MIDDLE EAST

MAPPING ENERGY LANDSCAPES IN THE GULF

Systems, Policies, and Transition Pathways

Parul Bakshi

ORF MIDDLE EAST

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INTRODUCTION

The Gulf Cooperation Council (GCC), comprising the United Arab Emirates, Qatar, Kuwait, Bahrain, Oman, and Saudi Arabia, sits at the core of global energy markets. Together, GCC states supply close to one-third of internationally traded crude oil and a growing share of global liquefied natural gas (LNG), anchoring their continued relevance in an evolving global energy system.[1] At the same time, each country has articulated long-term national strategies that place energy transition, system efficiency, and economic diversification at the centre of future growth.

Yet the Gulf's energy transitions are unfolding within a distinct structural context. GCC economies remain highly hydrocarbon-intensive, power systems are overwhelmingly reliant on natural gas, and demand profiles are shaped by rapid population growth, energy-intensive industrialisation, extreme cooling needs, and water desalination. As a result, decarbonisation pathways across the region are less about rapid fuel substitution and more about system optimisation, careful sequencing, and managing structural constraints alongside clean-energy scale-up.

The bloc has accounted for over 55 percent of the region's growth since 2000 and today represents around 37 percent of the regional Gross Domestic Product (GDP), despite comprising only about 12 percent of the population.[2] Looking ahead, oil-exporting GCC economies are expected to continue outperforming the wider region, supported by strong non-oil activity and sustained energy revenues. This economic backdrop shapes both the pace and priorities of national energy transitions.

While the Gulf is often discussed as a single energy bloc, its transition pathways diverge sharply at the national level, shaped by the priorities and constraints articulated in its capitals, from Abu Dhabi and Doha to Kuwait City, Manama, Muscat, and Riyadh.

This report provides a country-level primer on the Gulf's current energy landscapes, tracing how each system has evolved and how national strategies frame the next phase of transformation. It does not assess whether stated targets are sufficient, achievable, or aligned with global climate pathways. Instead, it offers a factual, system-level overview of energy mixes, power-sector structures, policy frameworks, and clean-energy deployment trajectories across the GCC.

For each capital, the analysis is structured consistently across six sections: energy system characteristics and emissions profiles; policy and decarbonisation frameworks; the energy mix; the structure and evolution of the electricity sector; recent energy landscape developments; and the key challenges and systemic constraints shaping future pathways, followed by a forward-looking outlook. Data and indicators are drawn primarily from the latest International Energy Agency (IEA) databases to ensure cross-country comparability and are supplemented by national statistics and sector-specific sources where relevant.

By mapping these foundational elements across countries, the report establishes a baseline for understanding how GCC energy systems are transitioning from strategy formulation toward on-the-ground execution. As regional coordination deepens across grid interconnections, hydrogen and ammonia supply chains, and clean-technology manufacturing, these country profiles provide a reference point for analysing emerging patterns of cooperation, competition, and system divergence within the Gulf.

ABU DHABI - UNITED ARAB EMIRATES

The UAE is the world's seventh-largest oil producer and the 14th-largest natural gas producer, illustrating its centrality to global hydrocarbon supply chains.[3] Natural gas accounted for 73 percent of CO_2 emissions from fuel combustion in 2023, while the power sector contributed 33 percent of total energy-related emissions.4 This emissions profile is reinforced by rapidly rising electricity demand, driven by population growth, industrial diversification, cooling requirements, and desalination dependency. As the UAE advances its Energy Strategy 2050 and Hydrogen Strategy, it faces the challenge of reducing emissions while maintaining system reliability within a predominantly gas-based power sector.

KEY TAKEAWAYS

1. Natural gas continues to dominate the UAE's energy system, accounting for about 60 percent of total energy supply and 72 percent of electricity generation in 2023, underscoring the scale of system-level transformation required.

2. The UAE has rapidly expanded its clean energy portfolio: renewables rose from 3 percent of electricity generation in 2019 to 8 percent in 2023, while nuclear supplied around 20 percent of total generation, the highest clean share in the Gulf.

3. The UAE's energy transition reflects a balancing act between rapid clean-energy scale-up and the operational realities of a gas-anchored power system, with electricity demand growth and the water–energy nexus playing a central role in shaping outcomes.

Energy Policy and Decarbonisation Framework

The UAE's policy landscape is anchored in the UAE Energy Strategy 2050 and the country's Net Zero by 2050 Strategic Initiative, making it the first country in the Middle East and North Africa (MENA) to formally commit to an economy-wide net-zero emissions target.[5] The overarching objective is to balance rapidly growing energy demand with decarbonisation goals while maintaining economic competitiveness and energy security.

UAE Energy Strategy 2050: Launched in 2017 as the country's first unified long-term energy strategy, the updated 2023 version introduces a more detailed implementation pathway for the 2030 horizon. Key targets include:6

- Tripling the share of renewable energy by 2030.
- Raising installed clean energy capacity from 14.2 GW to 19.8 GW by 2030.
- Increasing the share of installed clean energy capacity to 30 percent of the total mix by 2030.
- Boosting clean electricity generation to 32 percent by 2030.
- Phasing out clean coal from the energy mix, removing earlier provisions for coal-based electricity.
- Achieving a 42–45 percent improvement in energy efficiency compared to 2019, alongside AED 100 billion in financial savings through efficiency measures and clean energy deployment.
- Creating 50,000 green jobs by 2030.
- Mobilising AED 150–200 billion in investment to meet energy demand and sustain economic growth.

