

# Enhancing Research Data Management (RDM) through Use Cases in Energy Research

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# Outline

- Motivation: Use Cases for RDM Services
- Use Case 1: Co-Simulation in Laboratories with Power-Hardware-in-the-Loop (PHiL)
- Use Case 2: Long term Energy System Scenarios, Society and Energy Politics
- Use Case 3: Distributed Simulation in Distributed Energy Systems
- Further Use Cases

# Use Cases for RDM Services

- Realistic small research project in energy research with a typical research question
- Research is conducted in a different way than the status-quo:
  - Focus on RDM aspect of research process
  - Better RDM based on services during the whole research life cycle



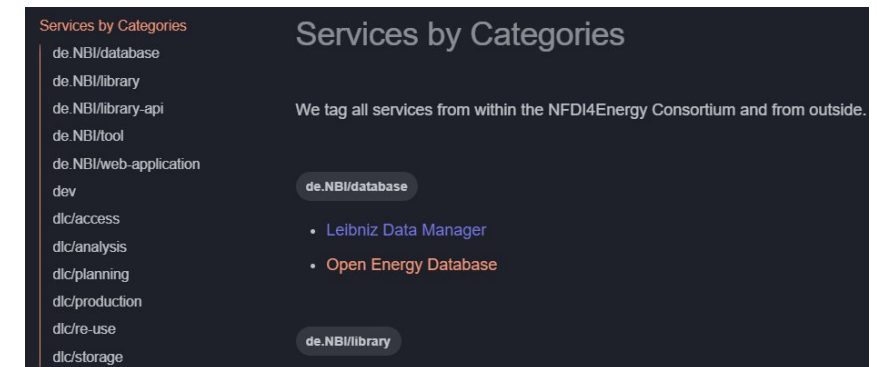
Continuously evaluate effect on usability of services & reusability and replicability of the results!

# Use Cases for RDM Services

- Services to improve RDM processes during the whole research life cycle
- In the use cases, suited RDM services are used
  - From NFDI4Energy and beyond (e.g., NFDI)
  - Feedback for services provided
  - Additional help for services: best practices, ..
  - Include services in typical workflow
    - To **improve** the workflow itself!



Overview of existing services!



# Use Cases for RDM Services

- Establish and support RDM services
  - and use in the community
- Showcasing services in typical research project
- Providing best practices, tutorials

