Research Data Management for Energy Systems Research

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NFDI: German National Research Data Infrastructure

- Vision: All research data is FAIR. For all. Forever.
  - FAIR = Findable, Accessible, Interoperable, Reusable
- Goals:
  - Establish and develop comprehensive research data management in Germany
  - Increase the efficiency of the entire German science system
  - 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.	27 consortia
• Association • Central coordination • 225 member institutions	• from different domains • covering all research • all funded for 5+ years

Motivation: Research Project Life Cycle

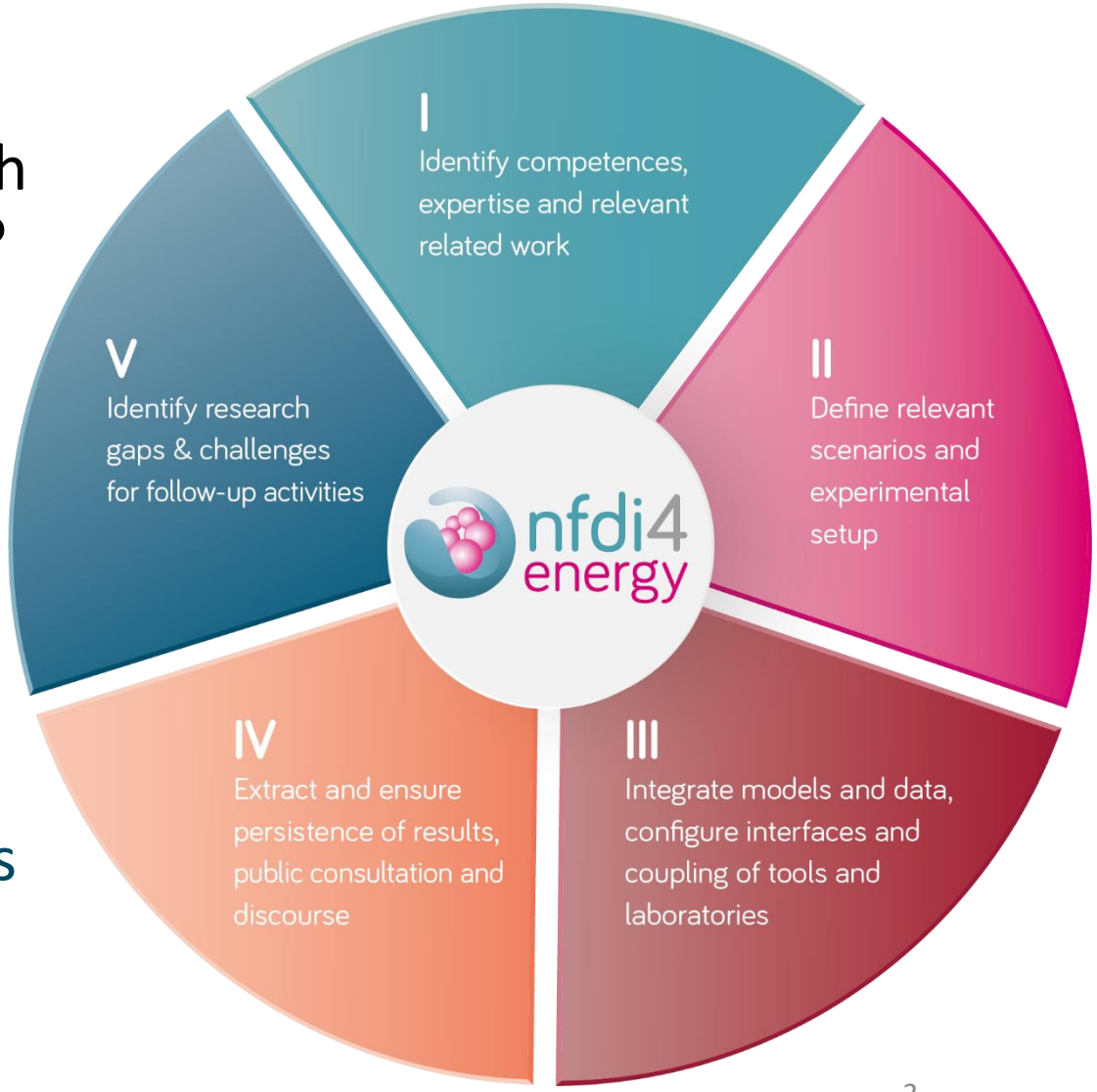
I What are the right partners for my research idea, and what are their results up to now?

