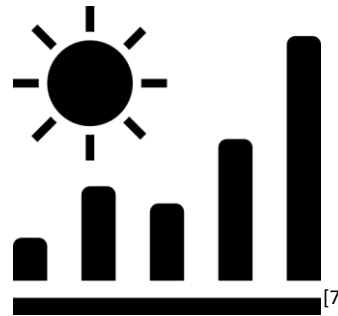
Energy Research
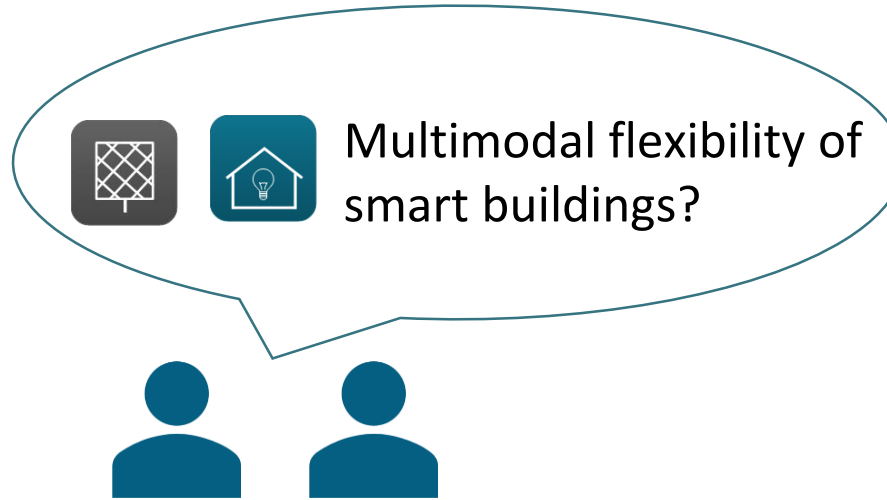
Reusable Research Artifacts

- Principles to make research artifacts reusable by Wilkinson et al. [1]
- Research artifacts should be:

Findable

Accessible

Interoperable

Reusable
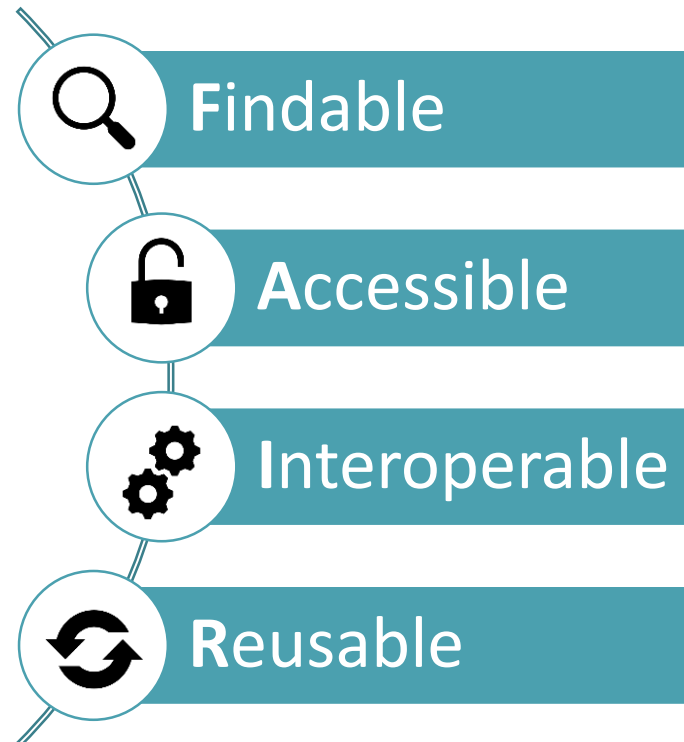
[1] M. D. Wilkinson *et al.*, "The FAIR Guiding Principles for scientific data management and stewardship," *Sci Data*, vol. 3, no. 1, Art. no. 1, Mar. 2016, doi: 10.1038/sdata.2016.18.

