ISSN 0140-8682

Briefing Paper

ODI Global

Climate risks to Syria's electricity systems

Sarah Opitz-Stapleton, Yue Cao, Camille Laville, Elena Kiryakova, Basile Maupu-Estupina, Jim Jarvie and Mauricio Vazquez

April 2026

Key messages

Restoring and expanding electricity generation and transmission is critical for Syria's socioeconomic recovery, but reconstruction must balance energy security, affordability, climate and disaster resilience, and sustainability to avoid locking in future risks.

Rising temperatures, heat waves and population return will increase electricity demand, particularly for cooling, while reducing operating efficiency, increasing generation losses, and placing additional strain on transmission and distribution systems.

A strategic shift toward energy efficiency, renewable energy, higher-efficiency generation and cross-border interconnections presents a 'triple win'. These will reduce demand and generation expansion needs, enhance energy security and improve environmental sustainability.

Without climate-resilient planning, reconstruction investments risk maladaptive decisions, stranded assets, and higher fiscal and financial vulnerabilities – undermining long-term economic growth and stability.

ODI Global, 4 Millbank, London SW1P 3JA, UK

ISSN 0140-8682

The research for this report was completed in December 2025.

This material has been funded by the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

How to cite: Opitz-Stapleton, S., Cao, Y., Laville, C., Kiryakova, E., Maupu-Estupina, B., Jarvie, J. and Vazquez, M. (2026) 'Climate and financial risks to Syria's electricity system'. ODI Global Briefing Paper. London: ODI Global (https://doi.org/10.61755/MRES9454).

Acknowledgements

About this publication

This briefing paper is published through the Pioneering a Holistic approach to Energy and Nature-based Options in MENA for Long-term stability (PHENOMENAL) programme, which is supported by the United Kingdom's Foreign, Commonwealth and Development Office (FCDO).

The authors are grateful to Mauricio Vazquez, Guy Jobbins, Christopher Kidner, Hiam Alashkar, Ruba Al Zubi and Andrew Lucas for their inputs and review of the briefs. We also thank Ruby Cowling for copyediting and Valerie Geiger for figure design and typesetting.

About the authors

Sarah Opitz-Stapleton

Sarah Opitz-Stapleton is a Senior Research Associate with the Global Risks and Resilience Programme at ODI Global

Yue Cao

Yue Cao is a Research Associate with the Global Risks and Resilience Programme at ODI Global

Camille Laville

Camille Laville is a Research Fellow with the Global Risks and Resilience Programme at ODI Global

Elena Kiryakova

Elena Kiryakova is a Research Fellow with the Global Risks and Resilience Programme at ODI Global

Basile Maupu-Estupina

Basile Maupu-Estupina is an independent consultant

Jim Jarvie

Jim Jarvie is an independent consultant

Mauricio Vazquez

Mauricio Vazquez is Head of Policy with the Global Risks and Resilience Programme at ODI Global

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Abbreviations and acronyms

BOO	build, own and operate
CCGT	combined-cycle gas turbine
CDD	cooling degree days
FDI	foreign direct investment
GDP	gross domestic product
GW	gigawatt
IDP	internally displaced person
MW	megawatt
OCGT	open-cycle gas turbines
SSPs	Shared Socioeconomic Pathways
TDL	transmission and distribution lines
TFR	total fertility rate
Tmax	maximum temperature
Tmin	minimum temperature
UNDESA	United Nations Department of Economic and Social Affairs

1 Introduction

The restoration and expansion of electricity generation and transmission is critical for Syria's socioeconomic recovery from the conflict. Restoring and building out the generating and transmission capacity with the future in mind – accounting for population return, economic aspirations and climate change – will determine the country's economic growth trajectory in the coming decades.

Box 1 Snapshot of socioeconomic conditions post-Assad

In the decade up to 2011, agriculture, oil and gas production, a growing industrial sector with small to large enterprises, and increasing trade (including oil exports) were Syria's dominant economic sectors. Gross domestic product (GDP), driven primarily by growth in non-fossil fuel sectors, grew at an annual average of 4.3%. However, this economic growth did not translate to prosperity for all; overall poverty rates remained at 33.6% and were higher in rural areas, particularly in the northeast.

The conflict led to a severe economic downturn post-2011. Oil, export and foreign exchange revenues decreased significantly, while government debt for military expenditures rose. The destruction and damage of transport, electricity, water and other infrastructure; loss of key sector inputs (such as fertiliser for agriculture); and the migration and internal displacement of over half the population (some 14 million) have left Syria in a dire economic situation. International sanctions and asset freezing contributed to the economic decline. The 2023 earthquake in the north further damaged infrastructure, while the COVID-19 pandemic, regional instability and ongoing internal pockets of conflict continue to have socioeconomic impacts. GDP in 2025 is estimated to be less than half of pre-conflict levels; inflation is high and ~90% of the population are living in poverty.

Sources: World Bank (2017); UNDP (2025).

This briefing paper presents key findings from a semi-quantitative climate risk assessment of Syria's key lifeline infrastructure — specifically electricity (briefing paper 1) and urban drinking water and sanitation (briefing paper 2) — to support the country's reconstruction efforts. It presents considerations and opportunities for Syria to adapt electricity infrastructure to climate change and transition to a more diverse renewables and higher-efficiency generation portfolio in consideration of initial reconstruction plans (Section 2).

With limited domestic fiscal space and scarce international concessional finance, the Syrian government is turning to foreign direct investment (FDI) to drive reconstruction efforts, while leveraging international aid to support this process.[1] Reducing climate change risks can assist in safeguarding reconstruction investments from debt and financial vulnerabilities created by maladaptive decisions.

The considerations and opportunities are grounded in a snapshot of future electricity demand, plausible national socioeconomic development trajectories, and future climate risks to the sector through the 2030s (the period 2021–2050) – which are detailed in the remainder of this briefing paper (Section 3). They also draw from the accompanying briefing paper on urban drinking water and sanitation, part of the same climate risk assessment. Both papers will be complemented by a more detailed technical report outlining the analytical framework, data and methodologies used, including multi-model climate projections and qualitative analysis, and underlying assumptions.

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1 Since 2025, more than $28 billion in FDIs for infrastructure reconstruction have been announced, while donors, including the EU and the World Bank, have committed more than $6 billion in multi-year humanitarian and development assistance. See Arabian Business (2025); European Council (2025); World Bank (2025d).