The National Hydrogen Strategy (2023) sets out a long-term roadmap to position the country as a major global supplier of low-emission hydrogen, leveraging its solar resources, existing gas infrastructure, and industrial base. The strategy targets annual hydrogen production of 1.4 million tonnes per annum (mtpa) by 2031, scaling to 7.5 mtpa by 2040 and 15 mtpa by 2050. A national demand assessment projects 2.7 mtpa of domestic low-carbon hydrogen demand by 2031.[6]

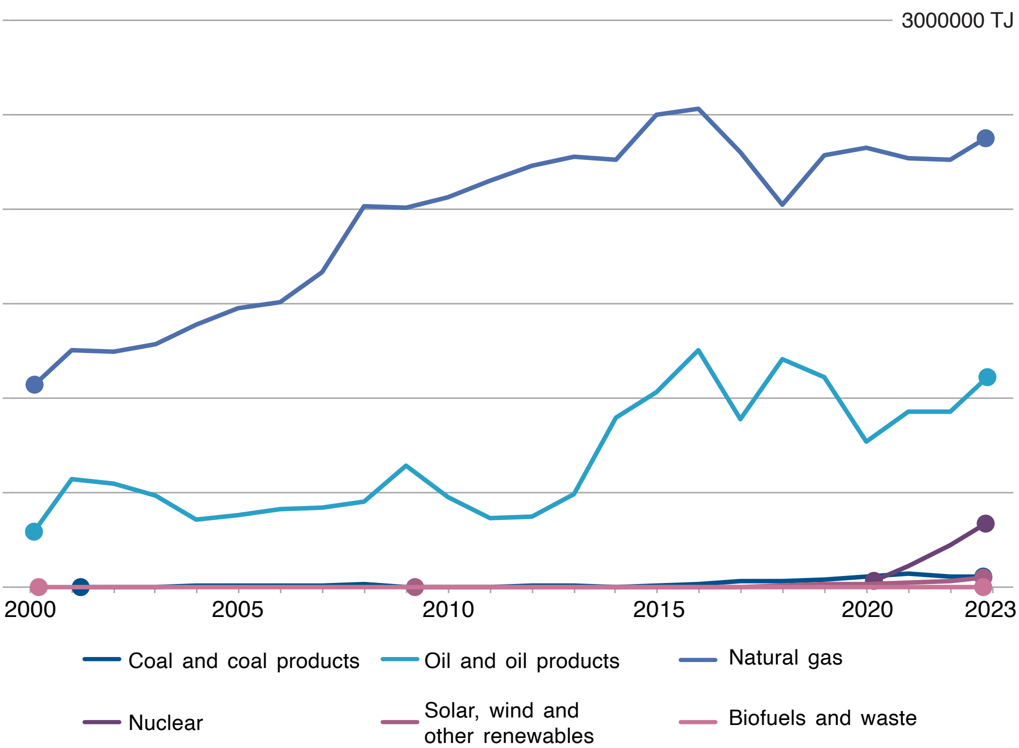
To enable this ramp-up, the UAE plans to establish two hydrogen oases by 2031, expanding to five by 2050, supported by dedicated export corridors, supply-chain infrastructure, and a national R&D centre. Production is intended to be diversified, with roughly half coming from blue hydrogen (fossil-based with CCS), most of the remainder from green hydrogen, and a smaller share from pink hydrogen using nuclear power.

Energy Mix

The UAE's energy mix remains dominated by natural gas and oil, reflecting its role as a major hydrocarbon producer and exporter within global energy markets. Natural gas constitutes the largest share of total energy supply and underpins electricity generation, desalination, industrial production, and cooling. This structural dependence is reinforced economically, with hydrocarbons accounting for roughly 30 percent of GDP and 13 percent of exports.[7]

Figure 1.

Evolution of total energy supply in United Arab Emirates since 2000



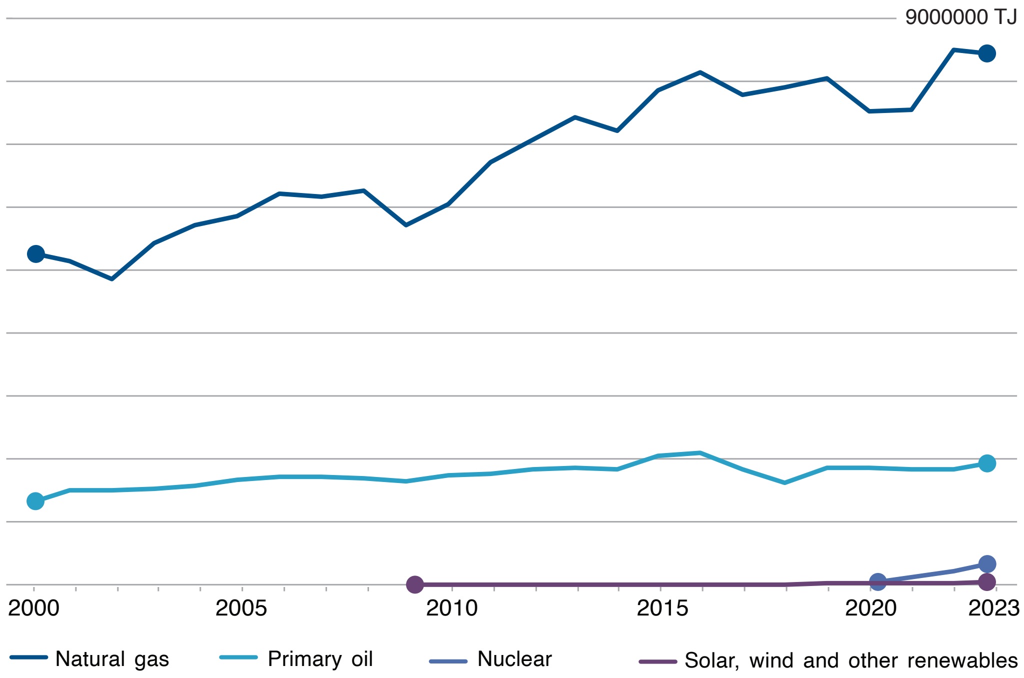
Source: IEA

IEA data shows that natural gas made up about 60 percent of the UAE's total energy supply in 2023, with domestic gas production supplied 81.2 percent of national gas demand—an increase of 51 percent since 2000.[4] Yet the UAE relies partly on imports via the Dolphin pipeline from Qatar, highlighting the structural tightness of its gas balance. The government aims to achieve natural-gas self-sufficiency by 2030, supported by increased nuclear and solar deployment that could enable more gas to be redirected towards LNG exports rather than domestic power generation.[7]

Primary oil remains the dominant component of domestic energy production, accounting for around 78 percent of total output, even as the UAE expands its renewable and nuclear portfolios.[4]

Figure 2.