FAIR Research Data Management
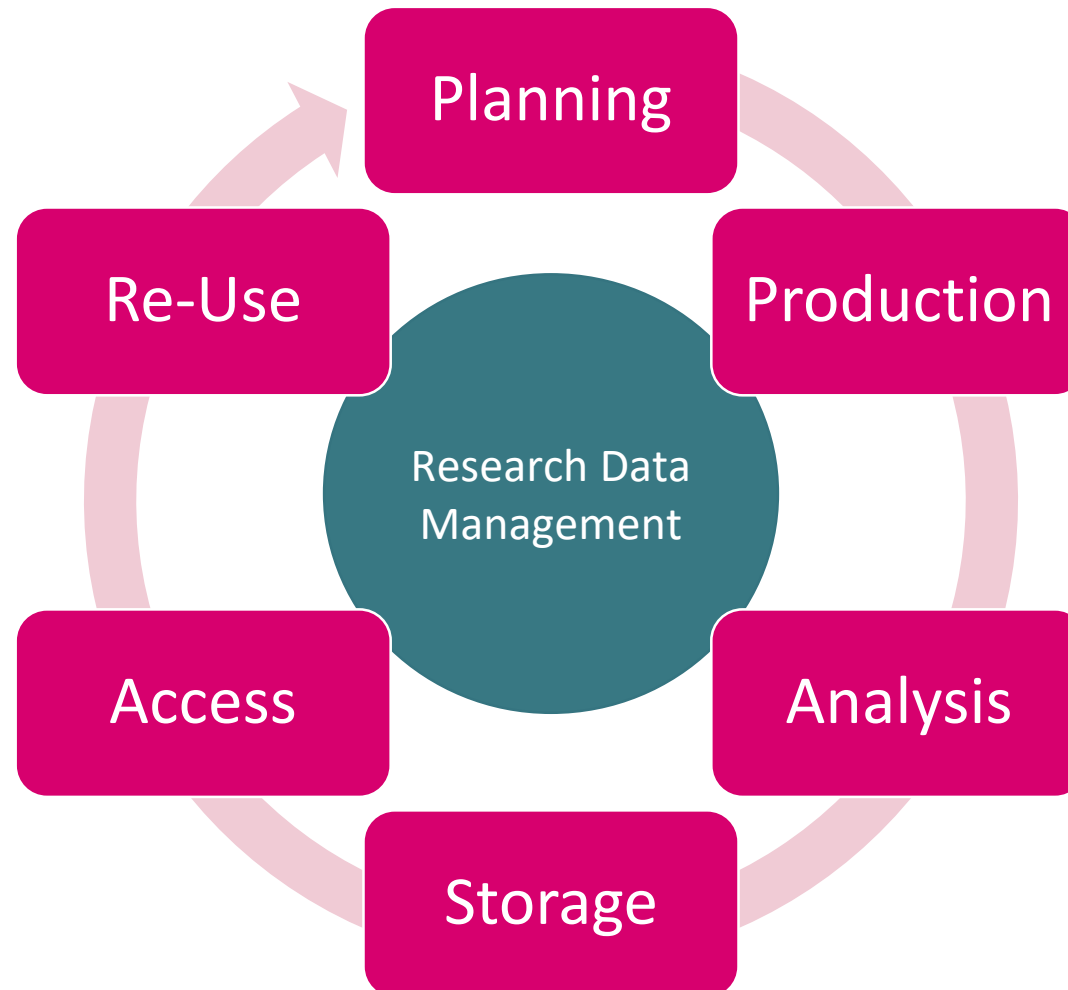
FAIR Research Data Management – how?