2 Considerations and opportunities for recovery and reconstruction of Syria's electricity infrastructure

The objective of any good energy policy is to strike a balance between energy security, affordability, climate and disaster resilience, and sustainability. Following a decade of conflict, rebuilding Syria's electricity infrastructure presents a critical 'triple win' opportunity to reduce current and future climate risks, shift toward a more diverse mix of renewable and high-efficiency generation fleet and energy saving, and protect reconstruction investments from financial and debt challenges caused by maladaptive decisions. This section outlines key considerations to help capture this opportunity and inform reconstruction planning.

Consideration 1. Demand-side management

Electricity use in Syria is expected to increase from a combination of population growth including returnees, demand for cooling services due to increased temperature extremes, and potential economic diversification towards more industry and services owing to decreased viability for water-intensive agriculture as a result of climate change and depleted groundwater resources (as covered in the water briefing paper). Meeting this growing demand through supply-side measures alone would require costly expansion of electricity generation capacity.

Opportunity

There is a clear 'triple win' opportunity to reduce electricity demand and generation expansion by reconstructing the building stock in an energy-efficient manner. The World Bank conservatively estimates that 23% of residential buildings and 27% of commercial/government buildings' total value was damaged or destroyed during the conflict, with the highest levels of destruction concentrated in Aleppo, Deir ez-Zor, Idlib, Hama and Homs (World Bank, 2017). Our climate projections also show that these cities will experience some of the most severe climate change-driven increases in temperatures, aridity, and heat waves, and are likely to experience the fastest electricity demand growth due to the above drivers.[2] Therefore, improving the thermal insulation of homes and commercial buildings as they are rebuilt can reduce air conditioning needs and lower peak electricity demand.[3] This will improve energy security and environmental sustainability.

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2 Nearly 85% of the population is projected by UNDESA to live in towns and cities by 2050 (United Nations, 2025).

3 Peak electricity generation capacity is generally the greatest determinant of electricity costs and prices.

Since rebuilding the residential and commercial building stocks comes at an estimated price of $75 billion and $59 billion respectively (World Bank, 2025e) economic incentives will need to be realigned, as the upfront cost of efficiency upgrades are often borne by households and businesses. To achieve this, reform of electricity tariffs, enhanced cost recovery, operational changes to reduce wholesale supply costs, and regulatory reforms will have to be considered to address affordability concerns (RCREEE, 2025; Marhej et al., 2026). In the long run, avoiding costly generation and grid expansion will lower the cost of the whole system.

Consideration 2. Renewable energy, higher-efficiency thermal generation, and interconnections

Syria's stated short-term objective is to restore electricity infrastructure to pre-2010 levels, increasing supply from an estimated 2–4 hours per day during the conflict period to 24-hour service (Daily Sabah, 2025). Beyond immediate recovery, our analysis indicates that additional generation will have to come online before 2040 to account for population growth (up to 2045), alternative economic diversification trajectories, climate-driven demand for cooling services and potential generation and transmission losses. How this capacity is expanded matters because it will form the backbone of Syria's future economy and influence long-term energy security, sustainability, and affordability.

Opportunity

In the short term, it is strategic for the Syrian government to restore, and upgrade where feasible, damaged thermal generation capacity. When rehabilitating generation, hydropower should not be considered a renewable energy source in Syria, as increasing aridity and frequency and intensity of droughts around the Tishreen, Al-Thawrah/Tabaqa and Freedom/Baath hydroelectric power plants, as well as ongoing upstream hydropower and irrigation plans on the Euphrates River under Türkiye's Great Anatolian Project, will limit the country's hydroelectric potential. Therefore, caution is also warranted in linking future hydropower revenue streams with upfront investments in restoring turbine and dam equipment.

Over the longer term, thermal generation should be viewed as a temporary measure. Priority for capacity expansion should instead be given to renewable energy, energy storage technologies, and cross-border interconnectors to enhance energy security and sustainability. Syria has significant solar potential and good wind resources that can be leveraged to diversify the generation mix. While both renewable and thermal technologies' performance is affected by higher temperatures and heat waves, the impacts are generally more pronounced for thermal power plants. This is particularly significant at the system level in countries where thermal capacity dominates the generation mix, as in Syria, where it accounts for approximately 95%.[4] Thermal power plants are additionally exposed to international fuel price volatility and supply chain disruptions, raising exchange and commodity price risks. Prioritising thermal power plants also risks incurring opportunity costs, as the capital cost of renewable energy and storage is declining fast globally (IEA, 2025b); there are also additional environmental and public health risks associated with fossil fuel use. Where new thermal capacity is pursued, it should ideally be in the form of highly efficient, inlet-cooled combined-cycle gas turbine (CCGT), possibly using integrated solar thermal technology.

In 2025 agreements have been made to rehabilitate the electricity interconnectors with Jordan and Turkey, with capacity expected to reach approximately 300 MW. While this represents a positive step forward, it remains below previous operating levels (approximately 800 MW with Jordan and 600 MW with Turkey) and does not yet reflect the full scope of the regional energy systems integration envisaged under the 1988 agreement between Jordan, Syria, Egypt, Turkey, and Iraq. Nor does it anticipate demand growth. The government may wish to re-engage and advance dialogues with neighbouring countries within that broader framework.

Overall, more in-depth climate risk assessments at the asset and strategic levels, to understand overall system vulnerabilities, are recommended on new capacity investments. International donors and development partners are well positioned to support such assessments and help integrate climate resilience into Syria's long-term power sector planning.

Consideration 3. Efficiency of existing infrastructure

Adapting Syria's electricity sector to climate change and its associated financial risks requires improving the efficiency and resilience of existing infrastructure, both at the asset and system levels.

At the asset level, our analysis indicates that the Aleppo, Al Taim and Suwaidiyah thermal plants, which supply electricity to the Northern zone, will likely face the largest increases in temperatures and in the frequency and intensity of heat waves. This will pose the risk of reduced generation outputs, thermal stress on equipment, and accelerated asset degradation. Without adaptation measures, such risks could cascade to load shedding and blackouts – particularly during periods of peak demand for air conditioning – resulting in lost revenues.

At the system level, the transmission and distribution network remains severely damaged despite its critical role in linking generation capacity to demand centres and enabling reliable power flows across the country. The expansion of utility-scale solar and wind generation also needs to rely on

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4 While Syria-specific assessments are unavailable, analysis of empirical data from the European Union and the United States carried out by the International Energy Agency indicates that at extreme high temperatures forced outages of thermal power stations are more likely to occur, last longer and leave a larger share of capacity unavailable (IEA, 2025b).

a resilient, flexible and well-integrated grid. Syria's current electricity grid is not a single coherent network, but a patchwork of subnetworks/service areas that vary in size, connectivity, and resilience, reflecting pre-existing technology, network/distributed configurations, energy value chain, and former zones of control. As a result, recovery has been geographically uneven, with the northwest experiencing relatively rapid improvements, while parts of the northeast, south, and coastal regions have seen slower progress (Mercy Corps, 2025). Moreover, the transfer capacity of transmission and distribution lines decreases at high ambient temperatures due to increased resistance, and system operators may be forced to de-energise lines as these are rated for the maximum amount of power they can safely carry before they begin to sag due to excessive heat, which will increase under climate change. These challenges, therefore, should be accounted for in grid reconstruction and expansion plans and investments.

