

Methodische Transparenz & Forschungsdatenmanagement in der Systemanalyse - Einblicke und Diskussionen aus NFDI4Energy -

Jahrestreffen 2026 des Forschungsnetzwerks Energiesystemanalyse

In cooperation with

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Wer sind wir?



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SOFI Soziologisches
Forschungsinstitut
Göttingen

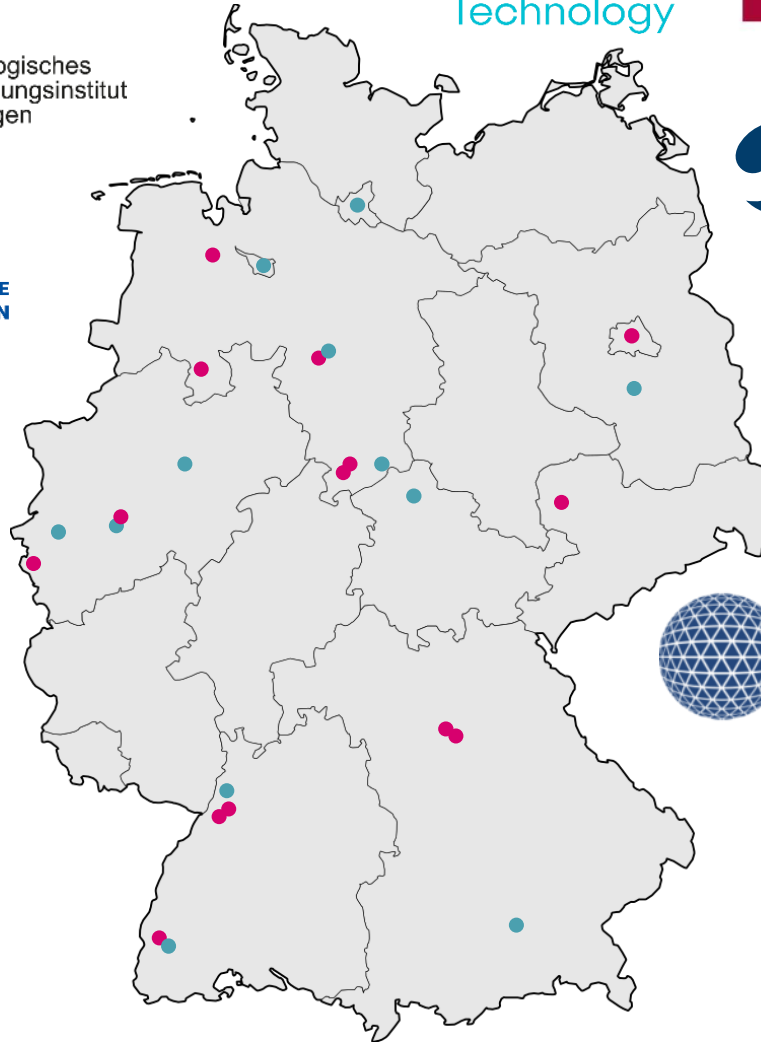


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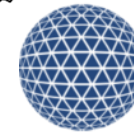
JÜLICH
Forschungszentrum

**Leibniz
Universität
Hannover**

fortiss

DLR Deutsches Zentrum
für Luft- und Raumfahrt

P I K
POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH



InfAI
Institut für Angewandte Informatik

**Technische
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Braunschweig**

Öko-Institut e.V.
Institut für angewandte Ökologie
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Funded Consortium

Consortium in the NFDI

Map by David Liuzzo, [CC BY-SA 2.0 DE](https://upload.wikimedia.org/wikipedia/commons/e/e3/Karte_Deutschland.svg), via Wikimedia Commons,
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Carl von Ossietzky
Universität
Oldenburg