Evolution of domestic energy production in United Arab Emirates since 2000



Source: IEA

While the share of renewables has increased in recent years, the UAE's energy system remains structurally dependent on natural gas, mirroring regional pattern but distinguished by the country's expanding clean-energy ambitions and its unique combination of solar, nuclear, and emerging hydrogen capacity.

Electricity Landscape

The UAE's electricity system has undergone a significant structural shift over the past decade, marked by the entry of nuclear power and rapid solar deployment, but natural gas remains the backbone of power generation. In 2023, gas accounted for 72 percent of total electricity output, followed by nuclear energy at around 20 percent and renewables at 8 percent.[3]

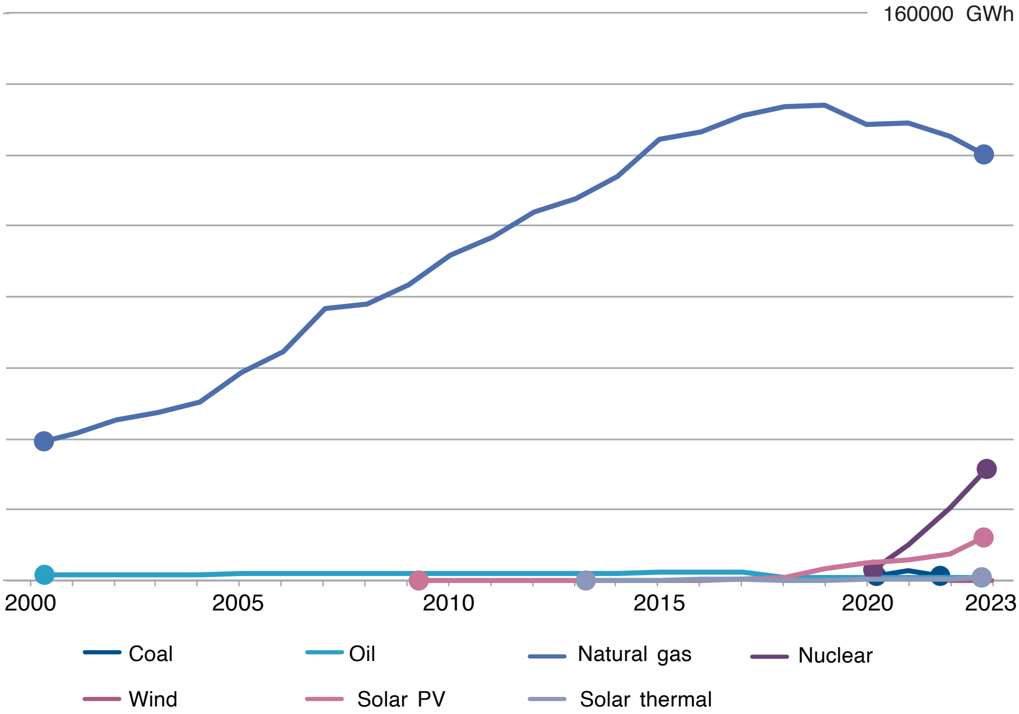
Electricity demand has grown at an average of 3.5 percent annually over the past decade and is projected to increase from 155 TWh in 2025 to roughly 184 TWh in 2030 and 444 TWh by 2050.[8] This sustained growth is driven by population expansion, industrial diversification, rising cooling loads, and the electricity–water nexus linked to desalination.

The UAE's power-sector emissions have also tripled over the last two decades, mirroring demand growth and the country's historical dependence on fossil gas.[9] While natural gas still dominates power supply, its share has declined from 99 percent in 2018 to 72 percent in 2023 as nuclear and renewables come online.[3]

However, system dependence on gas continues to remain substantial, as 2.1 GW of new gas-fired power capacity was added in 2023, with a further 9 GW currently in the development pipeline.[3]

Figure 3.

Evolution of electricity generation in United Arab Emirates since 2000

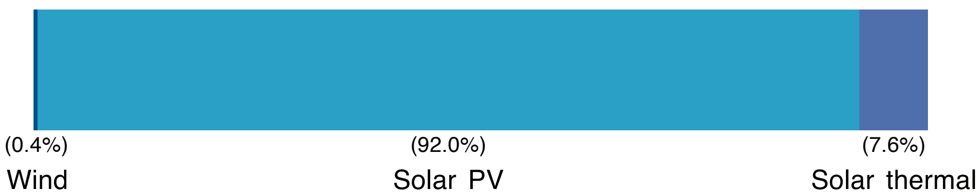


Source: IEA

Meanwhile, renewables have expanded rapidly, rising from 3 percent of electricity generation in 2019 to 8 percent in 2023.[3] Installed renewable capacity reached approximately 6 GW in 2023. Under the updated Energy Strategy 2050, the UAE targets 19.8 GW of renewables by 2030. Yet current project pipelines suggest the country may reach closer to 9 GW by 2030, indicating a substantial gap between ambition and delivery, according to Climate Action Tracker.[3]

Figure 4.

Renewable electricity generation by source (non-combustible), United Arab Emirates, 2023



Source: IEA

Despite this gap, the UAE has emerged as a global benchmark for low-cost solar deployment. Dubai's Mohammed bin Rashid Al Maktoum Solar Park, among the world's largest single-site solar installations, continues to deliver record-low tariffs.[10] Meanwhile, Abu Dhabi's 2 GW Al Dhafra Solar Project, one of the largest solar PV plants globally, can power approximately 200,000 homes and avoid more than 2.4 million tonnes of CO_2 annually through its advanced bifacial PV technology (can capture sunlight from both sides).[11]

The UAE is also beginning to diversify beyond solar, exploring wind and waste-to-energy sources to broaden its clean-energy base.

