German Economic Team

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POLICY BRIEFING UZBEKISTAN

Uzbekistan's electricity demand forecasting: an outlook until 2035 - Summary of results -

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Executive Summary

- Rapid **economic and population growth** are driving changes in electricity use, also influenced by industrialisation, transport electrification, and energy efficiency measures
- Furthermore, electricity consumption **patterns** are expected to shift due to factors such as increased **industrialisation**, the **electrification of transportation**, and the implementation of **energy efficiency** measures
- Persistent **supply shortages** highlight the urgency of aligning **capacity expansion** with projected demand growth
- This study models **electricity demand in Uzbekistan up to 2035**, evaluating the potential impact of various economic and policy assumptions on the country's electricity needs
- **Electricity demand** is **expected to increase significantly** in the coming years
  - Annual consumption forecasts range from **109 to 123 TWh in 2030** (+35-52%) and **131 to 151 TWh in 2035** (+62-87%)
  - Peak demand is projected to reach **17.4 to 19.2 GW in 2030** (+41-56%) and **20.3 to 23 GW in 2035** (+64-86%)
- **External variables** such as expectations on GDP growth, sectoral shifts, and tariff changes were found to **significantly influence the projections**
- To meet future electricity demand while supporting economic growth, this study identifies several direct and indirect implications for policy-making:
  - Establish in-house forecasting capabilities, ensure robust capacity planning, maintain tariff reforms and leverage demand-side management tools

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1. Introduction

- Rapid **economic and population growth**, alongside **industrialisation, transport electrification**, and **energy efficiency** initiatives, are influencing future electricity consumption
- Accurate demand projections essential for appropriate **capacity expansion** planning
- This study models **electricity demand in Uzbekistan up to 2035**, evaluating the potential impact of various economic and policy assumptions on the country's electricity needs

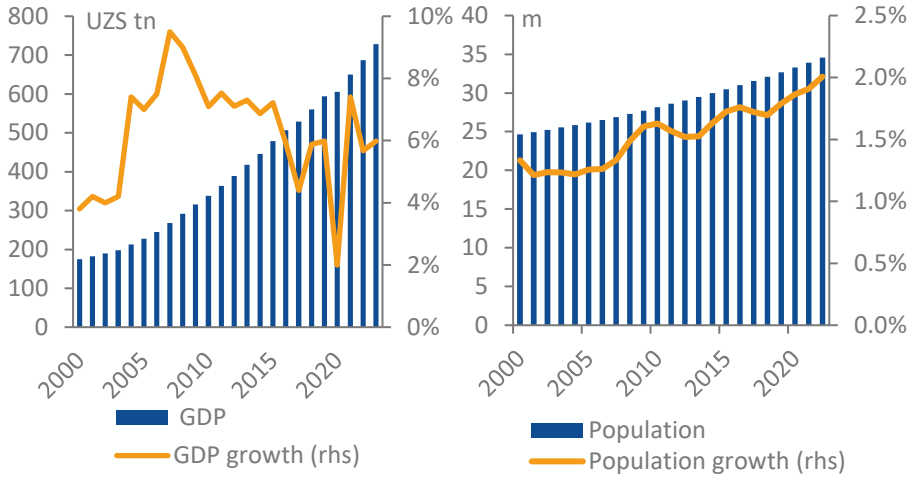
Relevance of electricity demand forecasting

- Policy planning
  - Ensure **adequate capacity expansion** plans to align with projected demand growth
  - Incorporate policy measures to mitigate demand growth (e.g., energy efficiency measures)
- Risk of underestimating demand
  - Threatens energy security, potentially leading to blackouts and **supply disruptions**
  - Impacts daily life, industrial activity, and overall economic stability and growth
- Risk of overestimating demand
  - Could result in inefficient allocation of resources and overinvestment in infrastructure
  - Emphasises the need for strategic decision-making to ensure **cost-efficient planning** without excessive costs