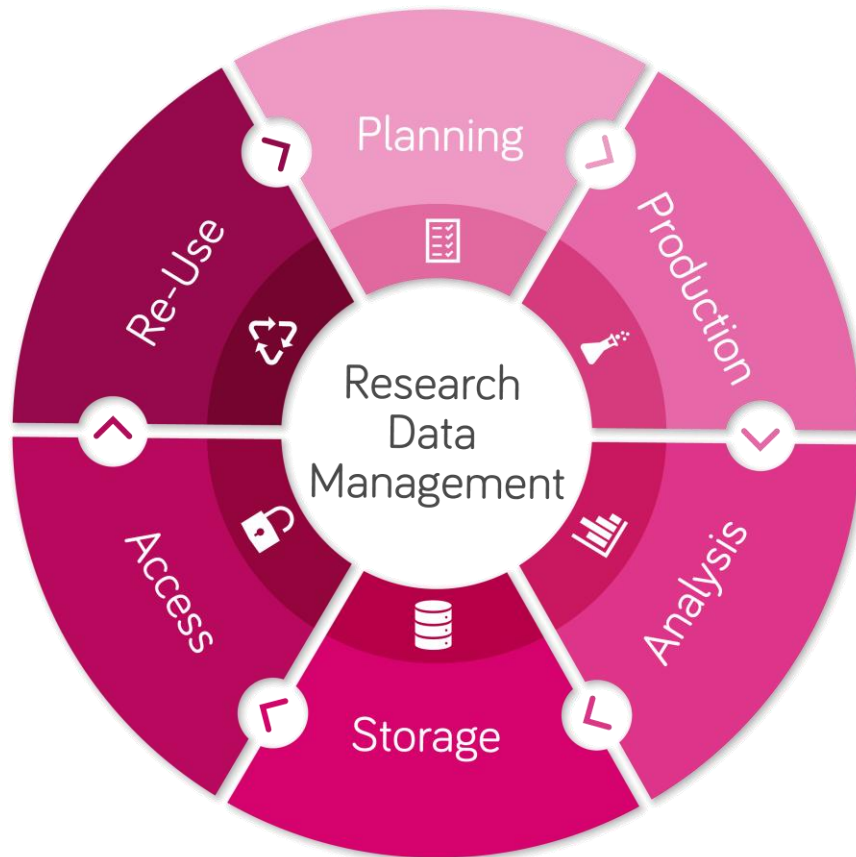
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Bremen** universität freiburg



Planung (Planning)

Forschungsfrage, Datenbedarf, Formate und Zuständigkeiten festlegen

Produktion (Production)

Daten erfassen, generieren und dokumentieren.

Analyse (Analysis)

Daten bereinigen, verarbeiten und auswerten.

Speicherung (Storage)

Daten organisieren, sichern und aufbewahren.

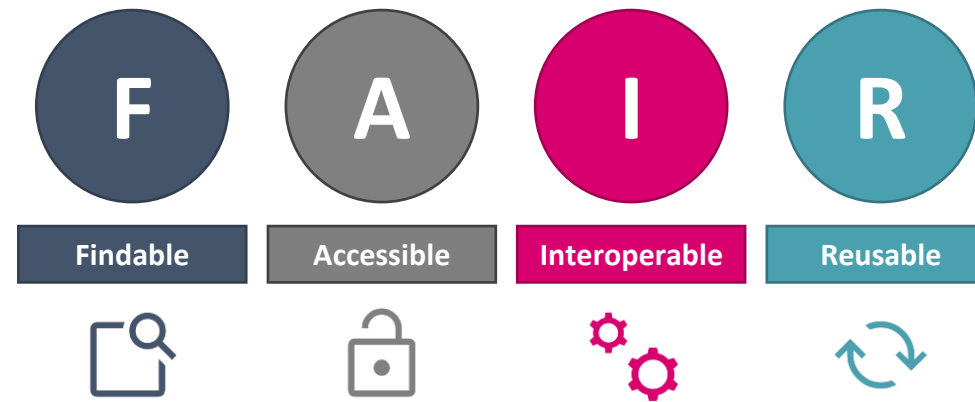
Zugang (Access)

Daten in Repositorien mit klaren Berechtigungen und Metadaten teilen.

Wiederverwendung (Re-Use)

Neue Forschungen, Nachuntersuchungen und Analysen ermöglichen.

FAIR Prinzipien



Findable (*auffindbar*)

Daten sollten durch eindeutige Metadaten und dauerhafte Identifikatoren leicht auffindbar sein.

Accessible (*zugänglich*)

Daten sollten über Standardprotokolle abrufbar sein, wobei die Zugangsbedingungen klar festgelegt sein müssen.

Interoperable (*kompatibel*)

Daten sollten einheitliche Formate, Vokabulare und Standards verwenden, damit sie von verschiedenen Systemen verarbeitet werden können.

Reusable (*wiederverwendbar*)

Daten sollten gut beschrieben, lizenziert und dokumentiert sein, damit andere sie wiederverwenden können.

Was sind Metadaten?