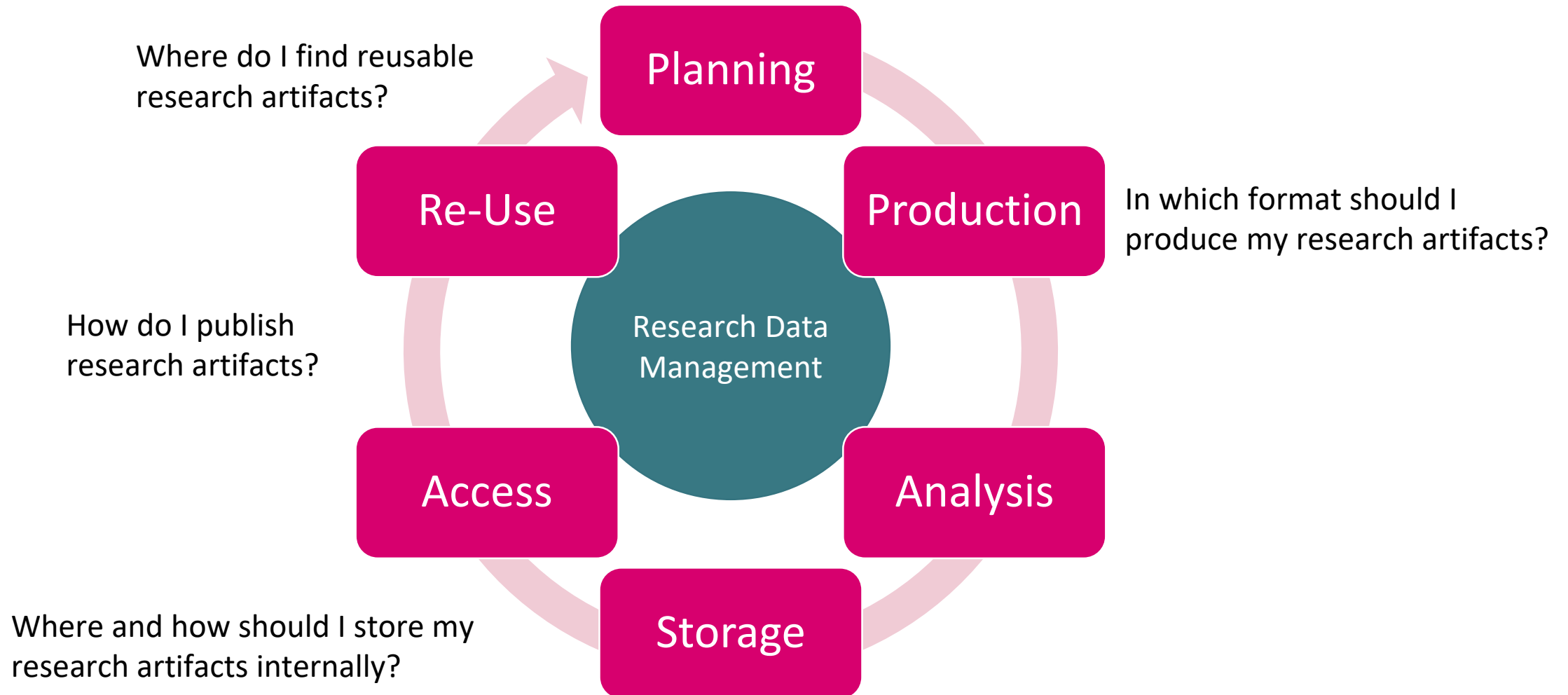
Where do I find reusable research artifacts?