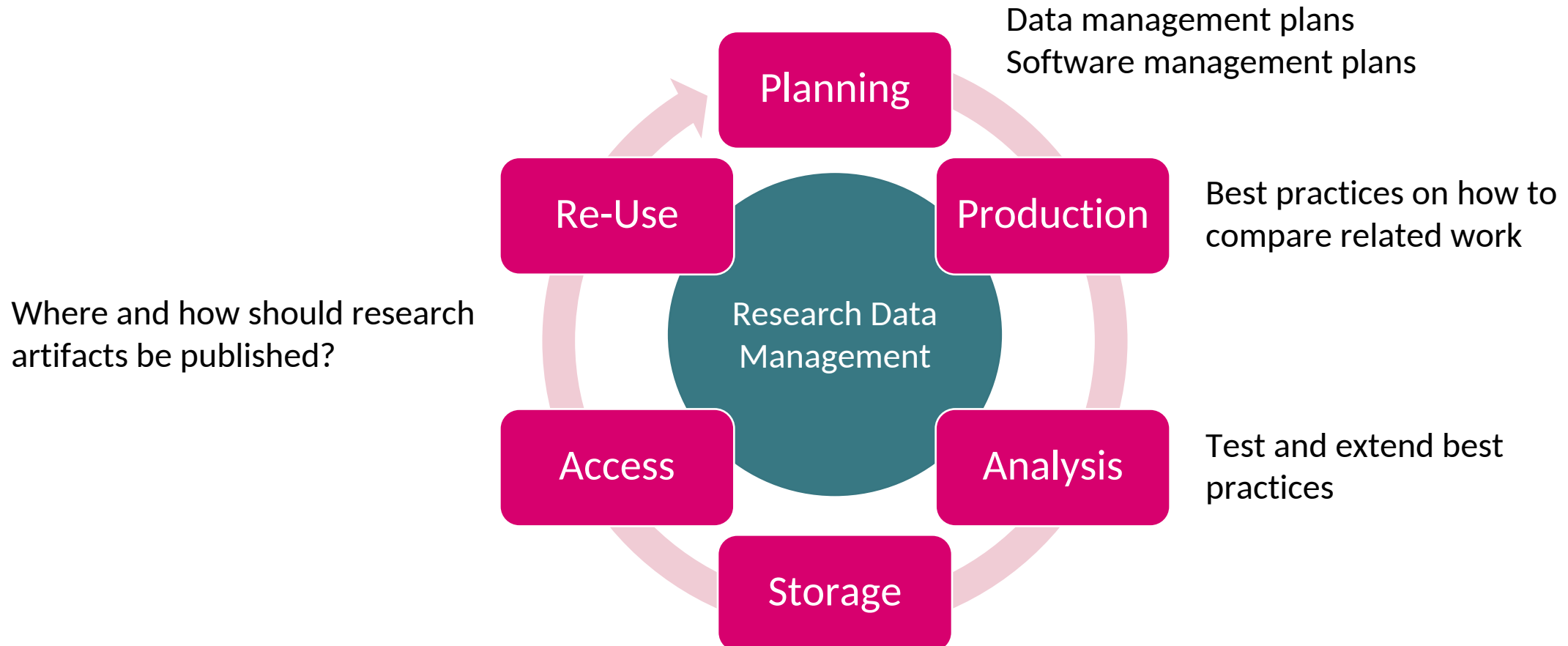
# Research Data Life Cycle

- NFDI4Energy aims to provide useful services for energy researchers in FAIR RDM:



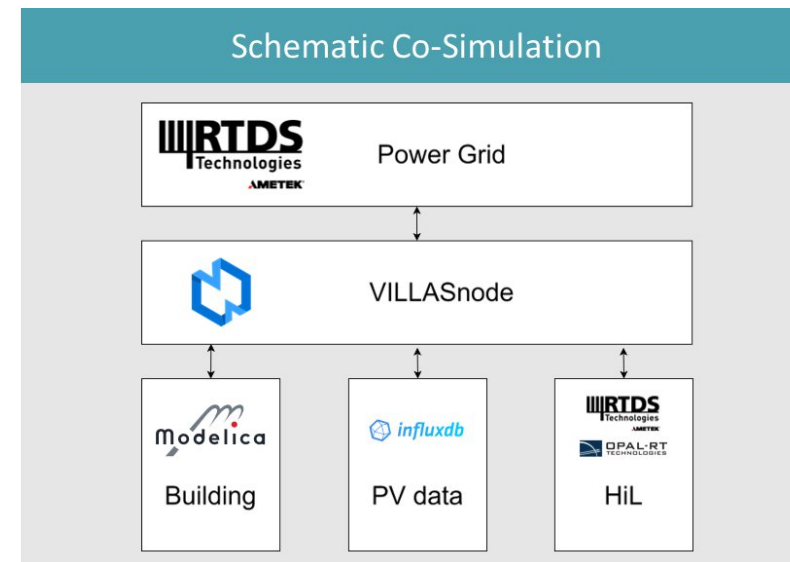
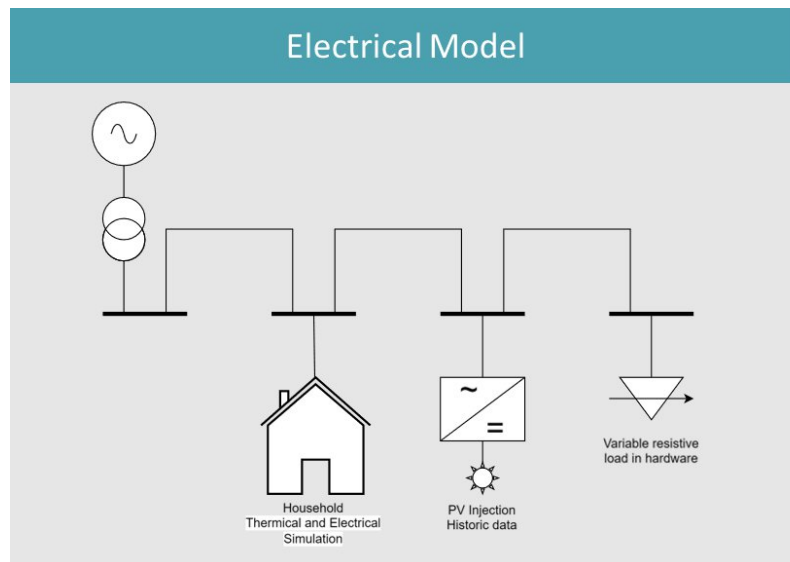
# Research Data Life Cycle