Opportunities

As power generation is rehabilitated in Syria, it is recommended that advanced air- and/or water-intake cooling technologies be installed to reduce CCGT power output losses associated with higher temperature under climate change. This should be prioritised for the Aleppo, Al Taim and Suwaidiyah power plants, as well as for the new North Aleppo Power Plant (1.2 GW) and Deir ez-Zor Power Plant (1 GW) that will be built by the Qatari–Turkish–US consortium as part of their $7 billion, 5 GW generation expansion investment in Syria, to avoid costly future retrofits (Kazinform, 2025).

If water cooling technologies are chosen, detailed surface and groundwater surveys and joint water–energy climate risk assessments should be carried out to determine their feasibility. As noted in the water briefing paper, the Al Khabour basin where the Suwaidiyah power plant is located already presented a groundwater extraction deficit estimated at -1.79 to -2.08 billion cubic metres per year in the 2000s. Our scenarios of future municipal water demand indicate that 17%–64% of additional pre-conflict estimated renewable water supply will be required for drinking across the whole of Syria by 2045. This increase does not account for agricultural needs. Moreover, the Aleppo and Deir ez-Zor governorates, where the respective power plants are located, rely heavily on surface water from the Euphrates for urban supplies – with the river projected to experience greater evaporative losses during longer hot seasons. Therefore, enhanced water conservation measures should be prioritised as part of, or in connection with, planned power plant investments.

Expanding and reinforcing the transmission and distribution network should be a priority for greater renewable energy integration, to reduce regional disparities in electricity access and service quality, and to mitigate the distributional impacts of uneven post-conflict recovery. Prioritising the restoration and expansion of the grid should also account for future climate change, in order to reduce technical losses and maintain system reliability under higher temperatures. However, there is currently no comprehensive financing plan for its reconstruction. While the World Bank has committed $146 million to rebuild some of the main transmission lines in 2025, the Ministry of Energy has estimated the total cost of reconstruction at $1 billion (World Bank, 2025a).

As consumers have increasingly turned to rooftop solar systems, informal 'amperage' mini-grids,[5] and in some cases electricity theft in response to unaffordable electricity bills, there is an opportunity to support the formalisation of decentralised systems (Marhej et al., 2026). This could be achieved through net-metering incentives, clear rooftop solar photovoltaic standards, dedicated mini-grid regulations, and broader sector reforms (such as tariff reform). Such measures would help serve underserved or hard-to-reach areas while simultaneously reducing non-technical losses from a system-wide perspective.

5 These are neighbourhood private generator lines, relying on solar power or batteries, that are billed by amperage – a pay-by-amp arrangement. See Marhej et al. (2026).

3 Risks to Syria's electricity sector

Climate change, population and economic growth need to be taken into account in the reconstruction and expansion of Syria's electricity generation and transmission sector. Some climate change risks can be avoided or reduced by combining climate resilience measures in electricity infrastructure reconstruction and development. Financial risks may arise if increased climate extremes and potential damage to electricity infrastructure are not accounted for, and there are potential lost opportunity costs if the sector stays locked into lower-efficiency thermal generation as the world moves towards lower-carbon economies. This section analyses these risks.

Current state of the system and known plans for expansion

In 2010, the Syrian population was estimated at 22.5 million; following the outbreak of conflict in 2011, an estimated 6.3 million became refugees abroad and a further 7.4 million were internally displaced (World Bank, 2025c). Per-capita electricity demand in 2010 was estimated to range between 1.61 and 2.20 MWh (Hatahet and Shaar, 2021; IEA, 2025; World Bank, 2025a), and peak load demand increased from ~6,000 MW to 8,000 MW in 2010. In part due to the economic reforms instituted in the decade prior to the conflict, Syria's per-capita electricity demand was growing annually at approximately 4.9%–7.5%, on par with neighbouring Jordan (4.5%). Demand was already outstripping supply, particularly during summer, presenting load shedding problems.

Between 2011 and 2024, demand plummeted due to the conflict and its subsequent effects of migration and internal displacement, and the disruption of infrastructure and economic sectors. By 2023, even the decreased per-capita demand of 0.85–1.20 MWh was not sufficiently met by net supply; electricity was delivered only intermittently a few hours a day, including during the hot summers (Shaar, 2025). Due to the unreliability of supply throughout the conflict, many Syrians resorted to private off-grid diesel generation and some household-level solar photovoltaic.

Sixteen thermal power plants and three hydroelectric power plants generated an estimated 46,200 to 46,413 GWh in 2010 (Ministry of Electricity, 2021; IEA, 2025; RCREEE, 2025; World Bank, 2025a). Approximately 94% of generated power was from conventional thermal power plants, with the remaining from hydropower; natural gas accounted for 55% of conventional generation. From 2005, the transition from oil-fired to gas-fired thermal power plants began. Syria's 2010 total installed capacity – the maximum electrical generation under ideal conditions – was estimated to range from 8.3–9.8 GW. However, most of Syria's steam, open-cycle and older combined-cycle power plants are low-efficiency (18%–37%) and have internal generation losses of 5%–6% of total production (World Bank, 2025a).

By 2023, installed capacity had decreased to between 4.4 and 6.8 GW. While estimates of that year's remaining generation capacity vary, the lower available capacity value is from the former

Ministry of Electricity. There are also conflicting reports on the extent of damage to generation capacity. The thermal power plants of Al Taim, Aleppo, Al Forat and Zayzoon, representing 18% of installed capacity, were destroyed or sustained significant damage during the conflict (Hatahet and Shaar, 2021; Global Energy Monitor, 2025; World Bank, 2025a). The thermal plants at Teshreen, Mahrada and Al Zarah also sustained some damage but continue to function. Disruption to the supply of domestic and imported heavy fuel oil and natural gas, and parts for maintenance, also curtailed generation, particularly at Al Zarah, Teshreen, Banyas and Mahrada thermal plants, as did inability to conduct regular maintenance. The three hydropower plants require significant repairs. Statistics from the Ministry of Electricity reported in the media showed that generation in 2023 decreased to 12,900 GWh, or an equivalent of 2,200 MW available generation capacity, due to damages and fuel shortages (Shaar, 2025).