➢ **The study provides data-driven insights into Uzbekistan's electricity demand trends, enabling informed policy decisions**

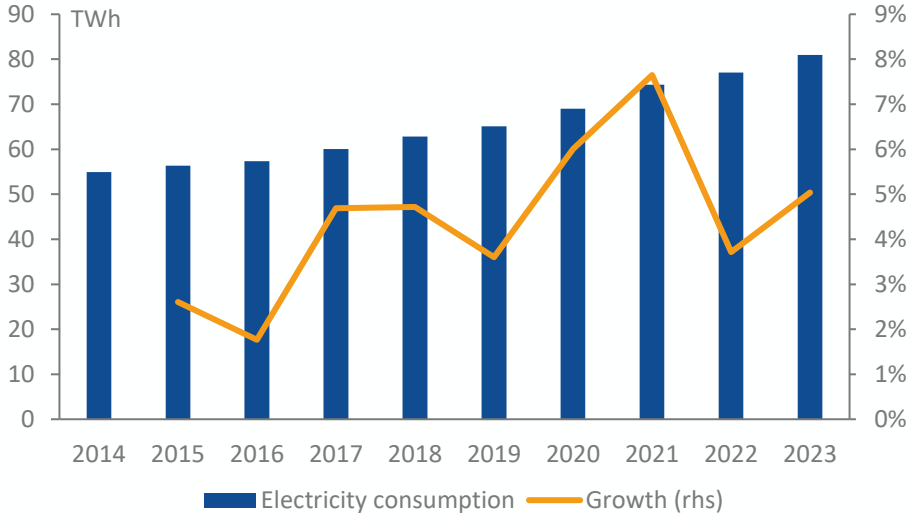
2. Country context

GDP in constant prices and population, 2000-2023



Source: International Monetary Fund, World Economic Outlook, April 2024. United Nations, World Populations Prospects 2024. Note: GDP at constant 2020 UZS.

Annual electricity consumption, 2014-2023



Source: CDC Energiya.

Drivers of electricity demand

- Rapid **economic growth**: Real GDP to reach UZS 1,055 trillion by 2030 (+45% from 2023)
- **Population** expected to hit 43 million by 2030 (+22%), and urbanisation on the rise
- **Industrialisation** and **electrification** trends expected to increase demand