Outcomes of the use cases:



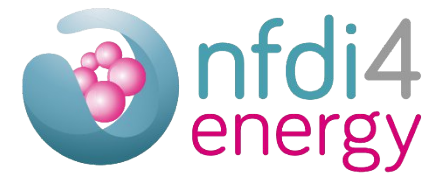
# Use Case 1: Co-Simulation in Laboratories with Power-Hardware-in-the-Loop (PHiL)

- Analysis of voltage quality in a distribution grid with and without controllable transformers with a hardware load that represents EV hyperchargers
- Using Co-Simulation with heterogeneous components and VILLASnode





# Use Case 1: Co-Simulation in Laboratories with Power-Hardware-in-the-Loop (PHiL)



- All simulation components need to be stored on open data registries and are resolvable to initiate the co-simulation
- The metadata for each component follows the NFDI4Energy guidelines on metadata
- The simulation scenario is defined as a semantic data artifact using the NFDI4Energy Co-Simulation ontology
- The simulation is orchestrated and executed from a simple interface via the NFDI4Energy Simulation-as-a-Service (SimaaS) hub

Meta
FAIR
Energy


Meta
FAIR
Energy


# Use Case 2: Long term Energy System Scenarios, Society and Energy Politics


- FAIR scenario data publication
  - Scenario factsheets coupled to database and model factsheets
- Scenario data comparison
- Visualizations and narratives






Climate neutrality, Energy security and Sustainability: A pathway to bridge the gap through Sufficiency, Efficiency and Renewables	CLEVER	<a href="#">CLEVER_suf</a>
Klimapfade 2.0 - Ein Wirtschaftsprogramm fuer Klima und Zukunft	Klimapfade 2.0	<a href="#">KP2.0-Referenz</a> <a href="#">KP2.0-Ziel</a>
Wege in eine ressourcenschonende Treibhausgasneutralitaet - RESCUE-Studie	RESCUE	<a href="#">Green Ee1</a> <a href="#">GreenLife</a> <a href="#">GreenSupreme</a> <a href="#">GreenMe</a> <a href="#">GreenLate</a> <a href="#">GreenEe2</a>
Langfristszenarien fuer die Transformation des Energiesystems in Deutschland 3	LFS-3	<a href="#">TN-H2-G</a> <a href="#">TN-Strom</a> <a href="#">TN-PIGPIL</a>
Treibhausgasneutralitaet in Deutschland bis 2045 - Ein Szenario aus dem Projekt SCI4climate.NRW	SCI4climate.NRW	<a href="#">S4C-KN</a>
Neue Ziele auf alten Wegen? - Strategien fuer eine treibhausgasneutrale Energieversorgung bis zum Jahr 2045	FZJI-KSG2045	<a href="#">FZJui-KSG2045</a>
The potential of behavioral changes to achieve a fully renewable energy system - A case study for Germany	Eerma-2022	<a href="#">Eerma-2022-LowAmb</a> <a href="#">Eerma-2022-HighAmb</a>
Centralized and decentral approaches succeed the 100 energiewende in Germany in the European context - A model-based analysis of generation, network, and storage investments	Kendzioriski-2022	
Deutschland auf dem Weg zur Klimaneutralitaet 2045 - Szenarien und Pfade im Modellvergleich	Ariadne-2045	<a href="#">E-Fuel</a> <a href="#">H2-Imp</a> <a href="#">H2-DE</a> <a href="#">Mix</a> <a href="#">Elek-DE</a> <a href="#">Trend</a> <a href="#">Elek-Imp</a>
dena-Leitstudie Aufbruch Klimaneutralitaet - E-gesamtgesellschaftliche Aufgabe		
Klimaneutrales Deutschland 2045: Wie Deutschland Klimaziele schon vor 2050 erreichen kann		