The former Ministry of Electricity had plans for constructing a new CCGT in Latakia and adding extensions to Dair Ali (CCGT) and Teshreen (steam). Thermal installed capacity through these additions could reach 6.1 GW by 2030, contingent on the rehabilitation of functional thermal generation and on securing fuel to operate plants; however, it is unclear whether these plans advanced. In 2025, a Qatari–Turkish–US consortium signed concessions with the government to invest in four CCGT plants, totalling 4 GW, to be completed by 2031 (Daily Sabah, 2025; Kazinform, 2025). It is not clear if these will be high-efficiency or air-/water-cooled.

The conflict also negatively impacted Syria's transmission and distribution grid. Nearly 99% of the population was connected to the grid in 2010, through over 5,719 km of 230 kV lines and 1,594 km of 400 kV lines (Hatahet and Shaar, 2021; Med-TSO, 2014). Syria's grid was also connected to neighbours through 400 kV interconnectors; this included a capacity of 800 MW (Jordan–Syria) and 600 MW (Türkiye–Syria). The grid was damaged during the conflict and suffered from looting, parts theft and lack of maintenance; the interconnectors with Jordan and Türkiye were nonfunctional as of 2023. In 2025, the World Bank approved grant funding to rehabilitate the interconnectors back to 300 MW each. Current total electricity losses between generation and transmission and distribution systems are estimated at an equivalent of 33% (World Bank, 2025a).

Due to the intermittent nature of solar and wind renewables, base generation stabilisation and repairs of the grid are necessary to support the expansion of renewables as part of the supply mix. Syria has significant solar resources, with median global horizontal irradiation of 5.5 kWh/m^2 and a practical photovoltaic potential above 4 kWh/kWp, though not all areas are suitable for solar power development (ESMAP, 2020). Expanding the share of renewables through utility-scale solar and wind projects was proposed in the Ministry of Electricity's 2021 Renewable Strategy. In the plan, the Ministry was reviving plans or was in discussion with international companies to install utility-scale solar plants (~30 to 300 MW) near Aleppo (the Sheikh Najjar solar plant), Jandar, and Damascus (the shelved Widyan al-Rabie); it is unclear whether these plans will be implemented.

In 2025, in addition to thermal capacity, the Qatari–Turkish–US consortium announced investment in a 1 GW solar power plant in southern Syria. Several governorate, regional council and city smaller-scale utility solar projects are also in pre-construction or operating with combined installed capacity of 89.3 MW. It is also possible that households who can afford it might continue or expand their use of private solar. However, expansion of private solar photovoltaic in rural areas to restore and expand pumping of groundwater for irrigation requires careful management to reduce pressures on already over-exploited groundwater resources.

Six shelved utility-scale wind farms would have had an installed capacity of 310 MW. Three sites were identified as having high, stable wind power density that could support large-scale wind farms; east of Latakia, Deir ez-Zor (which would theoretically be able to connect to the grid section related to the destroyed Al Taim thermal plant) and As-Suwayda (RCREEE, 2025). Under the interim government, the Public Establishment for Transmission and Distribution of Electricity put out a request for quotations to develop 100–200 MW wind farms under a BOO (build, own and operate) scheme on two sites between Qataina, Al-Sindiya, al-Higana, Ghabagb and al-Sukhna (Solarabic.com, 2025).

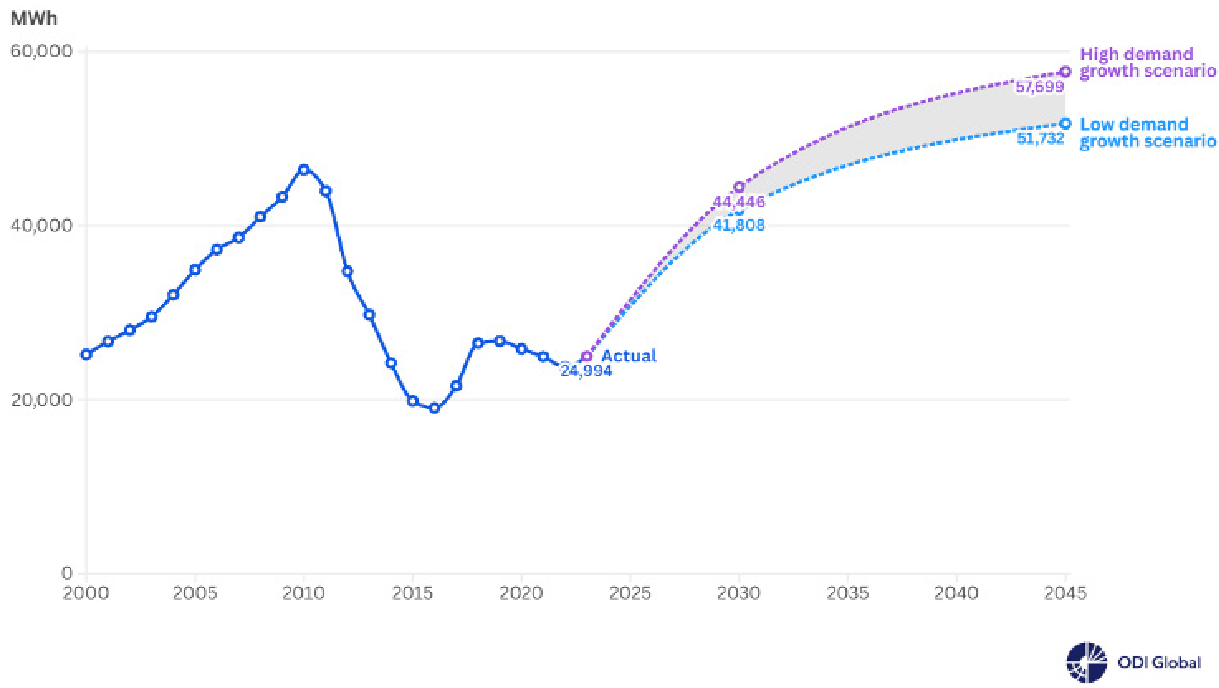
Scenarios for future electricity demand growth

The typical expected operating life for a CCGT is 20–30 years, which might be extended through retrofits. This implies that replacement generation assets at Al Taim, Aleppo, Al Forat and Zayzoon, as well as any new CCGT or less efficient open-cycle gas turbines (OCGT) that are commissioned and installed in the next two to five years, will likely be operational in 2045/2050. Therefore, the rehabilitation of existing generation and grid infrastructure, and any commissioning and expansion of new infrastructure, should account for long-term drivers of electricity demand.

