



## Bachelor Thesis

# Data Center Load Profiles and Electricity Demand for 2030 and 2045

Data centers consumed approximately 460 TWh of electricity in 2022, accounting for 2% of global electricity demand. This demand is expected to double by 2026 due to the rising needs for cryptocurrency mining, AI computation, and cloud services, and could potentially quadruple (IEA, p. 31). Understanding the structure of data center electricity demand is crucial for optimizing their role in the energy system.

This thesis aims to quantify future data center electricity demand in Germany and Europe using a bottom-up approach. The primary focus is on developing structured hourly load profiles from computational workloads, which will then be scaled to estimate yearly, national electricity demand for 2030 and 2045, weighted by data center type, technological development and operational characteristics.

The analysis will identify key drivers of electricity consumption for both data center load profiles (e.g., efficiency improvements, locational choices) and aggregated national demand projections (e.g., AI growth, increasing data traffic). Additionally, the thesis should assess uncertainties affecting future demand projections (e.g., market trends). While the primary goal is data center electricity demand, the study may optionally explore the potential for workload flexibility. By providing data-driven estimates, this thesis will contribute to a more precise understanding of data centers' role in the energy system.

## Key tasks and objectives of the thesis

- Collect and analyze data on data center electricity consumption by workload type, size, and operational characteristics.
- Develop a bottom-up methodology to generate structured hourly load profiles for data centers in Germany and Europe by data center type.
- Scale load profiles to estimate national electricity demand for 2030 and 2045, weighted by data center type and operations.
- Identify key data center electricity demand drivers for both data center load profiles (e.g., efficiency, cooling) and nation level (e.g., AI growth, cloud computing).

## Your profile

- Student in Economics and general knowledge in the field of Energy Economics
- Interest in data centers, energy demand and energy systems.

## Literature

- IEA, International Energy Agency. Electricity 2024 - Analysis and forecast to 2026.
- Masanet et al. (2020). Recalibrating Global Data Center Energy-Use Estimates. *Science*, 367(6481), 984-986.
- Malmodin & Lundén (2018). The Energy and Carbon Footprint of the Global ICT and E&M Sectors 2010–2015. *Sustainability*, 10(9), 3027.

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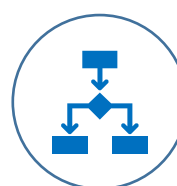
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## Topics



- Data centers
- Electricity load profiles

## Methods



- Data collection
- Bottom-up modeling
- Scenario analysis

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