 Database

 Scenario Bundles ▾

 Ontology ▾

 Academy 

 About ▾

 Scenario Bundles

OVERVIEW

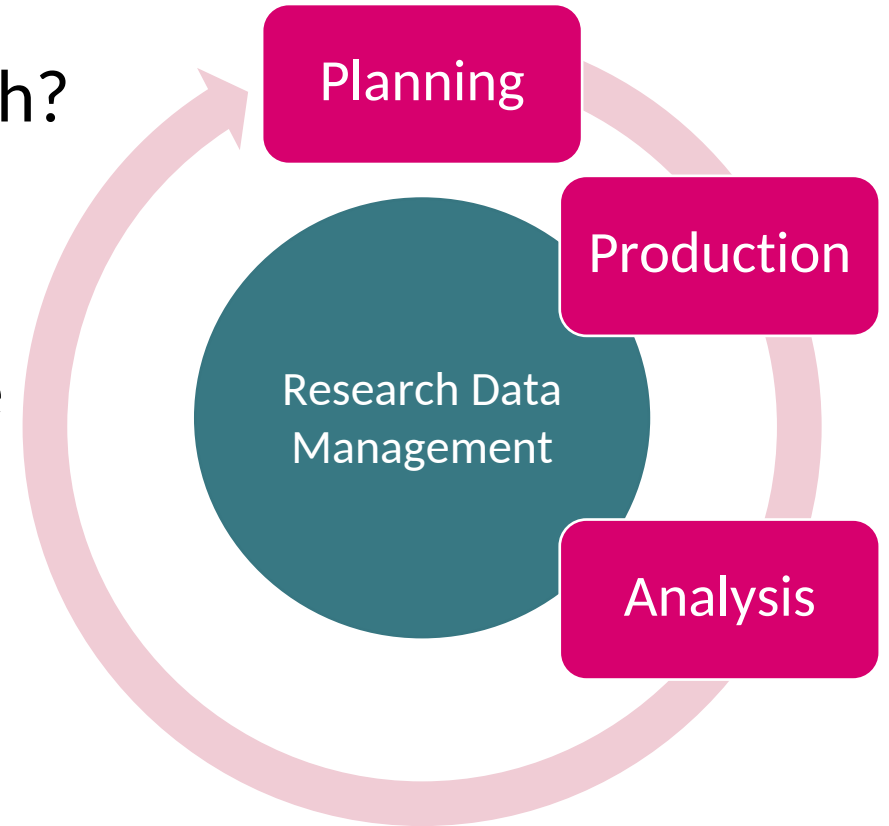
# Use Case 3: Distributed Simulation in Distributed Energy Systems

- *How to design a robust distributed system to coordinate flexibilities for the electricity grid?*
  - Decarbonization of the energy grid
  - Integration of decentralized generators, potentially flexible demand and local storage options
  - Distributed simulation is increasingly important in energy systems



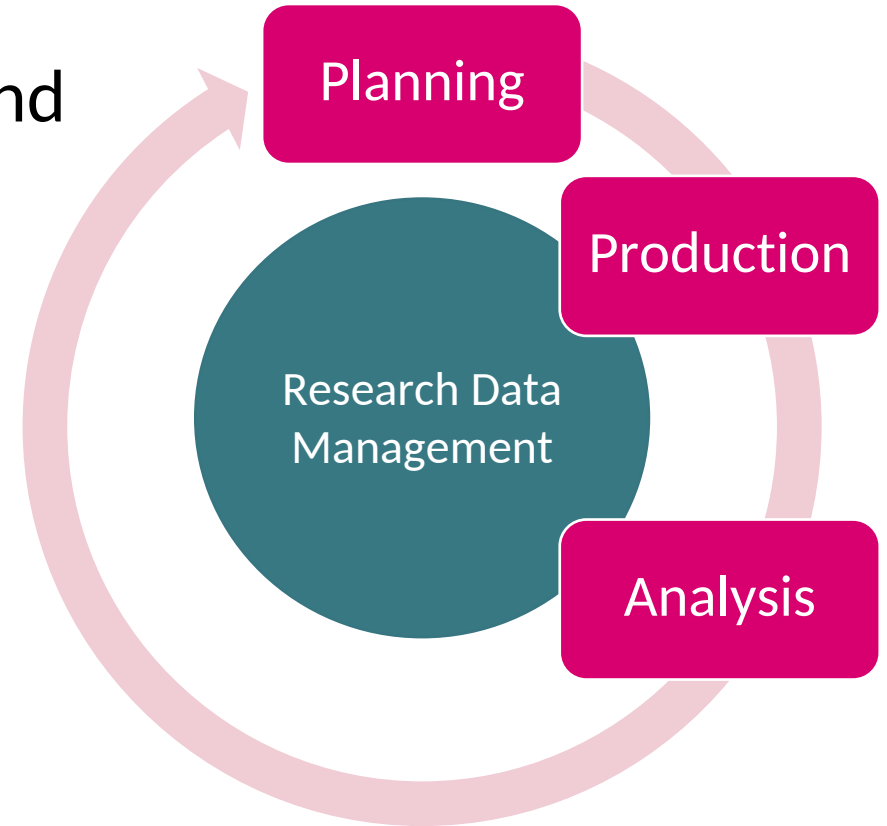
# Use Case 3: Distributed Simulation in Distributed Energy Systems