Planning

Re-Use

Production

In which format should I produce my research artifacts?

Research Data Management

How do I publish research artifacts?

Access

Analysis

Where and how should I store my research artifacts internally?

Storage

Building an Open Ecosystem for FAIR Research Artefacts in Energy Systems Research

- Establish common research **community services** to allow **reproducibility, transparency, and reusability** of research artifacts.
- Simplify identification, integration, and coordination of **simulation-based models**.
- **Support their use** in the research community.
- Enable and motivate the **involvement of society**.
- Promote better **collaboration and knowledge transfer** between scientific research institutes and **business partners**.
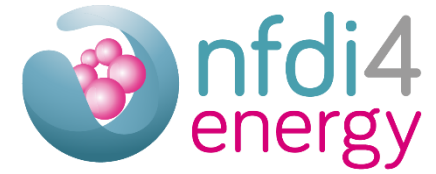- Integrate the provided services within the **wider NFDI ecosystem**.

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Wider NFDI ecosystem?

NFDI: German National Research Data Infrastructure

- Vision: All research data is FAIR. For all. Forever.
  - FAIR = Findable, Accessible, Interoperable, Reusable
- Goals:
  - Increase the efficiency of the entire German science system
  - Establish and develop comprehensive research data management in Germany
  - Develop a long time solution for research data management infrastructure
- Funded by state and federal governments with up to 90 million € per year
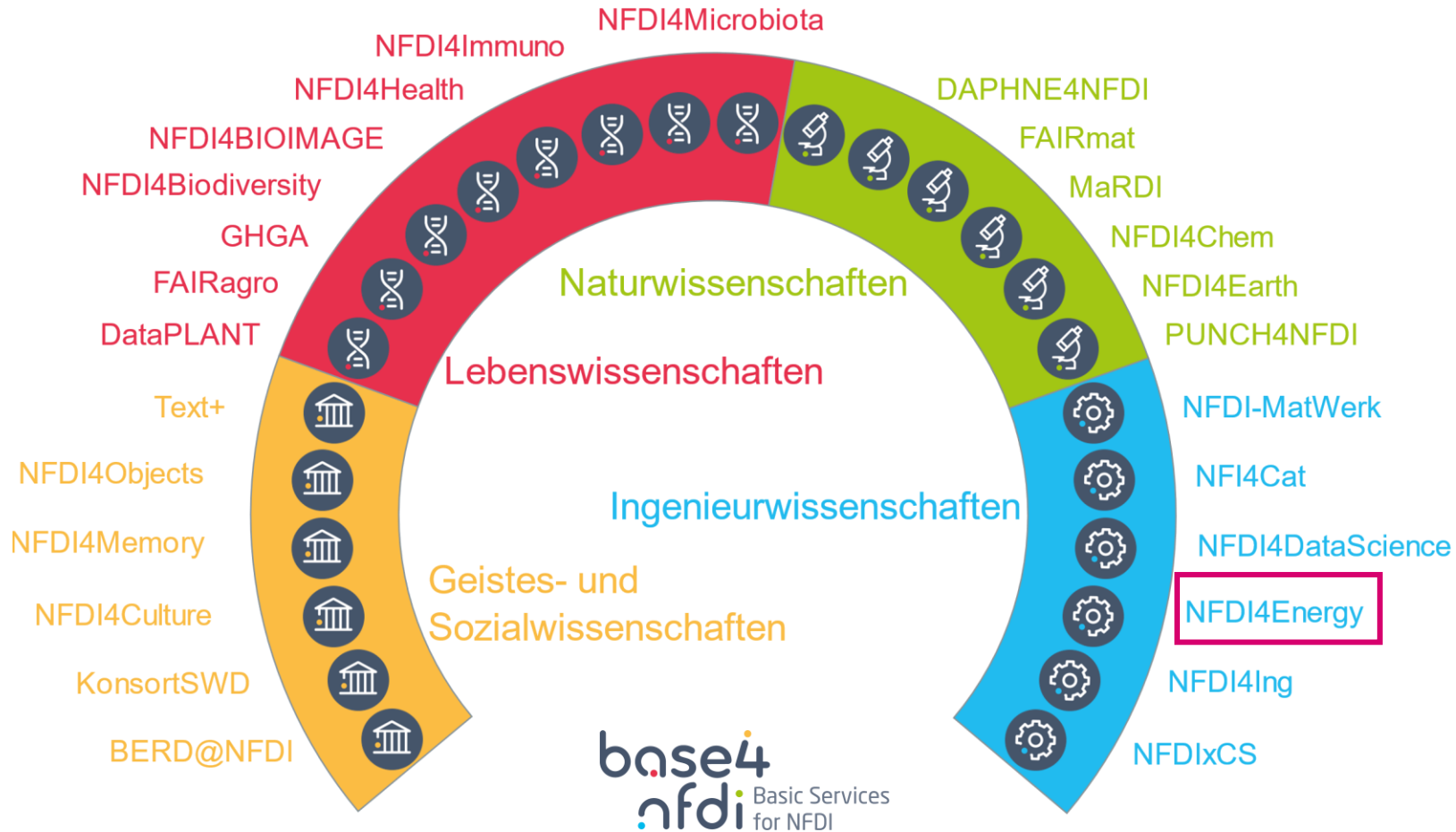
1 NFDI e.V.	26 domain consortia
• Association • Central coordination • >250 member institutions	• from different domains • covering all research • all funded for 5+ years