This section estimates future electricity demand over the next two decades (to 2045) under different scenarios for these drivers, including: (1) rates of refugee return; (2) rates of IDP return; (3) total fertility and mortality rates; (4) abilities to restore critical transport, electricity and water infrastructure; these, in turn, influence (5) economic recovery and diversification. The following section analyses risks arising from climate change.

In 2021, the former Ministry of Electricity assumed demand would grow from 22.0 GWh in 2020 to an estimated 55.0 GWh by 2030 (Ministry of Electricity, 2021). This projection was based on a population estimate of 25.2 million in 2025, rising to 27.7 million by 2030. However, it did not account for refugee or IDP return, nor for economic recovery and growth, all of which could raise or lower electricity demand trajectories (RCREEE, 2025). The projection also relied on assumptions about generation capacity recovery and further expansion that ultimately did not materialise.

Figure 1 Syria electricity demand-growth scenarios

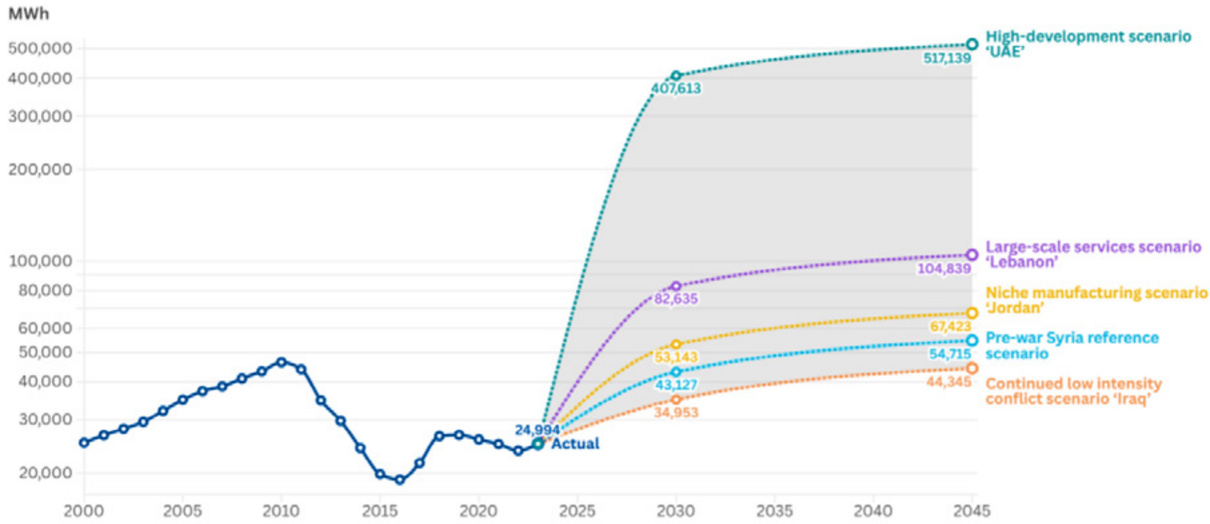


Note: Based on pre-war Syria (2000–2010) electicity demand-growth
Source: authors

For this briefing paper, we have developed several demand scenarios out to 2045, explicitly incorporating the drivers outlined above. Our primary electricity demand scenarios are as follows (Figure 1; see also Box 2):

- **Low demand-growth scenario:** a modelled total population of 30.5 million in 2030 and 37.8 million by 2045. It assumes a pre-war (2000–2010) average per-capita electricity demand of 1.37 MWh per year. This reflects the new government's commitment to rehabilitate the power infrastructure to pre-conflict levels and provide 24-hour electricity supply, when average per-capita consumption was 1.37 MWh per year.
- **High demand-growth scenario:** a modelled population of 32.4 million in 2030 and 42.1 million by 2045. It assumes the same pre-war average per-capita demand trend of 1.37 MWh/year.

Figure 2 Syria electricity demand alternative scenarios



Note: Based on neighbouring countries' electicity demand-growth

Source: authors

The median population projection from these two scenarios was then further applied to alternative demand scenarios to simulate hypothetical economic development trajectories modelled on neighbouring countries (Figure 2). Potential future demand will depend on the diversification directions Syria's economy takes; other types of services and industry have electricity demands that differ from those of agriculture.

- **Continued low-intensity conflict ('Iraq') scenario**: per-capita demand of 1.11 MWh/year, shaped by continued low-level conflict, massive expansion of the public sector and declines in industry and agriculture.
- **Pre-war trend ('Syria') scenario:** this is the reference scenario (a middle of the road between the two primary demand scenarios). Prior to conflict, agriculture was a major employer but decreasing in Syria. Industry was significant and services were growing.
- **Niche manufacturing ('Jordan') scenario:** per-capita demand of 1.69 MWh/year, influenced by a diversified economy with high share of services (ICT, logistics and tourism), industry (e.g. pharmaceuticals, fertilisers, textiles) and limited agriculture.
- **Large-scale services ('Lebanon') scenario:** per-capita demand of 2.62 MWh/year, driven by massive increase in the services sector (banking, tourism, real estate) prior to the financial crisis in 2019, and almost no agriculture or industry.
- **High-development ('UAE') scenario:** per-capita demand of 12.95 MWh/year with significant services (tourism, finance, logistics, etc.) and industry (manufacturing, jewelleries, machinery) diversification.

These per-capita electricity demand scenarios are aggregated on the national level; they do not indicate where demand might grow the most at the subnational level. Even prior to the severe drought from 2006–2011, Syria was urbanising as the economy diversified beyond agriculture. In 2010, nearly 56% of the population lived in cities and rates of urbanisation were increasing as farmers abandoned agriculture due to the drought and relocated to urban areas.

Nearly 85% of the population is projected by UNDESA to live in towns and cities by 2050 (United Nations, 2025). When accounting for possible refugee returns, urban areas in the Aleppo, Daraa, Homs, Idlib, Latakia, Tartus and Damascus governorates might experience the most population growth. Regardless of the national demand trajectory conditioned on economic diversification, much of Syria's future demand is likely to be concentrated and grow in urban areas.

Box 2 Estimating Syria's population to 2045

As of 2024, Syria's remaining population is estimated at 24.7 million with a median total fertility rate (TFR) of 2.7 children per woman. The return of over 6.2 million refugees will depend on security, and the political and economic stability of Syria and neighbouring countries, to which the majority of refugees fled. Of the estimated 1.5 million refugees who had returned as of March 2026, 84% returned to place of origin (UNHCR, 2026).