- Where do I find the right models to work with?
- Recommendation: use the Open Research Knowledge Graph (ORKG)!
- Encourage and help other researchers to use the ORKG for energy system research
- Collect findings and prepare explanation videos



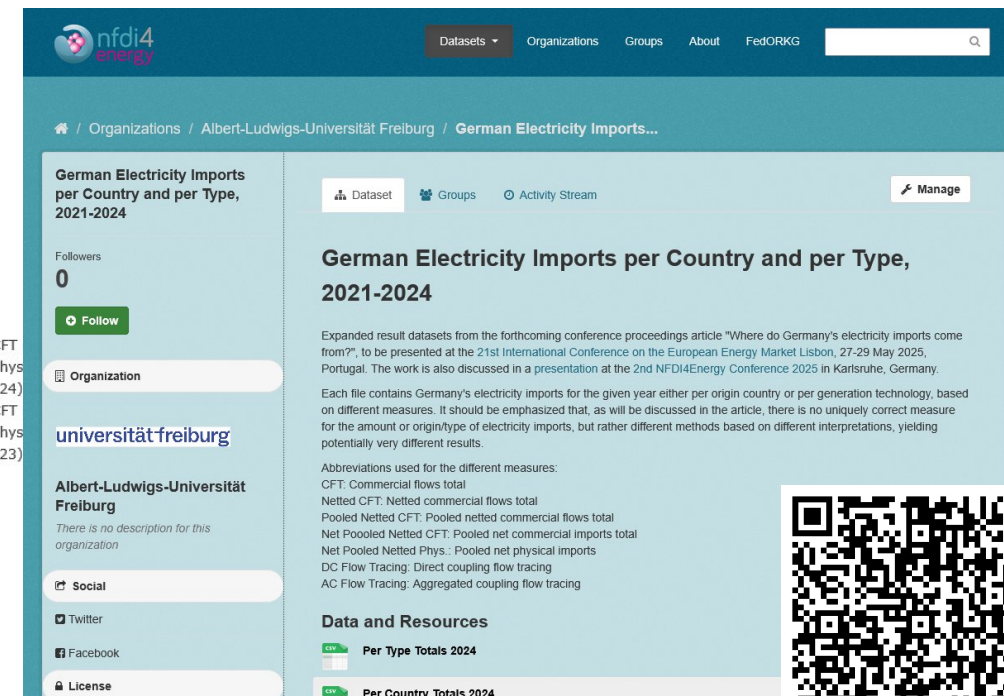
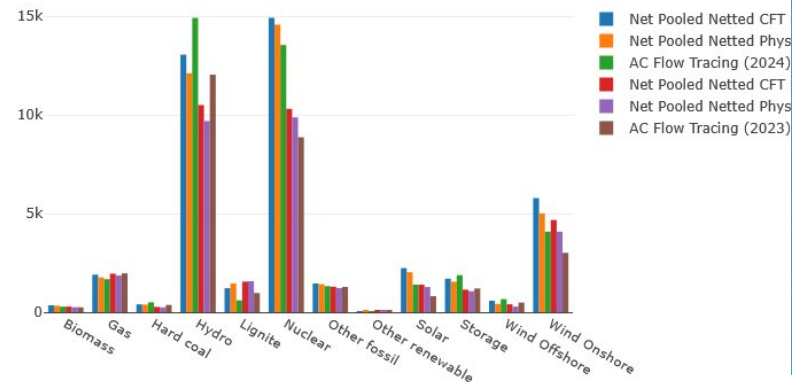
# Use Case 3: Distributed Simulation in Distributed Energy Systems