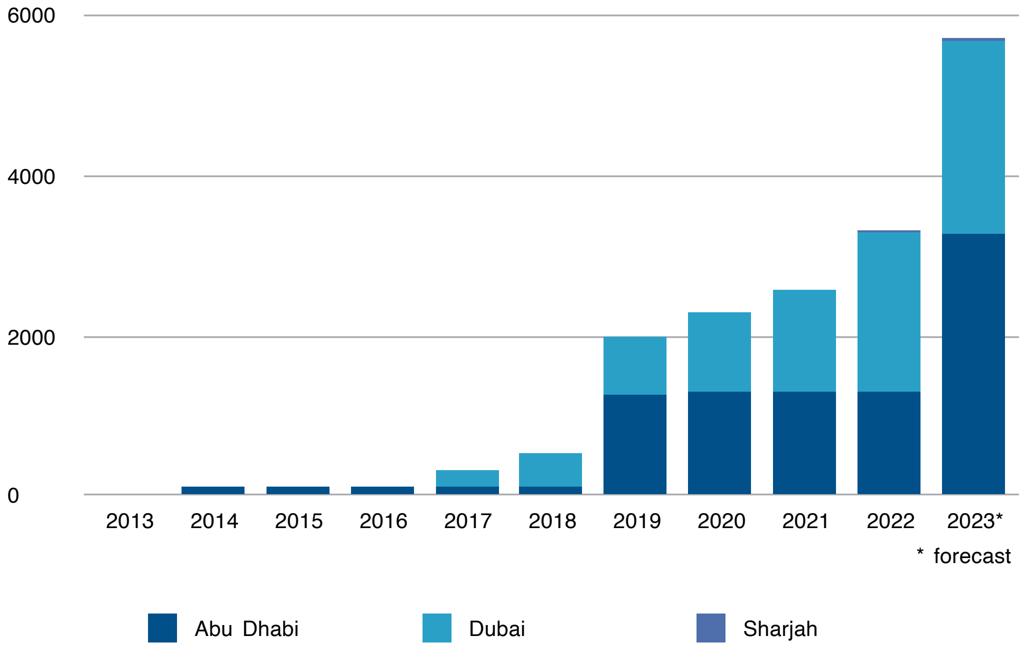
Key Developments

The UAE has moved from policy design to rapid deployment across solar, nuclear, hydrogen, and waste-to-energy, signalling a decisive shift towards implementation.

According to recent industry estimates, the UAE has committed tens of billions of dollars toward clean-energy and clean-tech projects, including an estimated US$12 billion across solar, nuclear, and green-hydrogen initiatives through entities such as Masdar. Long-term plans envisage US$163 billion in investment by 2050 to meet rising electricity demand and maintain system reliability.[12]

Figure 5.

UAE ramping up renewables capacity
(renewable energy capacity, MW; end-period)



Source: EIU

On the solar front, several large-scale projects anchor the UAE's clean-energy expansion. These include the 2 GW Al Dhafra Solar PV plant, Abu Dhabi's 1.5 GW PV3 project, and the fourth (950 MW) and fifth (900 MW) phases of the Mohammed bin Rashid Al Maktoum Solar Park, which is planned to reach 5 GW by 2030 and ranks among the world's largest single-site solar installations.[12] According to the Economist Intelligence Unit, Abu Dhabi, Dubai, and Sharjah are expected to continue accelerating renewable deployment through 2027, freeing up gas for export and supporting stronger GDP and external balances.[13]

Hydrogen development has also advanced from planning to early commercialisation. Masdar aims to produce 1 mtpa of green hydrogen by 2030 and has announced a US$5 billion strategic alliance with Engie to develop a 200 MW green hydrogen-to-ammonia project.[12] Additional private-sector initiatives include Helios Industry's US$1 billion green hydrogen and green ammonia project in Khalifa Industrial Zone Abu Dhabi (KIZAD), powered by an 800 MW solar facility and deploying Thyssenkrupp electrolyser technology. According to the project announcement, this will be the first commercial-scale plant in the UAE to produce carbon dioxide-free green ammonia from renewable resources.[12]

Diversification within clean energy is also extending to waste-to-energy and emerging offshore wind assessments. Dubai's Waste Treatment Centre, touted as the world's largest waste-to-energy facility, converts 45 percent of municipal waste into 200 MW of electricity, powering over 135,000 homes.[11]

In parallel, the UAE's civilian nuclear programme has become a backbone of its zero-carbon strategy. With the fourth unit at the Barakah Nuclear Energy Plant entering commercial operation in March 2024, all 5.6 GW of capacity is now online. Barakah supplies around 25 percent of national electricity demand and delivers the region's largest source of carbon-free baseload power, dramatically reducing grid emissions and enhancing system stability.[14]

Together, these developments demonstrate how the UAE is expanding a multi-pillar clean-energy portfolio and translating transition strategies into system-level outcomes

Challenges and Systemic Constraints

- **Gas lock-in and demand pressure via desalination:** Rapid growth in electricity demand from cooling, desalination, and industry continues to outpace clean-energy deployment. With most drinking water produced through gas-powered thermal desalination, the power system remains structurally tied to natural gas. Shifting desalination toward electricity-based reverse osmosis will require substantial infrastructure investment and careful sequencing to avoid water-security risks.
- **System-integration and peak-load vulnerability:** Scaling solar alongside new nuclear baseload is placing increasing strain on transmission capacity, grid flexibility, and storage. Summer cooling demand, reaching up to 75 percent of peak load in some emirates creates sharp seasonal spikes that compress reserve margins and complicate system balancing. The IEA underscores the need for accelerated investment in system-integration infrastructure to sustain higher clean-energy penetration.
- **Hydrogen commercialisation barriers:** While national hydrogen ambitions are advanced, progress toward scale is constrained by high electrolyser costs, limited certified export pathways, and a lack of binding long-term offtake agreements, delaying the transition from pilot projects to bankable commercial supply.

Outlook

The UAE's transition strategy rests on a multi-pillar clean-energy portfolio spanning solar, nuclear, hydrogen, and waste-to-energy, positioning it as the most diversified power system in the Gulf. Building on the momentum of COP28 and the UAE Consensus, which marked the first global call to "transition away from fossil fuels", the country is also emerging as a diplomatic convenor on climate and energy cooperation in the region.