Starting with this baseline, we developed three different scenarios of population out to 2045. TFR and mortality rate projections were extracted from UNDESA projections and combined different scenarios of refugees returning to place of origin. The pessimistic scenario assumes persistent conflict (higher mortality rates) and slow return (5%–20% of refugees). The neutral scenario takes a stable TFR, moderate reductions in mortality rates and refugee return of 20%–40%. The optimistic scenario assumes a temporary TFR rebound (largely in urban areas) for the next five years before declining, mortality reductions, and a return of 50%–70% of refugees.

The technical report accompanying the two policy briefing papers describes the methodologies, data sources and background for the population projections, climate projections, electricity demand scenarios and risks analysis.

Source: authors, derived from the accompanying Technical Report (Opitz-Stapleton et al., 2026)

Future risks

Risks to Syria's future energy security over the coming decades are assessed using the demand scenarios and climate change projections from multiple climate models (Box 3).

Box 3 Climate change projections

Syria has approximately four major precipitation zones: (1) Coastal zone – governorates of Latakia and Tartus; (2) Northern zone – part of Hama governorate, Idlib, Aleppo, Raqqa and Al-Hasakah governorates; (3) Middle zone – eastern portions of Hama and Rural Damascus governorates, Damascus and Homs governorates, much of Deir ez-Zor; and (4) Southern zone – western portion of Rural Damascus, Quneitra, Daraa and Suwayda governorates. The Ministry of Agriculture uses five zones, but for the purpose of the climate modelling, we use four.

Historical climate data from gridded global datasets were analysed for trends. Climate projections from seven CMIP6 general circulation models from the IPCC 6th Assessment were bias-corrected and downscaled to find potential future changes in mean seasonal precipitation; in maximum and minimum temperature; and in temperature and precipitation extremes such as cooling degree days and heat waves. Future projections for three periods (2030s: 2021–2050, 2050s: 2041–2070, and 2070s: 2061–2090) and two climate change scenarios: SSP2–4.5 (likely given current global emission pledges) and SSP5–8.5 (a more extreme scenario, and less likely) were used for this risk assessment.

Source: authors, derived from the accompanying Technical Report (Opitz-Stapleton et al., 2026)

Climate change risks

Between 1979 and 2024, climate change has already demonstrably increased temperatures throughout Syria and is having impacts on the remaining electricity generation and transmission infrastructure (Table 1).

Temperatures are projected to increase significantly in the future due to climate change in both scenarios SSP2–4.5 and SSP5–8.5. Increases in Tmax and Tmin (maximum and minimum daily temperatures) in all seasons are likely in the coming decades due to climate change. For instance, countrywide annual-average Tmax increases of 1.3°–1.9°C above the historical 1980–2010 averages are projected by the 2030s under SSP2–4.5; by the 2050s, Tmax increases of 1.8°–2.4°C are possible. The global greenhouse gas-emissions scenario matters for the severity of climate change outcomes. Under the high scenario SSP5–8.5, increases in Tmax are more severe in the 2050s (2.5°–3.2°C) than under the lower scenario.

Table 1 Climate trends 1979–2024 and impacts on energy security

Observed climate changes	Observed impacts on energy security
Maximum daily temperatures (Tmax)	
• increase of 0.3°–0.4°C/decade (December–February) • increase of 0.40°–0.57°C/decade (March–May)	• increasing energy demand • decreased operating efficiency of thermal power plants
Heat waves (days above 35°C)	
• increasing by 4.7–8.9 days/decade • largest increases across Southern zone	• additional strain on remaining low-efficiency thermal power plants, contributing to generation losses • increased distribution losses by reducing the transmission line ratings
Cooling degree days (CDD)	
• increasing by 32.5–45.0 days/decade depending on zone	• corresponding increases in peak load demand for cooling • worsening local air pollution as households deploy diesel generators for domestic electricity needs
Decreasing precipitation	
• below average winter rains since 1990s • multi-year droughts: 2006–2011 and 2020–2024	• decreasing river flows in the Euphrates (also due to upstream diversions by Türkiye), Orontes, Al-Kabir al-Shamali rivers and other surface water sources, challenging adoption of water cooling technologies • increased evaporation of surface and shallow groundwater sources (due to both hotter temperatures and less winter rain), challenging adoption of water cooling technologies • more dust storms, degrading thermal power plants and transmission lines and silting hydroelectric reservoirs

Note: a cooling degree day (CDD) is a value calculated for electricity providers to estimate air conditioning (cooling) demand and peak load based on when the daily mean temperature equals or exceeds a reference temperature, such as 25°C. In climates similar to Syria's, such as Qatar and Iraq, electricity demand and peak demand for cooling increase at 25°C (Al-Hafith et al. (2024); Gurriaran et al. (2023)).

Sources: authors' analysis (see the technical report for details); Hoerling et al. (2012); Otto et al. (2023)

There is less agreement among the climate models about projected changes in winter precipitation and precipitation extremes (Opitz-Stapleton et al., 2026). Potential decreases begin emerging around 2050 according to the multi-model projections, with the Coastal and Southern zones (particularly higher elevations) likely to experience more significant decreases than other areas under SSP5–8.5. Projected decreases under SSP2–4.5 are of a lesser magnitude than under the higher-emission scenario. By the medium (~2041–2070) to late (~2061–2100) terms, more climate models from multiple studies agree on mean annual precipitation declines for the Coastal and Northern zones, particularly for the high-emissions scenarios of SSP5–8.5 and

RCP 8.5 (SMHI and ESCWA, 2021; Hamed et al., 2022; Zittis et al., 2022; IPCC, 2023; Naaouf and Torma, 2023; Opitz-Stapleton et al., 2026). There is less agreement on the direction and amount of change for the Middle zone of the country (higher model uncertainty) over the medium term, with some models indicating none to a potentially small increase in precipitation during the September–November season[6] and others indicating decreases (SMHI and ESCWA, 2021; Naaouf and Torma, 2023; Opitz-Stapleton et al., 2026). By the late term, most models begin to converge in agreement on decreases over most of the country.

All zones of the country will experience increasing aridity, particularly the Northern zone where Lake Tabqa and the Tishreen, Al-Thawrah/Tabqa and Freedom/Baath hydroelectric power plants are located. The frequency and intensity of hydrological, agricultural and socioeconomic droughts will increase with hotter temperatures and more heat waves. The hotter temperatures, in combination with the continued upstream construction of hydropower and irrigation diversion systems on the Euphrates river under Türkiye's Great Anatolian Project, will limit Syria's hydropower potential. As such, hydropower should not be counted as a renewable energy source for the country.