Different Consortia

Our partners

Map by David Liuzzo, CC BY-SA 2.0 DE, via Wikimedia Commons, https://upload.wikimedia.org/wikipedia/commons/e/e3/Karte_Deutschland.svg
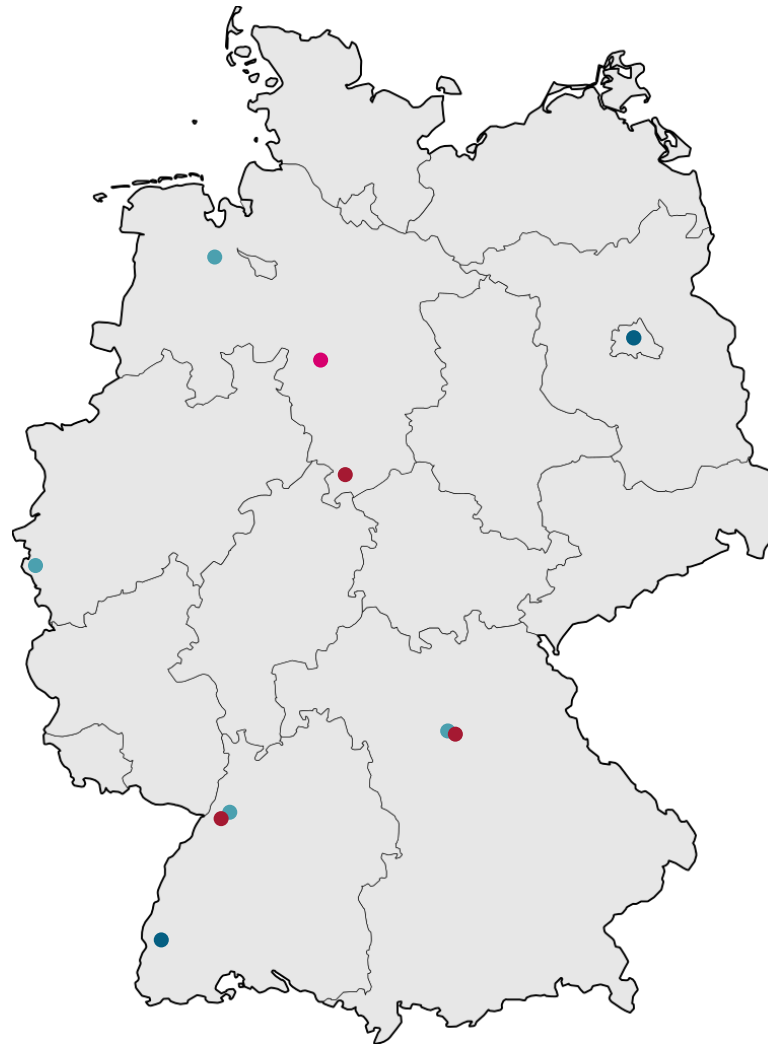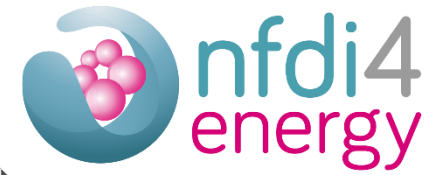
Power grids, automation systems

Long-term energy scenarios

Energy policy and societal aspects

Infrastructure & service provider

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Diverse stakeholders?