II What would be the appropriate energy system scenario and experimental setup?

III How can we use digitalization benefits to integrate our models, labs and data?

IV How can we discuss our results with community, public & industry?

V What are our blind spots and research gaps for follow up activities?



What are the services
that this community needs to deliver
excellent results?

Building and Serving the Energy Community

Research Community

- Develop incentives and feedback mechanisms for the use of community services
- Supported by community events

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

Industry

- High relevance of data from the industry
- Need for anonymized and artificial data
- Data and models also relevant for the industry

- Identify key requirements as well as best practices from all stakeholders
- Interview-based process

Development of interview guides

↓

Identify and motivate relevant stakeholders for interview participation

↓

Interviews to collect requirements

↓

Setup platform for community services

Digital Objects in CPES Research (Examples)

Datasets

- Timeseries e.g. weather, power input (wind, solar…), demand (industry, mobility, household, …)
- Parameters e.g. of devices,
- Demographic data

Software

- Grid Computation Frameworks
- Co-Simulation Frameworks
- Agent-based simulation frameworks

Models

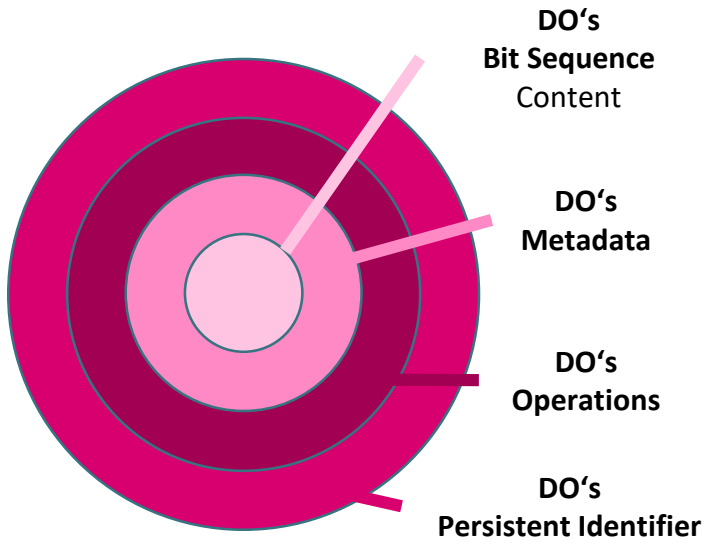
- Devices (Wind, PV, …)
- Networks
- Operational models

Scenarios

- Energy system transformation long term / short term
- Benchmark grids and device configurations
- Benchmark/Reference scenarios
- User acceptance scenarios