With nuclear already providing some zero-carbon baseload, the pace of future decarbonisation will hinge on how rapidly solar capacity can be integrated alongside investments in storage, transmission, and grid flexibility. At the same time, the National Hydrogen Strategy places the UAE among potential first movers in future hydrogen trade corridors linking the Gulf with Europe and Asia, though progress toward scale will depend on securing bankable offtake and export infrastructure.

As GCC energy systems evolve, the UAE's pathway will be shaped by a combination of domestic execution and regional dynamics, where competition in clean-energy leadership coexists with growing coordination on grids, fuels, and low-carbon supply chains.

DOHA - QATAR

Qatar is one of the world's leading hydrocarbon exporters, anchored by its vast natural gas reserves and dominant role in LNG markets. Its energy system is deeply integrated with global gas supply chains, even as the country pursues diversification in power generation and early-stage clean-energy deployment. Natural gas also dominates Qatar's emissions profile, accounting for over 80 percent of CO_2 emissions from fuel combustion, underscoring the close coupling between the power sector and gas production.[15]

KEY TAKEAWAYS

1. Qatar National Vision 2030 anchors the country's energy policy direction around economic diversification and sustainability, without adopting a formal economy-wide net-zero emissions target to date.

2. Qatar is a global LNG powerhouse, with continued planned expansions of the North Field to roughly 126–142 mtpa by the late 2020s, reinforcing its central role in global gas markets while also shaping early exploration of power-to-gas and low-carbon hydrogen pathways as longer-term diversification options.

3. Power generation in Qatar remains predominantly gas-based, though the 800 MW Al-Kharsaah Solar Power Plant marks Qatar's first utility-scale PV deployment, signalling the initial entry of domestic renewables.

Energy Policy and Decarbonisation Framework

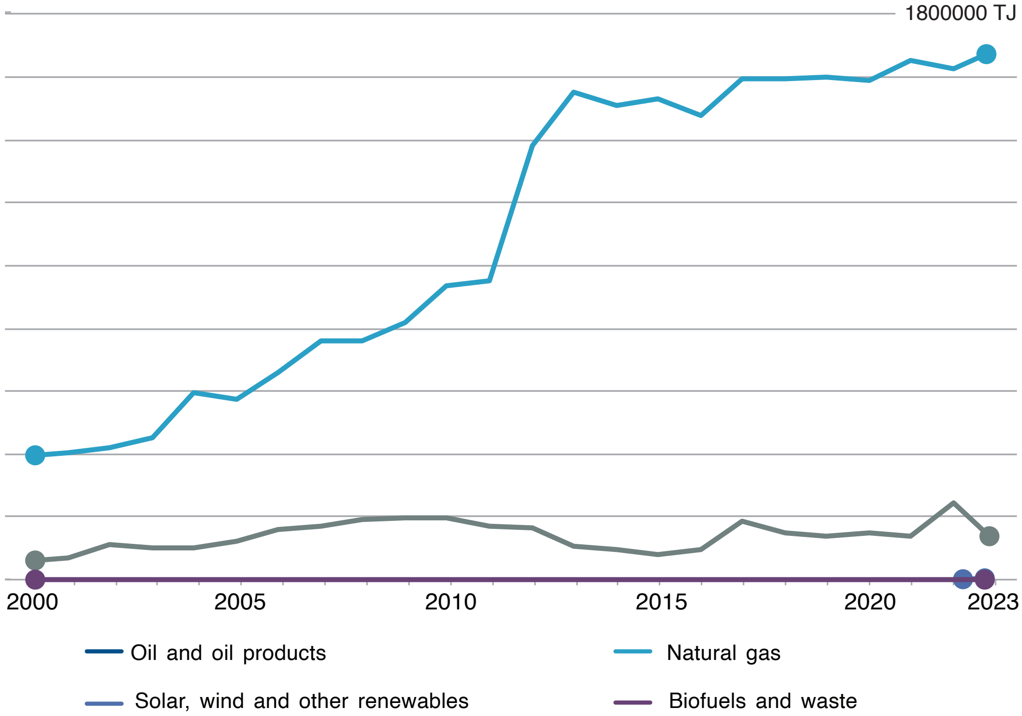
- As a signatory to the Paris Agreement, Qatar has committed to reducing GHG emissions by 25 percent from business-as-usual levels by 2030, as outlined in its National Climate Change Action Plan 2030 and NDC. However, it has not adopted an economy-wide net-zero emissions target yet.
- Qatar National Vision 2030 places sustainable development at the core of long-term planning, with the government allocating around US$5 billion toward renewable energy and associated low-carbon initiatives.[16]
- The National Renewable Energy Strategy aims to increase the share of renewables in its power mix to around 18 percent by 2030 (up from roughly 5 percent today). It targets up to 4 GW of large-scale renewable capacity by 2030, alongside approximately 200 MW of distributed solar generation, with a focus on solar PV.
- The share of combined-cycle gas turbine (CCGT) generation is projected to decline from roughly 80 percent today to around 72 percent by 2030, with the balance met through renewables, interconnections, and small-scale generation.
- Qatar plans to electrify 100 percent of public bus fleets and approximately 35 percent of the private vehicle fleet by 2030.

Energy Mix

Qatar's energy system is dominated by natural gas, reflecting its vast resource endowment and its role as the world's leading LNG exporter. In 2023, natural gas accounted for around 93 percent of total energy supply, making Qatar one of the most gas-intensive energy systems globally.[15]

Figure 6.

