

NFDI4Energy Case-Study: Comparative Analysis and Visualisation of Long-Term Energy System Scenarios

Mirko Schäfer¹, Ramiz Qussous¹, Ludwig Hülk², Johan Lilliestam³, Anke Weidlich¹

¹INATECH, University of Freiburg, Germany

²Reiner Lemoine Institut, Berlin, Germany

³Research Institute for Sustainability (RIFS) - Helmholtz Centre Potsdam, Germany

Abstract:

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1 Introduction and Motivation

Analysis and comparison of energy system scenarios provide valuable insights into potential transformation pathways. These studies on long-term developments can serve as new inputs for scientific research and decision-making processes, providing policymakers and other stakeholders with the necessary guidance to achieve sustainable energy systems. Generally, such scenarios are derived from energy system models which often seek a cost-optimal system design under a variety of boundary conditions, ranging from technical constraints to limits of land availability or a cap on overall greenhouse gas emissions [1]. For Germany, several larger energy system scenario studies have been published, addressing the goal of carbon neutrality in 2045 as prescribed in the German climate protection act [2]. These studies show differences in their specific methodology, sector representation, parameter settings or, more generally, overall scenario narratives. This diversity represents a challenge regarding the comparability of these studies, and consequently the ability to identify consensus and controversies in their findings. Often only limited access to data for parameter settings and scenario results is provided. Almost always the data is presented in different detail and formats, thus imposing further barriers for comparison and usability for the scientific community [3].

As one of the three use cases applied in Task Area 6 of the NFDI4Energy research project, we aim to address this challenge by providing transparent and open comparative information and data on long-term energy system scenarios. Selected scenarios for the transition towards a climate-neutral Germany will be annotated with terms from the Open Energy Ontology (OEO) [4]. The comparison is building on an already existing database infrastructure from the Open Energy Platform (OEP) [5]. Existing concepts for qualitative and quantitative comparisons will be used and improved to cover a wide range of existing energy system studies.

2 Task Area Objectives and Procedures

The Task Area consists of four measures, which are in various ways connected to other measures from different Task Areas of the NFDI4Energy project. In the first measure, the scope and requirements of the scenario analysis is defined. For this purpose, suitable scenarios and comparable parameters have to be identified and analysed. An overview regarding already existing scenario comparison studies and databases will be created. An important part of the process is the preparation of the needed data sets and the annotation of the parameters with corresponding ontology terms, which allows effective and semi-automated scenario comparisons.

In the second measure, the existing data infrastructure will be enhanced and additional scenarios will be implemented. The already existing concepts from previous projects like the research project SzenarienDB and the ongoing research project SIROP are examined and evaluated [6]. The existing Scenario Factsheets, a standardised energy scenario description, are improved and extended.

Whereas the first two measures focus on identifying, processing and comparing scenarios and data, the third measure (Develop and validate draft visualisations) addresses the visualisation and communication of scenario results. To clarify requirements for this process, target groups from the public will be selected based on results from Task Area 2 (Integrating Society and Policy in Energy Research). The goal is to provide visualisations with interactive elements, which address the target groups' interests and needs. Feedback cycles with the target groups and the scientific community will be implemented throughout the overall project to adapt the presentations to new scenario results or to specific interests from various stakeholders.

The fourth measure (Involve the public & decision-makers) will contain focus group processes with selected target groups to test the visualisation tools and interactive elements for scenario analysis. This process will not only allow to improve and adapt the scenario comparison service from this Task Area, but also helps to identify mismatches between the needs of users and modellers regarding the types of models and analysis applied to study long term scenarios of the energy transition [7], [8]. The central outcome of this measure will be a communication guide for modellers targeting specific audiences.

3 Conclusions

This case study from Task Area 6 of the NFDI4Energy project addresses different challenges from Research Data Management and Infrastructure. Data from a wide range of energy system scenario studies is collected, structured, and concepts for scenario comparison are developed and implemented. To facilitate the communication of the resulting analysis to a wide range of stakeholders, concepts for visualisations and interactive elements will be developed and tested with selected target groups. This process not only assures that the insights from these studies are understandable and accessible to the public, but also provides a valuable feedback cycle from the users of this service back to energy system modellers in the scientific community.

Author contributions

Conceptualization, M.S., R.Q., L.W.; methodology, M.S., L.W. writing—original draft preparation, M.S.; writing—review and editing, M.S., A.W., R.Q.,L.W.,J.L.; supervision, A.W.

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Competing interests

The authors declare that they have no competing interests.

ORCID iDs

Mirko Schäfer <https://orcid.org/0000-0002-8029-949X> Ramiz Qussous <https://orcid.org/0000-0002-1989-314X> Ludwig Hülk <https://orcid.org/0000-0003-4655-2321> Johan Lilliestam <https://orcid.org/0000-0001-6913-5956> Anke Weidlich <https://orcid.org/0000-0003-2361-0912>

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