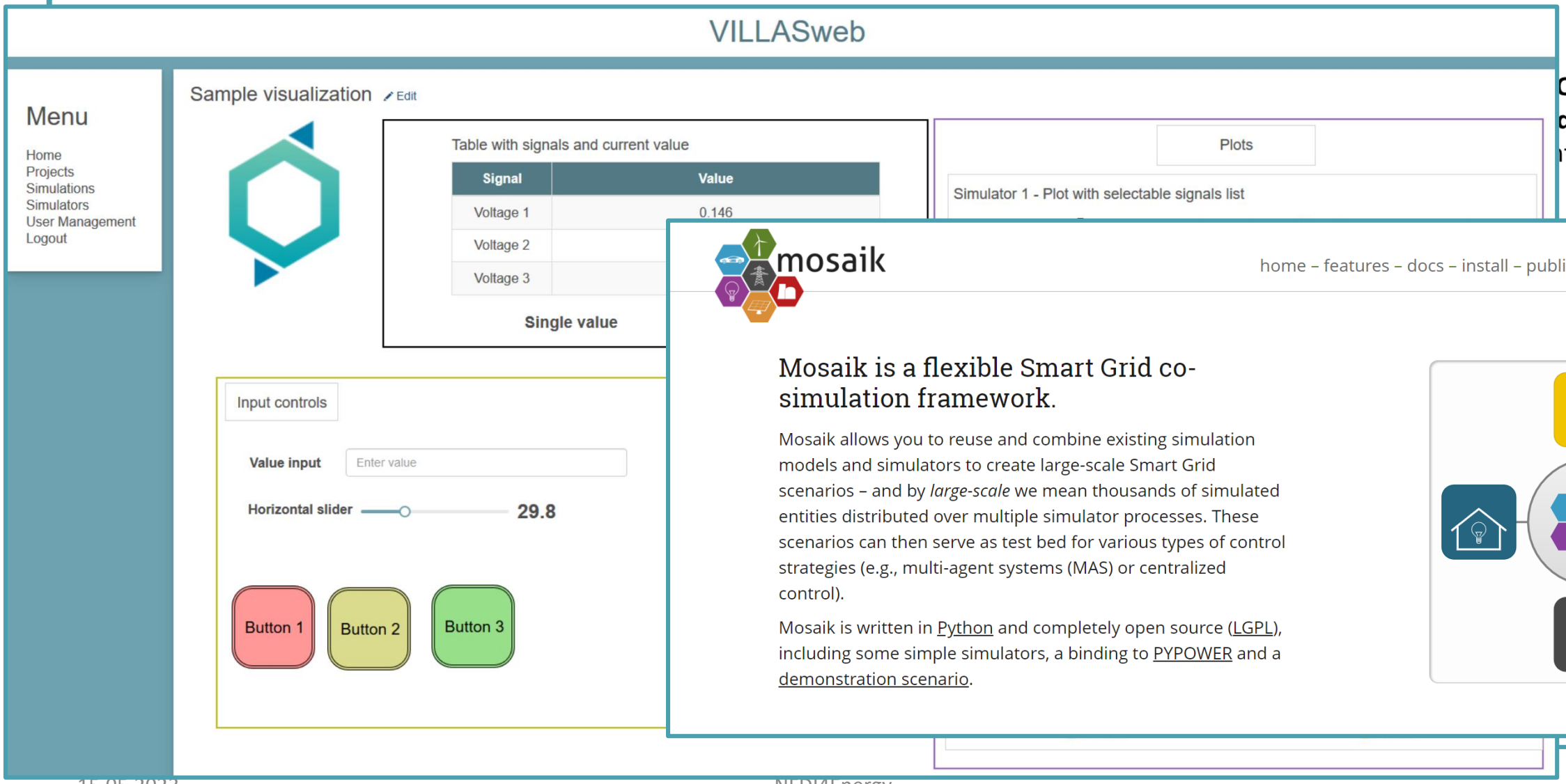
Workflows

- Detailed simulation configuration
- Best practices for public involvement



Own representation based on Wittenburg et al. 2019

Digital Objects in CPES Research (Examples)



Community Services

Competence to help to navigate the interdisciplinary research field

Transparency to involve more stakeholders in all research stages

Simulation **to couple existing simulations and, therefore, reuse software artefacts**

Best Practices to get information about successful conduct of research including research data management

Registry **to find suitable data and software**

Our partners

Power grids, automation systems, energy informatics

- **Spokesperson:** Prof. Astrid Nieße – Digitalisierte Energiesysteme, UOL
- Prof. Veit Hagenmeyer – Institute for Automation and Applied Informatics, KIT
- Prof. Reinhard German – Rechnernetze und Kommunikationssysteme, FAU
- Prof. Sebastian Lehnhoff – Energieinformatik, OFFIS
- Prof. Antonello Monti – Automation of Complex Power Systems, RWTH + FhFIT

Long-term energy scenarios

- Prof. Anke Weidlich – Institut für Nachhaltige Technische Systeme, Uni Freiburg
- Ludwig Hülk– Transformation von Energiesystemen, RLI

Energy policy and societal aspects

- Prof. Christof Weinhardt – Institute of Information Systems and Marketing, KIT
- Prof. Johan Lilliestam – Energy Transition Dynamics, RIFS
- Prof. Berthold Vogel – SOFI