Evolution of total energy supply in Qatar since 2000



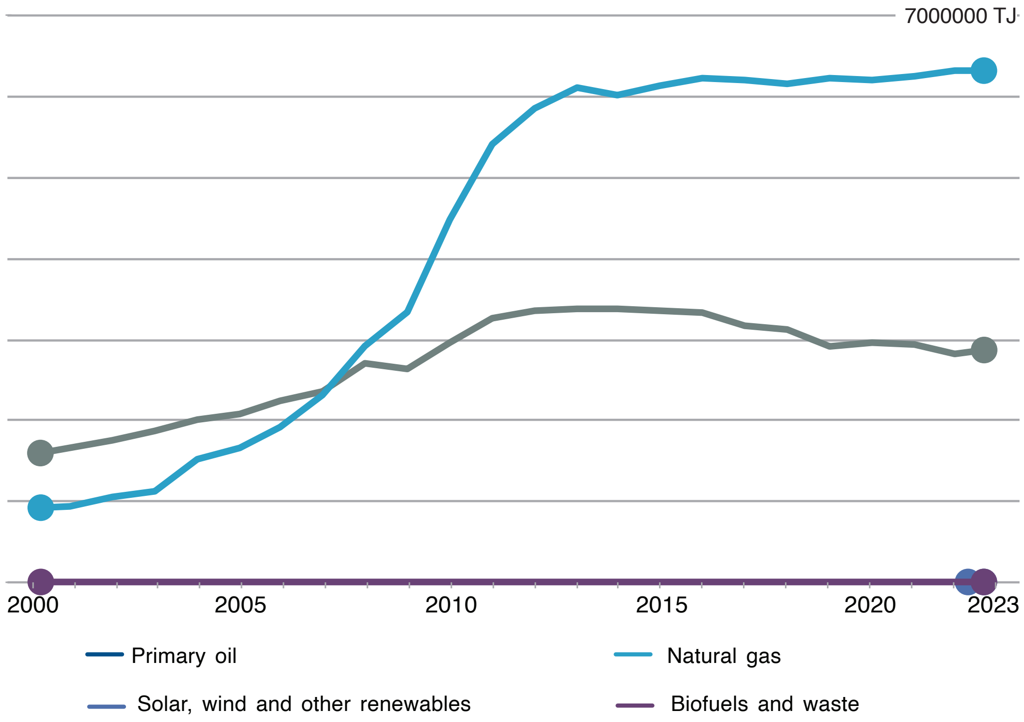
Source: IEA

Total energy supply has grown steadily since 2000, driven by population growth, rapid economic expansion, energy-intensive industrial activity, and desalination demand. The sharp increase in gas consumption from the mid-2000s onward mirrors the expansion of upstream gas production and downstream LNG infrastructure, reinforcing the tight linkage between Qatar's domestic energy system and its export-oriented gas sector. This strategic shift was reinforced by Qatar's exit from OPEC in January 2019, signalling a deliberate reorientation away from oil and toward natural gas and LNG infrastructure.[17]

Domestic energy production broadly mirrors this trend. Natural gas represents approximately 69 percent of total domestic energy production, with oil accounting for most of the remainder.[15] While oil production has remained broadly stable over time, gas output has expanded significantly since the mid-2000s, underpinning both rising domestic consumption and Qatar's growing LNG export capacity.

Figure 7.

Evolution of domestic energy production in Qatar since 2000



Source: IEA

Renewables and biofuels remain negligible in the total energy supply mix, reflecting the relatively recent start of domestic renewable deployment and the continued availability of low-cost natural gas for power generation, industry, and water desalination. As Qatar scales up solar deployment and explores low-carbon hydrogen pathways, the evolution of this structurally gas-dependent energy system will remain a defining feature of its transition trajectory.

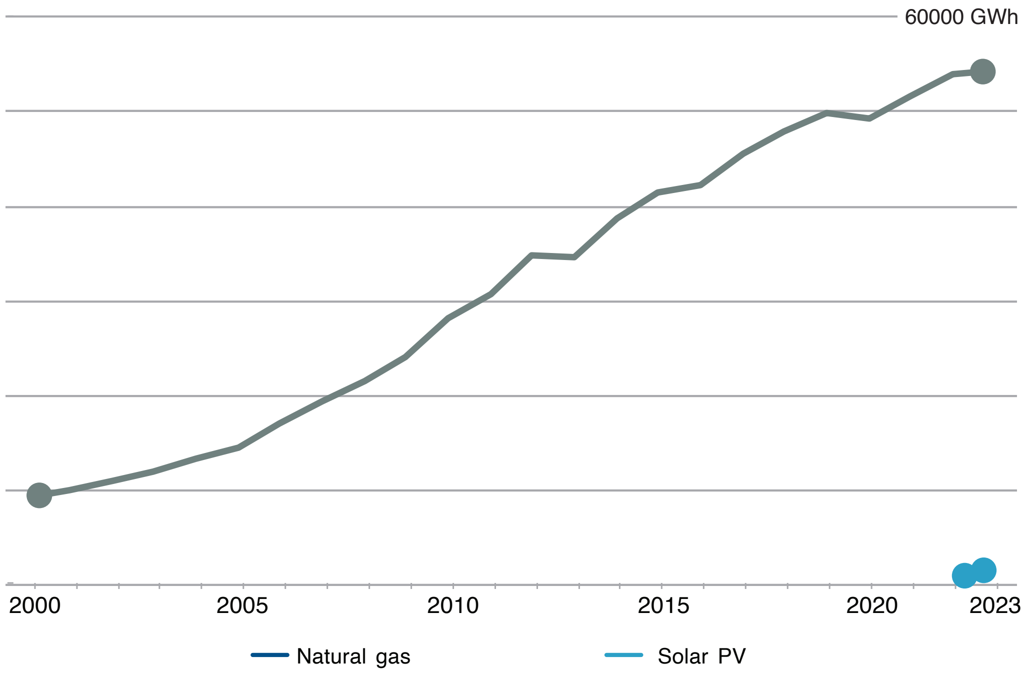
Electricity Landscape

Electricity demand in Qatar has grown substantially over the past two decades, driven by population growth, rapid economic expansion, rising cooling loads, and energy-intensive industrial and desalination activities. Total installed electricity generation capacity stood at approximately 11.4 GW in 2023, representing an increase of nearly 30 percent over the past decade, while net electricity generation expanded even more rapidly.

According to the IEA, natural gas accounted for around 97 percent of total electricity generation in 2023.[15] Natural gas continues to dominate the power mix, supported by abundant domestic supply and a fleet of CCGT plants closely linked to industrial and water-desalination demand.

Figure 8.