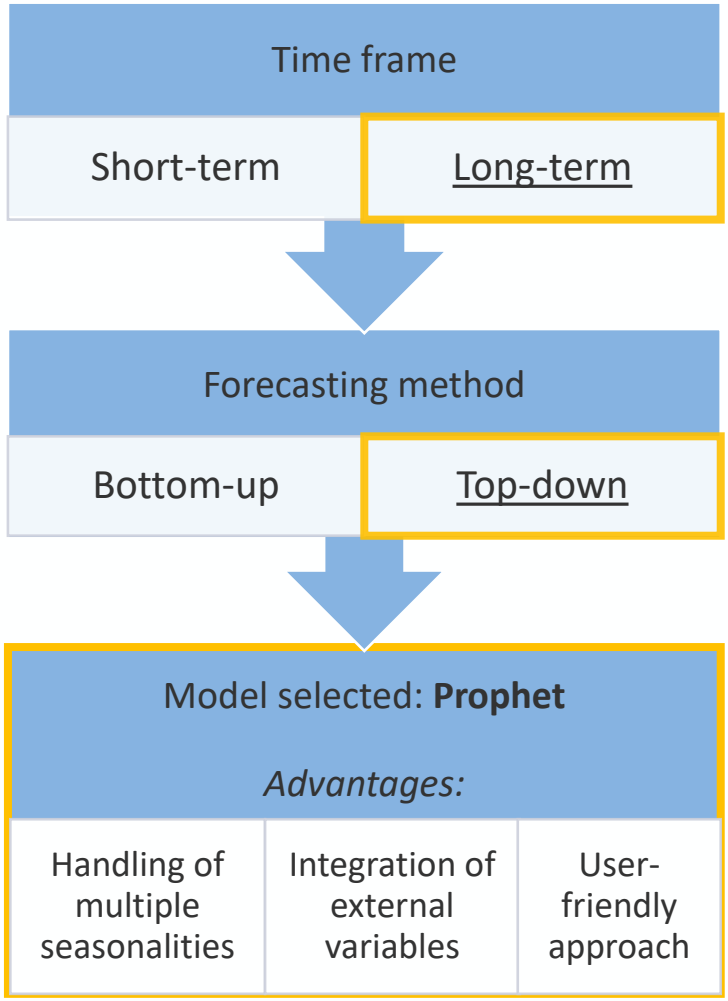
Electricity sector challenges

- Existing energy system already strained, with critical **gaps in supply** and challenges in **regional transmission**
- **Subsidised electricity tariffs** limit incentives for energy savings and necessary investments in the energy system

Implemented sector reforms

- **Tariff reform**: higher tariffs and tiered system for households, promoting efficiency while protecting low-consumption users as a first step toward cost-reflective pricing
- **Agency for Development and Regulation of the Energy Market** to oversee sector liberalisation

3. Methodological approach



Source: Own illustration.

Relevance of time frame

- Short term: for dispatch planning (precise, detailed forecasts for hours/days)
- Long-term: for generation adequacy and investment decisions over years

Forecasting method

- Bottom-up: aggregates consumer data; high accuracy but data-intensive
- Top-down: uses macro indicators (e.g., GDP, population); effective in data-scarce environments

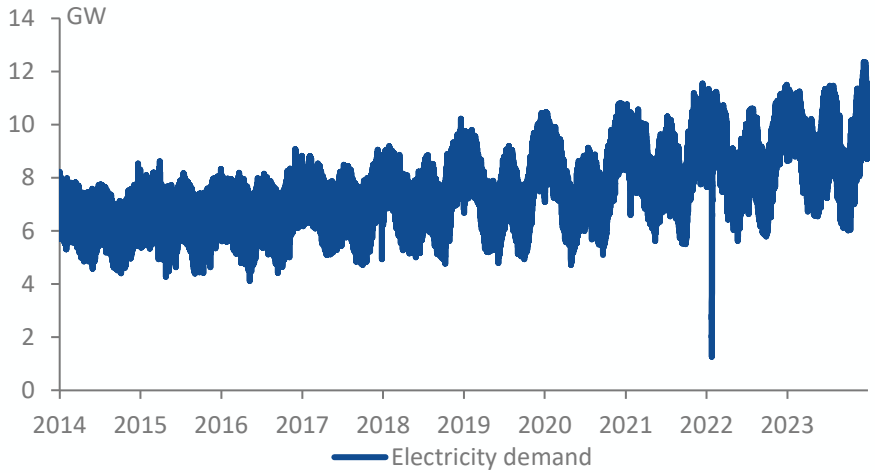
Model chosen: Prophet

- **Open-source** forecasting procedure
- Captures long-term **trends** and multiple **seasonal patterns** (daily, weekly, yearly)
- Integrates **external variables** (e.g., GDP) to improve prediction accuracy

➢ **Study provides long-term forecast on the national level, using the Prophet model and a top-down approach**