Infrastructure and domain-invariant service provider

- Prof. Sören Auer – TIB

Registry and Simulation Services

Registry

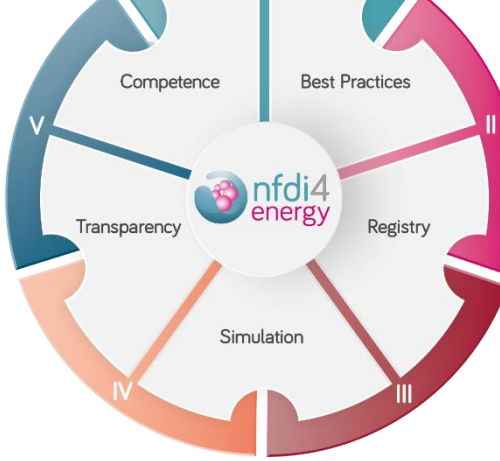
- **Metadata** for digital objects, based on requirement and involvement process
- Support of creation and integration of metadata based on **standards and controlled vocabularies**
- Based on **general services** like PID-Service from TIB
- Recommendation of existing **data repositories** for specific needs (e.g. high-temporal resolution)

Simulation

- **Simulation-as-a-Service** (SaaS) capabilities of the platform
- Distributed **co-simulation** and hardware-in-the-loop (HIL)
- **Access** also for non-simulation experts
- Include **interface exchange standards** like functional mockup interface (FMI)
- **Ontology-based assistance** for configuration and execution
- **FAIR**, not always open, data to support IP exploitation & reflect privacy restrictions

VILLASframework

Metadata, standards, ontology-based integration for research data and software



How do these service help me with my research?

Exemplary problem:
Coordinated Use of Flexibilities in the Electricity Grid

- Higher need for flexibility in the energy systems
- Market mechanisms can be used for flexibility
- Self-organization (SO) enable self-healing and adaptive systems
- Household and their acceptance for measures have to be considered from the start

Exemplary research question:

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

Find the Right Partners

What do we want?

- Industry knowledge on the flexible use of energy storages
- Research Partners with knowledge on flexibility from other domains, e.g., mobility
- Communication experts
- Social scientists to support with acceptance questions

How can the NFDI4Energy services help?

- *Competence* will provide an overview on research partners to find the right ones

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 to yield participation of all actors?

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

Comparing research via ORKG

ORKG View Tools About NFDI4DataScience Search... + Add new

Engineering » Mechanical Engineering » Energy Systems

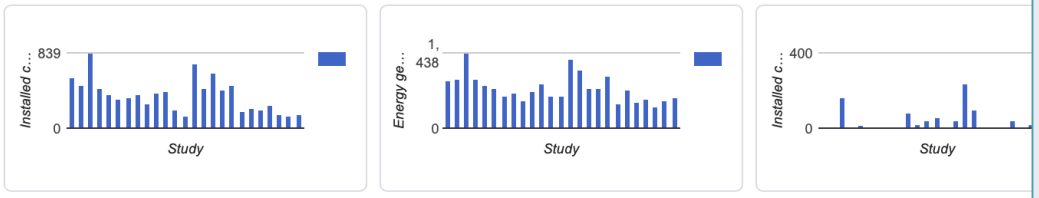
Comparison | 25 contributions

Comparison of Studies on Germany's Energy Supply in 2050

November 2021 | Felix Kullmann | Jan Göpfert | Oliver Karras | Patrick Kuckert | Peter Markewitz | Leander Kotzur | Detlef Stolten

This comparison compiles the results from various studies analyzing a future low-carbon ener
comparison is electricity generation. In the future, however, other essential characteristics of
individual studies will be listed.Installed capacity is given in GW and electricity generation is g
German Federal Government, the German State Governments, and the Joint Science Confere
the NFDI4Ing consortium. Funded by the German Research Foundation (DFG) - project numb
the Helmholtz Association under the program "Energy System Design".

DOI: https://doi.org/10.48366/r153801



ORKG View Tools About NFDI4DataScience Search...

Properties	Klimaneutrales Deutschland *Contribution - 2020*	Wasserstoff-Roadmap Nordrhein-Westfalen *Contribution - 2020*	Wege zu einem klimaneu Energiesystem *Contribution - 2020*
hasgoal/goal			
has description*	100% CO2 reduction until 2050	95% CO2 reduction until 2050	95% CO2 reduction unti
has value*	100	95	95
has unit*	percent	percent	percent
has type*	CO2 reduction	CO2 reduction	CO2 reduction
has time frame*	2050	2050	2050
has energy sources/bioenergy			
has electricity	Electricity generation	Electricity generation	Electricity generatio

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

How can the NFDI4Energy services help?

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

mango
modular python agent framework

mosaik
ecosystem

Combine the Models & Data to a Simulation Scenario

What do we want?