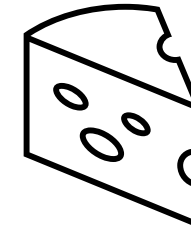
“Metadata is structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use or manage an information resource”

Oder einfach: **DATEN ÜBER DATEN**

Was sind Metadaten?



Informationsquelle/
Digitales Objekt



Attribut	Wert
Energie	307 kcal
Zucker	1 g
Fett	4 g
Protein	9 g

Metadaten Erklärung

Attribut	Wert
Energie	392 kcal
Zucker	0 g
Fett	32 g
Salz	2 g

U. Albano, "Entwicklung eines Metadatenschemas für Energieforschungsszenarien (EFS-Meta)", 2023.

Leibniz Data Manager (LDM)

Der LDM ist eine open-source, webbasierte Anwendung für das Forschungsdatenmanagement (FDM), entwickelt von TIB und Leibniz Universität Hannover. Er unterstützt die Verwaltung, den Zugriff und die Analyse heterogener Forschungsdaten unter Einhaltung der **FAIR-Prinzipien**.

Kernfunktionen



Hochladen



Herunterladen



Organisieren



2D/3D Visualisierung



CAD Unterstützung



Live-Coding



DOI Generierung



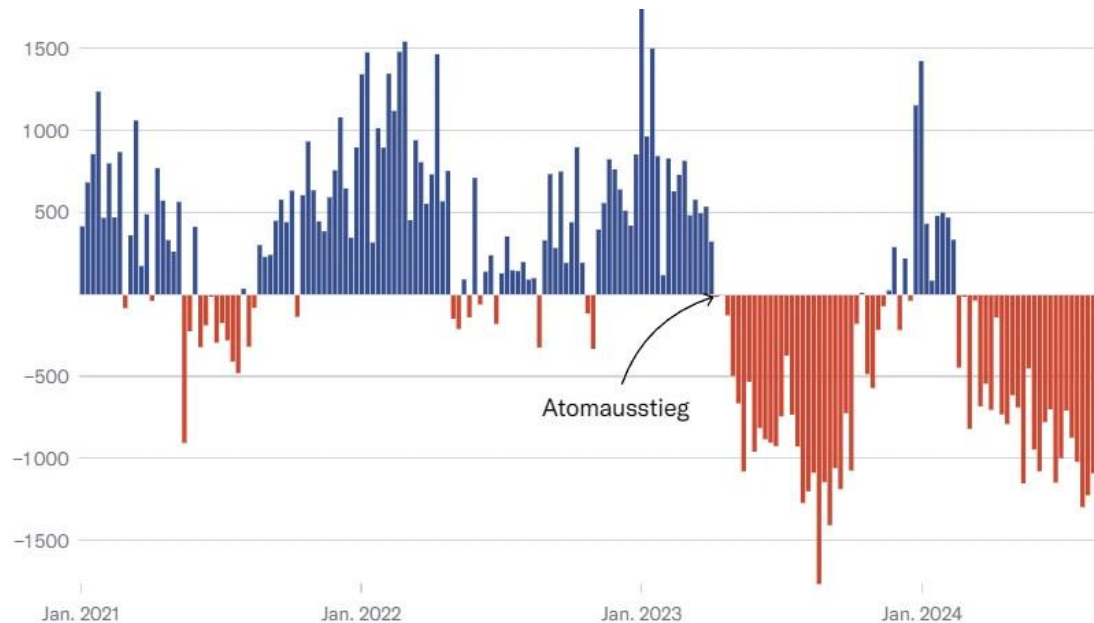
Synchronisierung



Semantische Suche



Warum der Fall "Stromimporte" wichtig ist



Negative Werte in Rot bedeuten Importe, positive Werte in Blau Exporte. Nachmeldungen möglich.

Stand: 26. 8. 2024

Quelle: [Bundesnetzagentur/Entso-E](https://www.bundesnetzagentur.de/Entso-E)

<https://www.nzz.ch/visuals/warum-ist-strom-in-deutschland-so-teuer-alle-zahlen-ld.1683901>

NZZ / sih.

- Auswertungen zu Umfang und „Herkunft“ von Stromimporten gehen in die öffentliche Diskussion ein
- Daten sind zwar verfügbar, Interpretation ist aber anspruchsvoll

M. Schäfer, T. Buckley, A. Weidlich and F. Boerman, "Where Do Germany's Electricity Imports Come From?," 2025 21st International Conference on the European Energy Market (EEM), Lisbon, Portugal, 2025, pp. 1-5, doi: 10.1109/EEM64765.2025.11050092.