Thermal power plants experience the greatest decreases in output with increases in ambient air temperatures.[7] The low-efficiency plants using OCGT at Suwaidiyah and Al Taim, Teshreen and Banyas or steam-only turbines (Banyas, Teshreen, and Mahradah) might be particularly affected. CCGT assets also experience decreases. Various studies suggest that power output decreases by 5%–12% for every 10°C increase in ambient air temperature above standard operating conditions (Farouk, et al., 2013; Şen et al., 2018; Bataineh and Khaleel, 2023; Junior et al., 2023). During heat waves, generation assets also face heat stress and can be damaged, resulting in load shedding and blackouts just as demand is peaking for air conditioning.

Temperature increases are likely to be greatest in the Northern and Middle zones, affecting existing thermal plants at Aleppo, Al Taim and Suwaidiyah and any new generation planned for these areas. Daytime temperatures regularly exceed 30°C in many parts of the country between June and September. By the 2030s, summer daytime temperatures are likely to be 1.3°–2.0°C warmer; by the 2050s, this is projected to be 1.7°–4.0°C depending on the region. Large parts of the country could experience 80–140 days/year with Tmax above 35°C

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6 In the past few decades, a small increase in September–November precipitation over the eastern areas of the Middle zone and central areas of the Northern zone has been observed. Due to hot temperatures, the small increase has had little impact on overall water availability over this desert region. Furthermore, the fall increases are offset by decreases in December–February amounts, contributing to an overall statistically significant decline in total annual precipitation.

7 ISO standard reference conditions for CCGT are ambient air at the compressor flange or inlet water temperatures of 15°C, relative humidity of 60% and absolute pressure of 101.3 kPa. Different types of turbines (OCGT and CCGT) have different operating efficiencies and are affected differently by ambient conditions. Age, condition and maintenance will also affect power output.

by the 2030s. It is recommended that air-/water-intake cooling technologies be installed to reduce power output losses associated with higher temperature under climate change.

More people and businesses will be exposed to routinely hotter temperatures and heat waves, increasing peak electricity demand for cooling. Temperature extremes – the number of heat waves and cooling degree days[8] – are projected to increase, which in turn will increase peak electricity demand (Figure 3). Increases in future demand are likely to be concentrated in major urban areas and their peripheries. In the Northern zone, encompassing cities such as Idlib, Aleppo and Al Hasakah, the number of annual average cooling degree days could exceed 660 by the 2030s and 767 by the 2050s under SSP2–4.5; Southern zone cities such as Damascus and Daraa could experience ~325 cooling degree days by the 2030s.

In addition to temperatures, peak electricity demand will be influenced by tariffs and the energy efficiencies (insulation) of reconstructed housing and commercial building stock across the country. Given time and lack of data, it was not possible to estimate possible increases in peak power demand under the different demand scenarios and due to climate change. However, in other countries in the region facing hotter temperatures, such as Jordan and Qatar, studies have shown that demand begins increasing at temperatures above 25–30°C and has led to peak demand increases of 15%–20% (Gurriaran et al., 2023; Momani and Alhmoud, 2023).

Syria's power network – transmission and distribution lines, connectors, interconnectors and substations – also face risks of damage and reduced capacity due to higher temperatures projected over coming decades. Lines have ratings for the maximum power that can be safely carried before the line begins to sag due to excessive heat. Higher air temperatures, wind, solar radiation and peak demand reduce line maximum transmission ratings. Transmission and distribution lines (TDL) have expected lifetimes of 30–80 years; new TDL or refurbishment of existing lines means that they could be operational well into the 2070s. Depending on the TDL, **transmission capacity might be reduced between 2% and 7% over the next few decades due to hotter temperatures** (Bartos et al., 2016; Burillo et al., 2019; TransGrid, CSIRO and BOM, n.d.); substations also will experience reduced load capacity. The grid network across the north of the country is particularly exposed to hotter temperatures and more heat waves.

Dust storms also present serious threats to TDL. The accumulation of dust on the line insulators can cause flashover and transmission failure, as well as accelerating corrosion (Jiang et al., 2020; Dadashzade et al., 2024). **The frequency and intensity of dust storms, particularly during the spring and summer months, is likely to increase in the future due to hotter temperatures and growing aridity in Syria,** and in neighbouring countries like Iraq (Abadi et al., 2025). Such storms are likely to occur when peak electricity demand is high – when TDL is already under increased strain – as hot, dry summer weather conditions (exacerbated during heat waves) facilitate their formation.

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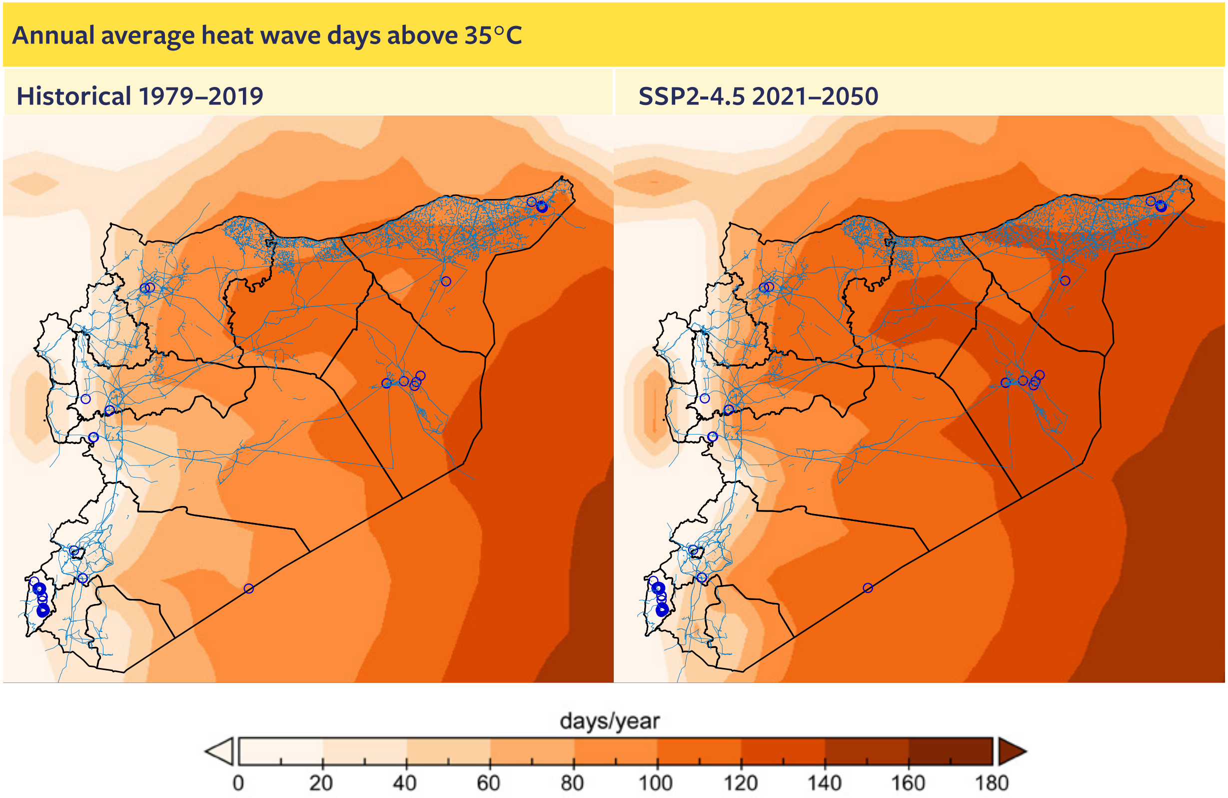
8 See note to Table 1.