- Couple the different models and data to one simulation scenario

How can the NFDI4Energy services help?

- *Best Practices* will provide an overview on different methodologies to couple simulation models
- *Simulation* will
  - provide access to different co-simulation tools like mosaik or villasnode
  - allow to run simple co-simulation online as simulation-as-a-service

Add new Models

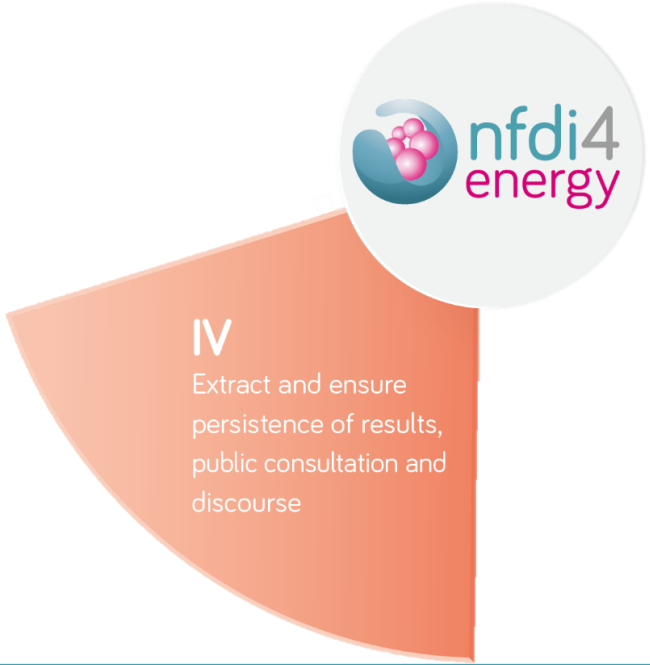
What do we want?

- A new robust distributed control strategy based on SO concepts

How can the NFDI4Energy services help?

- *Repository* will help to find existing models to built on
- *Best Practices* will provide an overview
  - on goods practices to write research software
  - on standardized interfaces to improve the interoperability of the new model

Analyze the Scenario



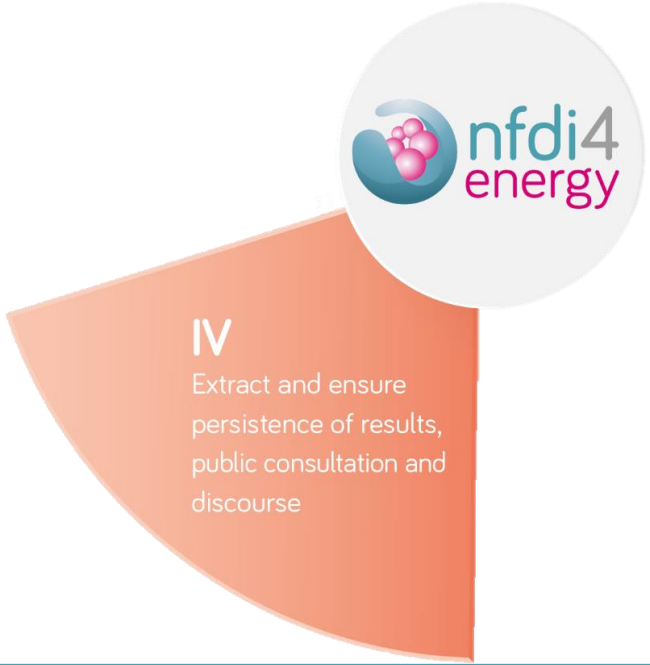
What do we want?

- Analysis of the performance of the new flexibility coordination
- Validation of the robustness of the new control strategy

How can the NFDI4Energy services help?

- *Best Practices* will give an overview on different methodologies and relevant characteristics to compare the performance
- *Best Practices* will give guidelines on how to validate robustness
- *ORKG* will enable directly comparison to other research results (consider connection to scenarios!)