► Ergebnisse hängen stark von **Daten** und **Methode** ab!

NFDI4Energy-Showcase:

Warum eine Veröffentlichung allein nicht reicht



- Paper liefert die **Hauptfrage** und die **Kernergebnisse**
- Für die vollständige Nachvollziehbarkeit reichen Text und Abbildungen oft nicht aus.



- Ergänzende **Daten** und **Methodenhinweise** werden deshalb separat veröffentlicht.

► Details zu **Datengrundlage**, **Varianten** und **Annahmen** bleiben nachvollziehbar erhalten.

FAIRe-Dokumentation im LDM

Das Paper liefert die Kernaussage – im LDM werden die ergänzenden Daten und Methoden transparent dokumentiert.

Where do Germany's electricity imports come from?

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Abstract— In 2023, Germany's electricity trade balance shifted from net exports to net imports for the first time since 2002, resulting in an increasing discussion of these imports in the public debate. This study discusses different data driven approaches for the analysis of Germany's cross-border trade, with a focus on the methodological challenges to determine the origin of imported electricity within the framework of European electricity market coupling. While scheduled commercial flows from ENTSO-E are often used as indicators, generally these do not correspond to bilateral exchanges between different market actors. In particular, for day-ahead market coupling only net positions have an economically reasonable interpretation, and scheduled commercial exchanges are defined through ex-post algorithmic calculations. Any measure of the origin of electricity imports thus depends on some underlying interpretation and corresponding method, ranging from local flow patterns to correlations in net positions. To illustrate this dependence on methodological choices, we compare different approaches to determine the origin of electricity imports for hourly European power system data for 2024.

Index Terms—Electricity markets, Electricity trading, Power transmission, Power system analysis, Load flow analysis

I. INTRODUCTION

The transformation of the German electricity system as part of the "Energiewende" is analyzed and discussed based on a variety of data sources, including generation and load data, prices on different markets, redispatch costs and further indicators. One topic which receives considerable attention also in the public sphere is the increasing amount of electricity imports of Germany. For the last two decades, Germany mostly had been a net exporter of electricity, but since 2023 shifted to being a net importer, with annual imports of 77.2 TWh facing exports of 48.9 TWh according to a report by Agora Energiewende [1]. Given that Germany has phased out its nuclear power plants and is in the process of phasing out its electricity generation from coal, this increase in imports has been discussed for instance in the context of energy security, system and consumer costs, or with respect to the type and origin of electricity imports. The annual trade balance of electricity imports in Germany still does only amount to about 5% of its total power consumption and is rather the result of efficient electricity markets than a sign of critical dependencies [2] [3]. But given the increasing interest in the topic, and the

challenges in correctly interpreting various data sources of coupled electricity markets, in this contribution we focus on this question - how much electricity does Germany import, and where do these imports come from?

Most analysis of electricity imports is based on data from the European Network of Transmission System Operators for electricity, ENTSO-E. Through the ENTSO-E Transparency Page [4], hourly values for scheduled commercial exchanges between physically connected bidding zones are published. These values are also republished by the service SMARD [5] from the German Federal Network Agency ("Bundesnetzagentur") and by services like Aggramer [6] from Agora Energiewende or Energy-Charts [7] from Fraunhofer ISE. The name and usage of this data suggests that these flows represent underlying bilateral trade relations between electrically neighboring countries, allowing conclusions about how much electricity has been imported from a specific country in a specific market time unit. However, such an interpretation is misleading.

For the day-ahead market, the published scheduled commercial exchanges are calculated algorithmically ex-post for scheduling purposes and as an analytical instrument, but do not directly represent underlying bilateral trades or necessarily take into account grid restrictions. The calculation takes place after the day-ahead market result, published as scheduled commercial flows day-ahead [8]. In the single day-ahead market coupling (SDAC), an optimum of exchange relationships is calculated across all participating countries, with transmission constraints integrated as restrictions on the set of allowed zonal net import/export values. This Europe-wide cost-efficient market result determines net exchange positions for each market zone to optimize overall welfare [9]. Accordingly, only these zonal net exchange positions have a direct economic meaning in the market data.