Building and Serving the Energy Community

Research Community

- Main producer and user of research artefacts
- Additional tools for handling of research artefacts are needed
- Need for easy information on services

Society and Policy

- Robust data on social and political factors are essential for energy modelling
- High need for communication of scientific results to these stakeholders

Business partners

- High relevance of data from business partners
- Need for anonymized and artificial data
- Data and models also relevant for business partners

Building and Serving the Energy Community through multiple mechanism

Collect requirements

- Identify key requirements as well as best practices from all stakeholders
- Use a methodical mix: interviews, surveys, and workshops

Community involvement

- We invite the different communities for involvement to different types of workshops and events
- e.g. industry workshops

Outreach

- Outreach to all stakeholders
- Through workshops, keynotes, booths at conferences or other events

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Why simulations?

Research Artifacts in Energy Research (Examples)

VILLASweb

Sample visualization ✎ Edit

Menu

Home
Projects
Simulations
Simulators
User Management
Logout

Table with signals and current value

Signal	Value
Voltage 1	0.146
Voltage 2	
Voltage 3	

Single value

Plots

Simulator 1 - Plot with selectable signals list

home – features – docs – install – publications – blog – live-

Input controls

Value input   Enter value

Horizontal slider ——○—— **29.8**

Button 1   Button 2   Button 3

mosaik

Mosaik is a flexible Smart Grid co-simulation framework.

Mosaik allows you to reuse and combine existing simulation models and simulators to create large-scale Smart Grid scenarios – and by *large-scale* we mean thousands of simulated entities distributed over multiple simulator processes. These scenarios can then serve as test bed for various types of control strategies (e.g., multi-agent systems (MAS) or centralized control).

Mosaik is written in Python and completely open source (LGPL), including some simple simulators, a binding to PYPOWER and a demonstration scenario.

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What kind of services?

Exemplary problem:
Coordinated Use of Flexibilities in the Electricity Grid

Identify research gaps & challenges for follow-up activities
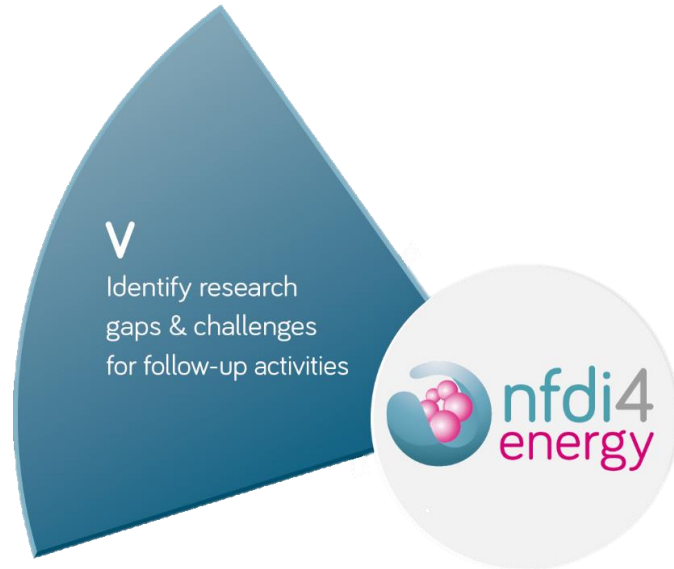
- Higher need for flexibility in the energy systems

- Market mechanisms can be used for flexibility

- Self-organization enable self-healing and adaptive systems

Exemplary research question:

How to design a robust distributed self-organization system to coordinate flexibilities for the electricity grid (consider e.g. new redispatch concepts)?

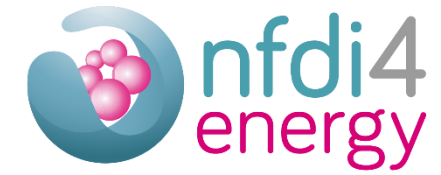# Find the Right Methods

What do we want?