Higher temperatures and the increase in the frequency and intensity of heat waves and dust storms also present risks to solar photovoltaic (utility and household scales) and utility-scale wind power generation (Feron et al., 2020; Chaichan et al., 2023; You et al., 2025). Solar panels' power generation is reduced for every degree above 25°C, and fuse and inverters' performance is also reduced; performance reductions are specific to panel type and cooling measures. Wind power generation might also decrease during heat waves, as wind speeds tend to reduce below cut-in levels for much of Syria during heat waves, except in proposed utility wind sites at Latakia and the southern Deir ez-Zor. While Syria-specific assessments are unavailable, the International Energy Agency modelling for the Middle East indicates that the combined effects of increased peak electricity demand (due to cooling) and thermal power capacity derating (due to extreme heat) could increase the total capacity required to meet projected peak demand by more than 6% by 2035.[9]

When counting for future population growth, increasing demand (including peak during hotter summers and heat waves) and demand locations, economic diversification, and potential generation and transmission losses due to hotter temperatures, additional capacity will have to come online before 2040. Such additional capacity might be realised through the construction of additional thermal generation (ideally high-efficiency, inlet-cooled CCGT, possibly using integrated solar thermal technology), expansion of utility-scale solar and wind generation and expanding interconnectors to neighbouring countries in a bolstered regional grid.

9 See IEA (2025b: 263, Figure 5.26). Modelled for the Stated Policies Scenario, which 'considers the application of a broader range of policies, including those that have been formally put forward but not yet adopted, as well as other official strategy documents that indicate the direction of travel. Barriers to the introduction of new technologies are lower than in the CPS, but the STEPS does not assume that aspirational targets are met'. (IEA, 2025b: 18)

Figure 3 Projected changes in heat waves



Note: approximate locations of thermal power plants (blue circles) and transmission lines (blue-grey) are shown.
Source: authors

Figure 4 Cooling degree days – historical and projected

Source: authors

Financial and economic risks

Physical and transition climate risks to Syria's electricity sector could trigger cascading effects across the real economy, public finances, and private investment. The physical risks outlined above impose costs through both direct impacts (such as damages to assets and higher operational costs from reduced efficiency) and indirect effects on investment decisions and production capacity. Transition risks arise from locking in long-lived electricity infrastructure that may underperform or fail under future conditions and require expensive retrofits, or from committing to technologies that incur opportunity costs as renewable energy capital costs decline. The cost to rehabilitate the electricity sector back to 2010 levels has been estimated at upward of $40 billion by the former Ministry of Electricity (Enab Baladi, 2025), then lowered to $11 billion by the new Ministry of Energy in May 2025, to be funded mainly by the private sector (Daily Sabah, 2025). Given the considerable costs and scarce domestic public and international concessional finance, climate-resilient planning is essential to protect these long-term investments.

At the national level, climate-related financial risks can heighten Syria's fiscal and sovereign debt vulnerabilities. The four major credit rating agencies already assign lower sovereign ratings to countries with higher physical climate risk, which can raise future borrowing costs (Capiello et al., 2025). Unexpected fiscal costs can also materialise from contingent liabilities, including explicit guarantees on project loans or implicit guarantees to loss-making state-owned enterprises.[10] Prioritising gas-fired electricity generation in reconstruction efforts also creates foreign exchange and commodity price risk as Syria currently relies on fuel imports, which are sensitive to fluctuations in oil and natural gas markets and are paid in foreign currency while tariffs are collected in local currency (World Bank, 2025a; 2025b). If fuel cost increases cannot be passed on to consumers, the resulting losses may translate into fiscal costs through higher electricity subsidies. For example, in neighbouring Lebanon, the government has historically covered the substantial financial losses of the state electricity company, which accounted for approximately half of the country's total fiscal deficit between 2008 and 2017 (Fay et al., 2021).

At the project level, heightened physical risks can decrease asset profitability, increase insurance premiums and constrain project financing. Foreign direct investors are likely to require long-term contracts, such as power purchasing agreements, to ensure return on their electricity generation investments. Increasing heat and aridity can decrease the operating efficiency of power plants, leading to generation losses, which in turn translate to financial losses due to contract lock-in. Natural hazards can induce similar negative consequences. The natural hazard insurance protection gap for the Middle East in 2024 exceeded 60%, and while terms for Syria's reconstruction deals remain undisclosed – such as for the $7 billion investment announced by the Qatari–Turkish–US consortium – coverage may be similarly limited (Aon, 2025). If risk-transfer mechanisms are absent from financing agreements, the government may be forced to absorb losses from climate-related impacts.

Indirect economic losses from unmet power demand may exceed the value of direct asset damages (CDRI, 2023). Disrupted electricity services hinder wider economic activity, with power outages estimated to cost between 0.002% and 0.150% of annual GDP.[11] These service disruptions create expensive coping costs for Syrian households and businesses through the use of expensive off-grid back-up power solutions. For example, the private costs of running diesel generators are reported to reach as high as nine times the full cost of grid-supplied electricity provision (which is already higher than the tariffs charged), based on 2023 prices (World Bank, 2025a).

10 Contingent liabilities are off-balance sheet payment obligations that only arise if a particular event occurs (Boukezia et al., 2023).

11 Estimate based on modelled results in low- and middle-income economies (Hallegatte et al., 2019).

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ODI Global
4 Millbank,
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