In the intraday market, continuous trading between market participants takes place, with trades between different bidding zones algorithmically given a certain path in the system [10]. The superposition of trade paths from the single intraday coupling (SIDC) and the scheduled commercial flows from the day-ahead market result are published by ENTSO-E as scheduled commercial flows total [10]. This dataset is most commonly used for electricity import and export analysis. Consequently, these commercial flows cannot be directly used

German Electricity Imports per Country and per Type, 2021-2025 [Dataset and supplementary material]

Expanded result datasets from the conference proceedings article presented at the 21st International Conference on the European preprint available here). The work was also discussed in a press Karlsruhe, Germany.

Each file contains electricity imports of the Germany-Luxembourg (accordingly, per origin country can be calculated by aggregating technology, based on different measures. Additionally, complete per origin type per bidding zone are available. It should be emphasized that these measures are for the amount or origin/type of electricity interpretations, yielding potentially very different results.

Abbreviations used for the different measures*:

CFT: Commercial flows total
Netted CFT: Netted commercial flows total
Pooled Net CFT: Pooled net commercial imports total
Pooled Net Phys.: Pooled net physical imports
DC Flow Tracing: Direct coupling flow tracing
AC Flow Tracing: Aggregated coupling flow tracing

All results are given in TWh for yearly values, and MWh for hourly values. Additional information on the flow tracing method can be found in the supplementary material. Values can slightly differ despite conceptually being equal due to rounding.

*Note that the Pooled Netted CFT method has been deprecated.

Data and Resources

DE_LU Import Per Bidding Zone Totals 2025

CSV containing DE_LU's annual import totals (in TWh) for 2025 across all 6...

Explore

Supplementary Material

Definitions of the different measures applied to determine the origin of...

Explore

1 Input data

All data is taken from the ENTSO-E transparency page [1] unless otherwise stated. In the following n represents a region (either a country or a bidding zone), and t denotes a specific hour. If a time series is originally published with a higher temporal resolution (quarter-hourly, for instance), its average for the given hour is calculated. The following data is used:

- Actual Generation per Production Type $g_{(n,\alpha),t}$ at time t in region n , where α denotes the production type (like Fossil Gas or Lignite, for instance) [2]. The generation mix $r_{(n,\alpha),t}$ in region n at time t is defined as
$$r_{(n,\alpha),t} = \frac{g_{(n,\alpha),t}}{\sum_{\alpha} g_{(n,\alpha),t}} \quad (1)$$
- Scheduled Commercial Exchanges from region k to region n at time t , with $f_{k \rightarrow n,t}^{C:DA}$ denoting the Commercial Schedules after Single Day-Ahead coupling (SDAC), and $f_{k \rightarrow n,t}^{C:T}$ representing the Commercial Schedules after Single Intraday Coupling (SIC) [3].
- Cross-border physical flows $f_{k \rightarrow n,t}^P$ from region k to region n at time t [4].

Search:					
Bidding Zone	CFT	Netted CFT	Pooled Net CFT	Pooled Net Phys.	DC Flow Tracing
AT	1.2269231922500001	0.8856297455	0.5323540015878885	0.5596663330725867	1.3419855829835636
BA	0.0	0.0	0.33779394629959053	0.3475161552013359	0.0005061562902689724
BE	6.2052678000000006	4.605829875	0.026719707770042896	0.02757065956325563	3.431644313017298
BG	0.0	0.0	0.427773177738267	0.475351831937172	0.00021304002422290567
CH	6.461046889250001	6.20847017425	1.5601527621116156	1.5311923651263062	3.6651900236025328
CZ	2.652481675	1.664547	1.3926984876996775	1.229646566678868	1.7661027979239146
DK_1	14.979172375	12.2015035	0.42276668733157363	0.24946939427344267	3.6885402766091913
		3.3674769749999998	0.0034556075375144356	0.0041613906189169915	1.5945195160919285
		0.0	0.005270800040484846	0.006077344108617715	0.001162680968044475
		0.0	1.3658614534225894	1.3771868908724494	0.23888188037029354
Additional Information					
Field	Value				
Created	April 21, 2026				
Last updated	April 22, 2026				
Format	CSV				
Automatic Update	No				
Encoding	UTF-8				
Media Type	Files				
Publication Date	2026-04-22				
Spatial Information	Spatial Information 1				
Hidden Location	Location 1				
Address	Germany and Luxembourg				
Latitude	51.165691				
Longitude	10.451526				
Export					

Ablauf des Workshops