Evolution of electricity generation sources in Qatar since 2000

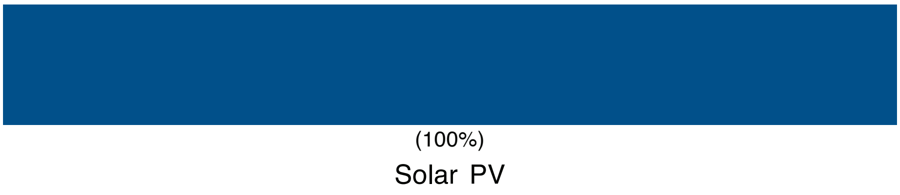


Source: IEA

Solar capacity is now moving from pilot-scale to system-relevant deployment. Qatar's first utility-scale solar project, the 800 MW Al-Kharsaah Solar Power Plant, entered commercial operation in 2022, marking a turning point in domestic renewable deployment. This was followed by the Ras Laffan and Mesaieed solar power plants, which were inaugurated and brought online in 2025, lifting Qatar's installed solar capacity to roughly 1.7 GW.[18] Looking ahead, QatarEnergy has announced plans for an additional 2 GW solar project in the Dukhan area, which would further scale utility-scale renewables.[19]

Figure 9.

Renewable electricity generation by source (non-combustible), Qatar, 2023



Source: IEA

Qatar’s energy strategy prioritises further expansion of utility-scale solar to increase the share of renewables in electricity generation and support broader decarbonisation objectives. The phased addition of new solar projects is expected to gradually displace a portion of gas-fired generation, though gas is projected to remain dominant in the near term.

Key Developments

Qatar’s transition activity has increasingly focused on system efficiency, demand management, and strategic sequencing rather than rapid diversification away from gas.

A central pillar is the Tarsheed programme, a national energy efficiency and water-conservation initiative targeting residential, commercial, and industrial consumers. Through efficiency standards, audits, and behavioural measures, it aims to moderate demand growth in a system where electricity use is closely tied to cooling, desalination, and industrial loads.[20]

Beyond its flagship utility-scale plants, QatarEnergy has increasingly linked solar development to industrial cities and gas-processing zones, aligning renewable capacity additions with energy-intensive economic activity. This reflects an approach centred on incremental decarbonisation within a gas-centric system rather than wholesale restructuring of the power sector.

At the same time, Qatar’s energy strategy remains anchored by the North Field Expansion, the largest upstream gas development currently underway globally. The project is designed to raise LNG production capacity from 77 mtpa to around 126 mtpa by 2027, with a further expansion phase potentially lifting capacity to 142 mtpa by the end of the decade.[21] This expansion reinforces Qatar's central role in global LNG markets while shaping the fiscal and system conditions under which domestic decarbonisation is pursued.

Together, these developments underscore Qatar's dual-track strategy: expanding gas supply to meet global demand while incrementally integrating efficiency measures and low-carbon energy within its domestic system. Rather than signalling a rapid pivot away from hydrocarbons, Qatar's transition pathway prioritises emissions-intensity reduction, system optimisation, and long-term market positioning.

Challenges and Systemic Constraints

- **Heavy reliance on gas and export revenues:** Qatar's energy system and wider economy remain deeply anchored in natural gas production and LNG exports, limiting the pace of domestic diversification and reinforcing sensitivity to long-term shifts in global gas demand.
- **System flexibility and peak demand management:** High summer cooling loads and desalination-driven electricity demand increase reliance on gas-fired capacity for system balancing, limiting the near-term role of variable renewables without additional storage or demand-side flexibility.
- **Renewable resource constraints and technology readiness:** While solar potential is high, technical barriers such as grid interconnection costs, intermittency management, and performance degradation due to dust and high temperatures can constrain rapid expansion without significant supportive infrastructure.[22]
- **Legal, regulatory, and investment frameworks:** Qatar's renewable deployment is still nascent, and current legal and regulatory frameworks are evolving. Effective incentives, transparent governance structures, and private-sector engagement mechanisms are necessary to attract sustained investment and accelerate renewable scale-up.

Outlook

Qatar's approach positions it as a stabilising energy supplier in a transitioning global system, with decarbonisation framed around emissions management, operational efficiency, and long-term optionality rather than rapid fuel substitution. Over the coming decade, the pace at which solar deployment, demand management, and low-carbon fuels mature alongside continued LNG expansion will determine whether Qatar's domestic power system evolves beyond incremental decarbonisation. As regional energy systems evolve, Qatar's trajectory will increasingly intersect with Gulf-wide discussions on hydrogen supply chains, grid interconnections, and coordinated low-carbon infrastructure, shaping both competitive dynamics and selective areas of cooperation within the GCC.

KUWAIT CITY - KUWAIT

Kuwait's energy system is among the most hydrocarbon-intensive in the Gulf, reflecting its long-standing role as a major oil producer and exporter and its near-total reliance on fossil fuels for domestic energy supply. Oil and natural gas underpin electricity generation, desalination, and industrial activity, resulting in one of the most emissions-intensive power sectors in the Gulf. Electricity and heat production account for roughly half of Kuwait's total energy-related CO_2 emissions. Energy demand is projected to rise sharply over the coming decade, with total energy demand expected to more than triple by 2030.[23] Within this context, Kuwait's energy transition agenda is shaped by the dual challenge of meeting rapidly rising demand while gradually diversifying an energy system that remains structurally anchored in hydrocarbons.

KEY TAKEAWAYS

1. Kuwait's energy system is almost entirely reliant on fossil fuels, with oil and gas underpinning electricity generation, desalination, and industrial activity.

2. Kuwait has set a target to increase the share of renewable electricity to around 15 percent by 2030, though deployment remains limited relative to regional peers.

3. While Kuwait has articulated a long-term ambition to achieve carbon neutrality by 2060, near-term policy focus remains on system efficiency, fuel switching within hydrocarbons, and incremental renewable additions rather than rapid diversification.

Energy Policy and Decarbonisation Framework

- As a signatory to the Paris Agreement, Kuwait has submitted its NDCs but has not yet adopted a detailed economy-wide net-zero roadmap. It has, however, announced a long-term ambition to achieve carbon neutrality by 2060, while committing to net-zero GHG emissions in the oil sector by 2050, as announced at COP27 in Sharm Elsheikh, Egypt.
- Kuwait's national energy strategy targets increasing the share of renewable electricity generation to 15 percent by 2030, primarily through solar power.