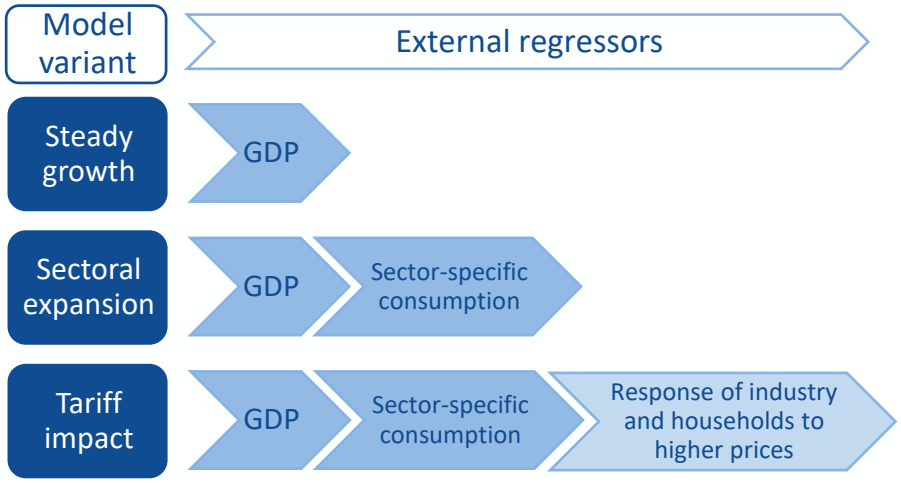
4. Data and model variants

Hourly electricity demand, 2014-2023



Source: CDC Energiya.

External variables included in each model variant



Sources: Own illustration.

Forecast variable

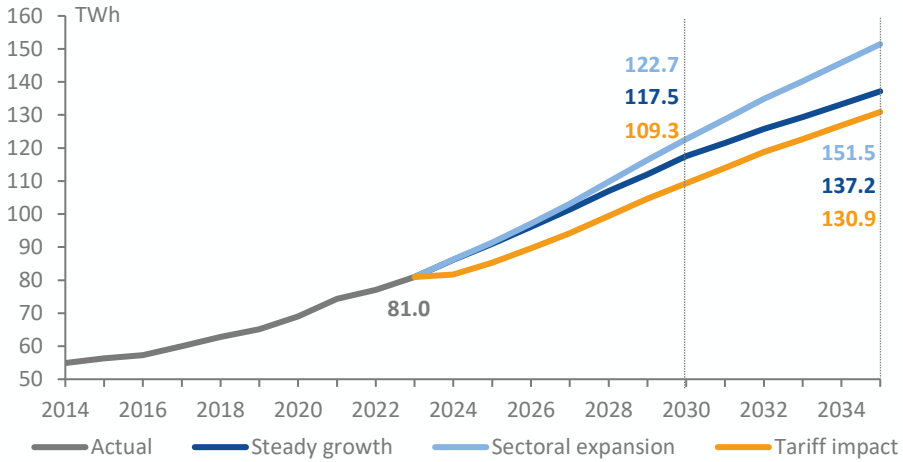
- Input: **hourly national electricity demand** from 2014 to 2023 (includes grid losses and own consumption by power plants)
- Output: **hourly demand (MW)**, capturing daily, weekly, and yearly demand patterns; total **annual consumption (TWh)**, aggregated from hourly data

Model variants

- Steady growth: **GDP** as a driver of demand
- Sectoral expansion: **Industrial, transport, and residential electricity demand** included additionally as regressors
- Tariff impact: Incorporates **tariff elasticity** for industry and residential consumption; includes adjustments made in 2023–2025, with real prices *assumed* stable 2026–2035
- All: 2030-2035 consumption increased by 10%; assumption that supply expansion sufficient to **meet previously unmet demand**

5. Model results

Annual electricity demand projection under the model variants



Source: CDC Energiya (2014-2023 data); own calculations (projected data).

Annual consumption (TWh)

2023	81.0		
	Steady growth	**Sectoral expansion**	**Tariff impact**
2030	117.5	122.7	109.3
2035	137.2	151.5	130.9

Peak demand (GW)

2023	12.4		
	Steady growth	**Sectoral expansion**	**Tariff impact**
2030	18.6	19.2	17.4
2035	21.2	23.0	20.3

Sources: CDC Energiya (2023 data); own calculations (projected data).