- Integration of different components
  - Unified flexibility model, including estimated flexibility potential

- A method to implement self-healing properties

- Guidelines how to ensure robustness in distributed systems

How can the NFDI4Energy services help?

- *Best Practices* will provide an overview on relevant methods

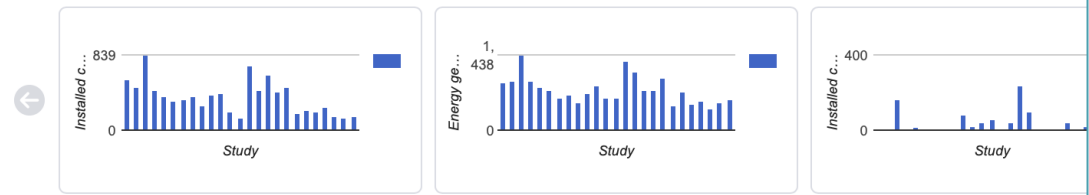- With the *ORKG* different approaches for flexibility modelling can be easily compared

II
Define relevant scenarios and experimental setup

Comparing research via ORKG

07.12.2023

Find the Right Models & Data

What do we want?

- Source code for a unified flexibility model

- Example scenario with an electrical grid and data for demand and supply

- An agent framework to model distributed control strategies

- A model for the communication network

Define relevant scenarios and experimental setup

How can the NFDI4Energy services help?

- *Registry* will provide a database of relevant source code and data which is easily searchable

mango
modular python agent framework

mosaik
ecosystem

Publish the new Model and Scenario

What do we want?

- Enable other researchers to reuse our new model and the scenario for their research to speed up research

- Make our model easily citable

- Make our research reproducible

How can the NFDI4Energy services help?

- *Registry* will
  - be the place to add information on our new software model and scenario
  - enable **linking to the relevant artefacts** & publication
  - introduce an identifier for the model to make it citable
  - simplify adding relevant metadata through automated metadata extraction from git repositories

- *Simulation* will allow others to reuse the new scenario & new model for their (online) simulations

IV
Extract and ensure persistence of results, public consultation and discourse

Building an Open Ecosystem for FAIR Research Artefacts in Energy Systems Research
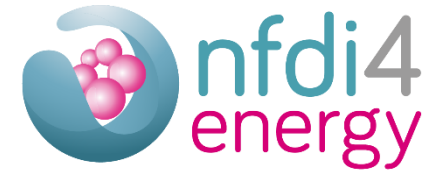
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How does NFDI4Energy fit into the international landscape?

- NFDI e.V. is the mandated member of the European Open Science Cloud (EOSC) for Germany
  - "The ambition of the European Open Science Cloud (EOSC) is to develop 'Web of FAIR Data and services' for science in Europe."
- Our (co-)spokesperson(s) are highly active in the ACM SIG Energy
- We are connected to multiple EU Horizons projects with similar focus like EriGrid, Int:net, …
- Ontology-connected work items work on integrating the OSS world (Open Energy Family) with international industry standards CIM/IEC61970

How to stay in touch

Website

All Information
on one site:
http://nfdi4energy.org

LinkedIn

Get the latest news!
https://bit.ly/46aFeDF

Newsletter

Stay up-to-date with
our newsletter:
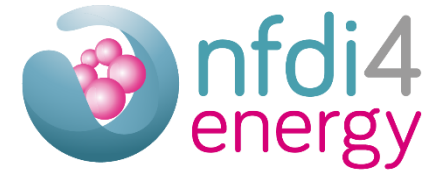https://bit.ly/48qeIrs

Coordination Office

Contact us:
info@nfdi4energy.org

Registration is now open!

1st NFDI4Energy Conference

Bringing the community of

energy research data management together

_____

20 – 21 February 2024

_____

Leibnizhaus, Hanover, Germany

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