- Simulation of distributed energy resources and their flexibility
  - Very complex
  - Many different approaches
- Best practices on which criteria to consider
- Support others in finding a suitable model for their use case
- Publishing a website: flexibility models recommender



# Further Use Cases

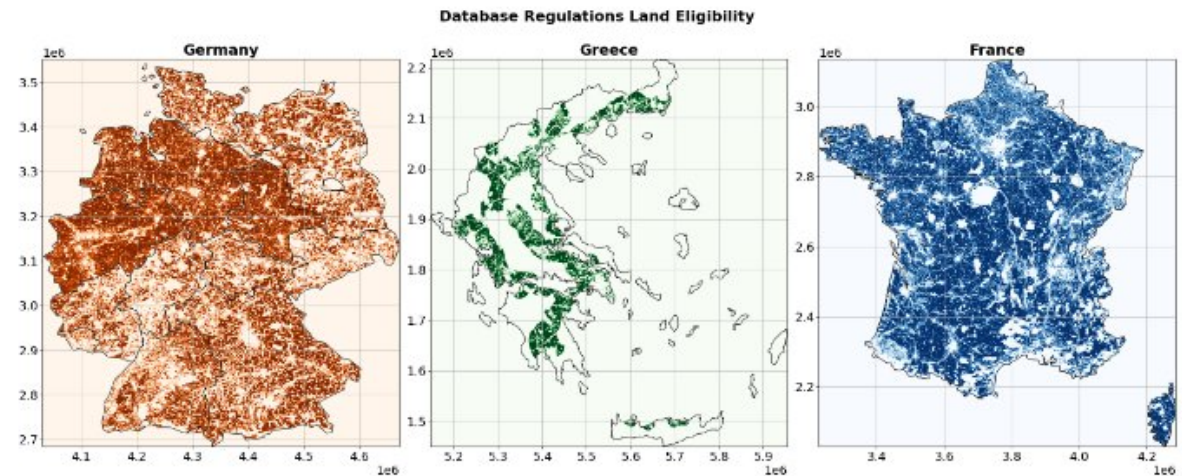
- Supplementary material in the Leibniz Data Manager in NFDI4Energy
  - Results data (visualization, comparison)
  - Additional material
  - ...



The screenshot displays the NFDI4Energy website interface. The top navigation bar includes links for Datasets, Organizations, Groups, About, and FedORRG. The main content area shows the dataset 'German Electricity Imports per Country and per Type, 2021-2024' under the organization 'Albert-Ludwigs-Universität Freiburg'. The page includes a 'Follow' button, a description of the dataset, and a QR code. The dataset description mentions that it contains Germany's electricity imports for the given year either per origin country or per generation technology, based on different measures. It also provides abbreviations for the different measures: CFT (Commercial flows total), Netted CFT (Netted commercial flows total), Pooled Netted CFT (Pooled netted commercial flows total), Net Pooled Netted CFT (Pooled net commercial imports total), Net Pooled Netted Phys (Pooled net physical imports), DC Flow Tracing (Direct coupling flow tracing), and AC Flow Tracing (Aggregated coupling flow tracing).

# Further Use Cases

- Integration of regulatory constraints into an energy system modeling tool
  - NFDI4Energy policy database including regulatory constraints on land availability for wind power expansion
  - Modeling tool *atlite* integrates constraints from database





# Use Cases to improve RDM

- Presented use cases will support workflows by
  - Usability of RDM services
  - Providing example applications
  - Making existing data easily accessible
  - Providing tutorials and best practices
- Showcase how concepts and services simplify existing workflows along the research life cycle
  - Supporting users in applying services
  - Promote use in the community



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Use existing services!  
Think about possible use cases!

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