Annual consumption (TWh)

Steady growth:

- +45% 2023-2030, +69% by 2035
- Reflects **economic expansion** with capacity improvements, moderate baseline growth

Sectoral expansion:

- +52% 2023-2030, +87% by 2035
- Higher demand due to **industrialisation** and **transport electrification**, capturing sectoral dynamics

Tariff impact:

- +35% 2023-2030, +62% by 2035
- Demand **moderation** from expected **price elasticity effects** in response to recent and upcoming tariff adjustments

Peak demand (MW):

- Parallel increase of +41-56% by 2030 and +64-86% by 2035

➢ **Results show influence of economic growth and sectoral shifts on electricity demand**

6. Discussion of results

Model assumptions and limitations

- **Energy efficiency** improvements are not explicitly modeled, potentially overstating demand growth
- **Technical losses and own consumption of power plants** are assumed constant. Reduced losses through infrastructure investments would mean an overestimation of demand, while insufficient investments could increase them
- The **assumption of unchanged real tariffs post-2025** shape the "Tariff Impact" model. Additional increases in tariff levels could further suppress demand, while lower real tariffs could increase it
- The model relies on **general price elasticity estimates.** Using elasticities based on local data would improve accuracy as tariff reforms progress

Model accuracy and reliability

- Models achieved **~5.5% Mean Absolute Percentage Error** (MAPE) on 2020–2023 hourly data

Relevance for capacity planning

- Ensure sufficient **generation capacity** to meet growing **annual consumption**
- Build **system flexibility** to handle **peak load** growth, especially as the share of renewables grows.
  - Expand transmission, distribution and storage infrastructure to avoid supply bottlenecks (during demand surges)

➢ **Forecasts highlight the need to expand generation capacity and grid flexibility**

7. Implications for policy-making

Build in-house forecasting capabilities

- Establish a dedicated forecasting unit, e.g., within the Ministry of Energy, to **improve energy planning** and **reduce reliance on external models**
- Use **local data** on consumption, tariff elasticities and sectoral trends to refine demand projections

Generation capacity planning

- **Ensure supply aligns with forecasted demand**, accounting for technical uncertainties and potential capacity shortfalls. Include a 15-20% **reserve margin** to meet internal flexibility in system balancing
- Invest in **transmission, distribution, and storage** to manage **renewable variability** and peak loads

Continue implementing cost-reflective tariffs

- Implement cost-reflective tariffs to ensure **efficient energy use** and **financial sustainability**
- Strengthen regulatory oversight to ensure transparent pricing and investor protection
- Calibrate **social support measures** to protect low-income households while ensuring cost recovery

Strengthen demand-side management (DSM)

- Leverage digital tools like advanced metering infrastructure and real-time data analytics to enable more **precise control over demand** and allow implementation of time-of-use pricing
- Empower end-users with greater control over their electricity use, e.g., off-peak EV charging
- Provide grid operators with enhanced visibility into usage patterns, allowing for **more efficient load balancing,** reducing the need for costly capacity expansions

8. Conclusion

- Uzbekistan's **economy and population are growing rapidly**, leading to a substantial **increase in overall electricity consumption**
- Furthermore, electricity consumption **patterns** are expected to shift due to factors such as increased **industrialisation**, the **electrification of transportation**, and the implementation of **energy efficiency** measures
- Persistent **supply shortages** highlight the urgency of aligning **capacity expansion** with projected demand growth
  - While insufficient supply could stifle economic development, an overestimation could lead to excessive investment, potentially straining resources
- The study provides data-driven insights into Uzbekistan's **electricity demand trends**, enabling informed and sustainable policy decisions
- **Electricity demand** is **expected to increase significantly** in the coming years
  - Annual consumption forecasts range from **109 to 123 TWh in 2030** (+35-52%) and **131 to 151 TWh in 2035** (+62-87%)
  - Peak demand is projected to reach **17.4 to 19.2 GW in 2030** (+41-56%) and **20.3 to 23 GW in 2035** (+64-86%)
- **External variables** such as expectations on GDP growth, sectoral shifts, and tariff changes were found to **significantly influence the projections**
- The presented **implications for policy-making** aim to promote efficient, equitable access to electricity and strengthen Uzbekistan's energy security, while supporting economic growth