Publish the new Model and Scenario



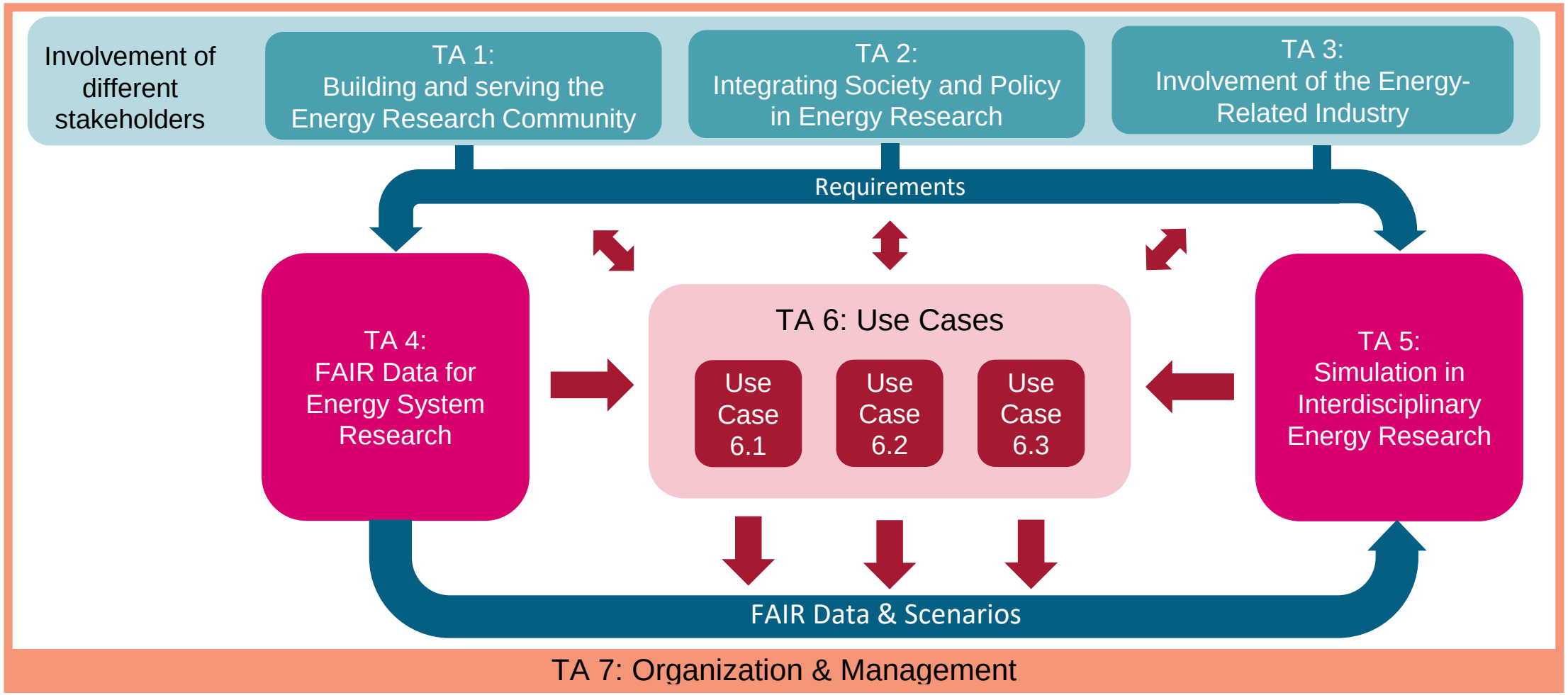
What do we want?

- 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?

- *Repository* 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

Overview on the Work Program



Building an open and FAIR Research Ecosystem for Energy Systems

1. Establish common research **community services** to allow **traceability, reproducibility, and transparency** with research data and software**.**
2. Simplify identification, integration, and coordination of **simulation-based models**.
3. Integrate the provided services within the **wider NFDI ecosystem**.
4. **Support their use** in the research community.
5. Enable and motivate the **involvement of society**.
6. Promote better **collaboration and knowledge transfer** between scientific research institutes and **business partners**.

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

Want to be kept updated?

- Website: nfdi4energy.de
- Newsletter: nfdi4energy@uol.de
- Twitter: @nfdi4energy
- LinkedIn: NFDI4Energy

- Yearly open community meeting to discuss developments in research management in energy research
  - First edition in March/April 2024!

Summary

- Project with high national relevance in Germany
- You are the “customers” ;-)
- Meta-project with focus on research data and research software
- Goal: Building a FAIR & Open Research Ecosystem for Energy Systems

→ We want to improve **your life** as researchers!

Contact

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