About the German Economic Team

Financed by the Federal Ministry for Economic Affairs and Climate Action, the German Economic Team (GET) advises the governments of Ukraine, Belarus*, Moldova, Kosovo, Armenia, Georgia and Uzbekistan on economic policy matters. Berlin Economics has been commissioned with the implementation of the consultancy.
**Advisory activities in Belarus are currently suspended.*

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Annex

Hourly electricity consumption input data

January 25 to 27, 2022, are marked as outliers in the Prophet model: large-scale power outage that affected Uzbekistan, Kazakhstan, and Kyrgyzstan. In Uzbekistan, outage began around 11:00 a.m. According to the Ministry of Energy it took approx. 53 hours to fully restore electricity supply. Typical consumption patterns resumed on 28 Jan

Prophet model specifications

- The Prophet model was configured with daily, weekly, and yearly seasonalities, using Uzbekistan-specific holidays. To better capture recent trends, the number of changepoints was increased from 25 to 50, allowing the model to respond more effectively to shifts in electricity demand
- To evaluate forecast accuracy, we utilise the Mean Absolute Percentage Error (MAPE) metric (2014-2019 for training the model, 2020-2023 for testing). All variants achieve high accuracy with around 5.5% MAPE
- Prophet smooths irregular spikes, leading to narrower fluctuations in forecasts. To address potential underestimation of peak loads, we scale the 2023 hourly demand profile to match the projected 2030 annual demand, increasing peak load estimates by 11–16%. Therefore, peak loads are reported with a 16% increase

Detailed assumptions of model variants

- Increase forecasts after 2029 by 10%, as an estimated 10% of electricity demand goes unmet (Ministry of Energy)

Sectoral expansion:

- Industrial electricity consumption: Future demand tied to industrial production (IP), with a coefficient based on 2010–2022 linear regression. IP growth (1.4x by 2026) follows Uzbek government targets (Development Strategy of Uzbekistan for 2022-2026), with post-2026 growth based on a five-year moving average
- Transport electricity consumption: Demand growth linked to population growth and increasing EV adoption, using coefficients from regressions based on 2000–2019 (population) and 2016–2019 (EV adoption). EV stock data and projections (2016-2029) are sourced from Statista; projections for 2030-2035 follow IEA global growth rates
- Residential electricity consumption: Demand modeled on population growth and GDP per capita, both with an elasticity of one. Population data from UN projections

Annex

Detailed assumptions of model variants (continued)

Tariff impact:

Electricity tariff reform 2023-2025

- Industrial tariff
  - Doubled from 450 to 900 UZS/kWh in 2023
  - Assumed to increase to 1000 UZS/kWh in 2025
- Household tariff
  - 295 UZS/kWh in 2023. Block tariff system for households introduced in 2024. Due to lack of detailed data, we assume 80% of households fall within Block I (450 UZS/kWh) and Block II (900 UZS/kWh), covering usage below 1,000 kWh/year. An average of Block I and II tariffs is used to approximate household costs under this structure (675 UZS/kWh)
  - Block I and Block II assumed to increase to 600 and 1000 UZS/kWh in 2025 (average of 800 UZS/kWh)
- After 2025: both nominal tariffs assumed to increase in line with inflation, keeping real tariffs stable

Price elasticity assumptions

- Elasticity values derived from established studies and reflect typical consumer behaviour in response to price changes in comparable markets
- Industrial demand: Price elasticity of -0.15 (10% tariff increase reduces demand by 1.5%)
- Residential demand: Price elasticity of -0.1 (10% tariff increase reduces demand by 1%)