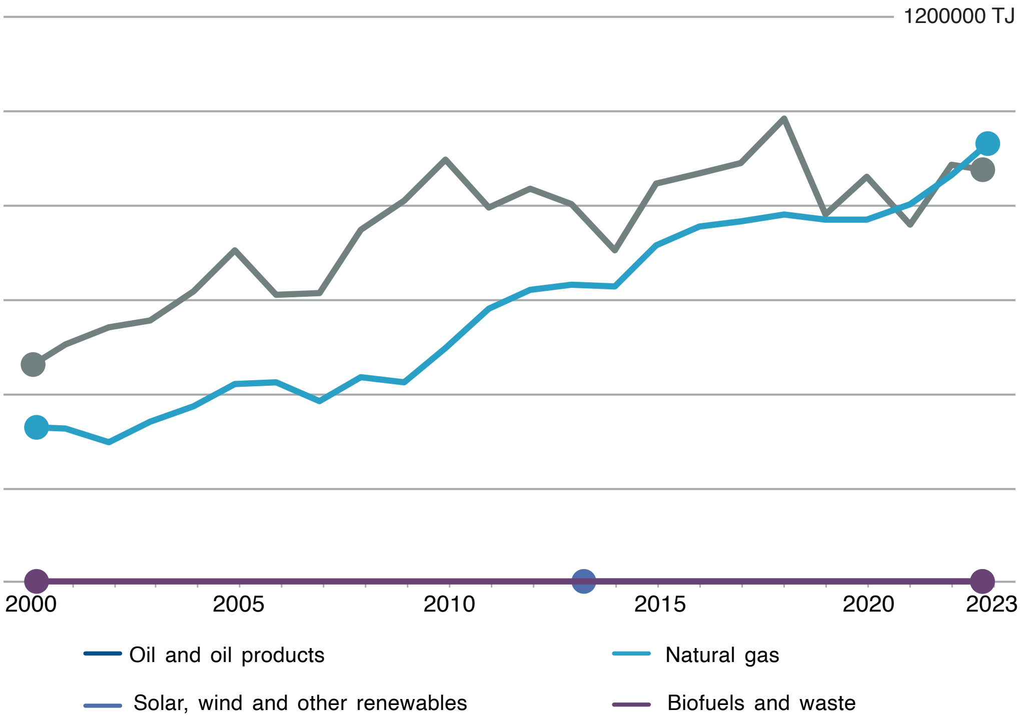
Energy Mix

Kuwait's energy system remains overwhelmingly hydrocarbon-based, reflecting its position as the world's eighth-largest oil exporter and the central role of oil revenues in the national economy. Over the past decade, oil and its derivatives have contributed between 51 percent and 67 percent of GDP, underscoring the structural linkage between energy supply, fiscal stability, and economic activity.[24]

In 2023, natural gas accounted for approximately 52 percent of Kuwait's total energy supply, while oil and oil products made up the remaining 48 percent.[23] This relatively balanced split at the consumption level contrasts with the country's production profile and reflects efforts to use gas more intensively in power generation and desalination, preserving oil for export.

Figure 10.

Evolution of total energy supply in Kuwait since 2000

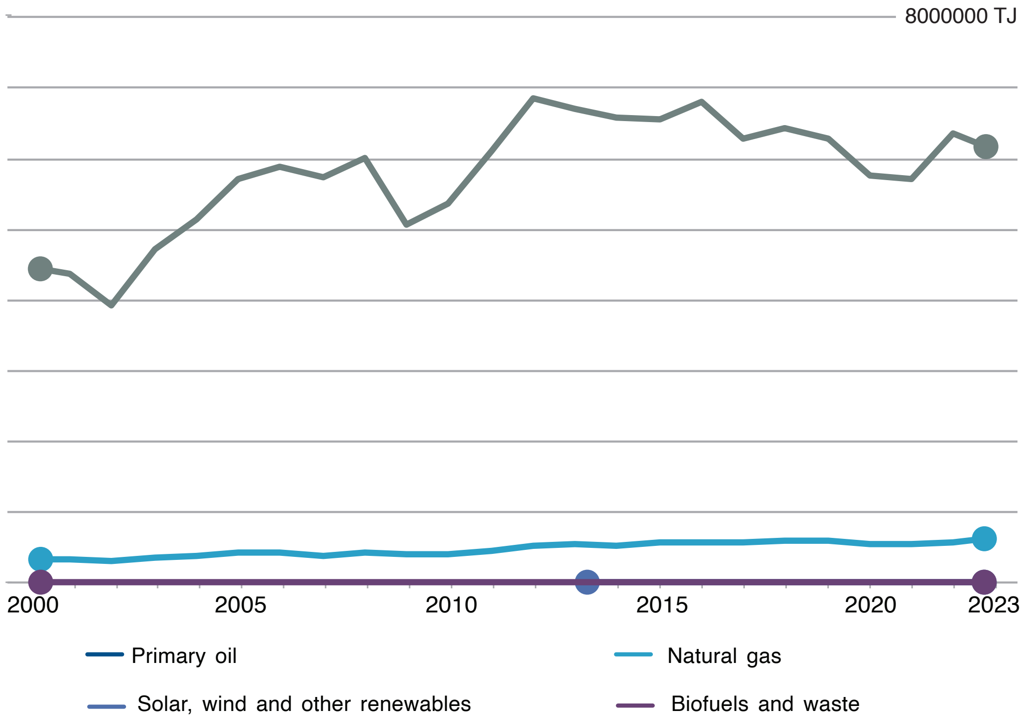


Source: IEA

Domestic energy production, however, remains heavily skewed toward oil. Primary oil represents around 90 percent of total domestic energy production, with natural gas accounting for a much smaller share. This asymmetry highlights Kuwait's continued reliance on oil extraction as the backbone of its energy economy, even as gas plays a growing role in domestic energy use.

Figure 11.

Evolution of domestic energy production in Kuwait since 2000



Source: IEA

Despite modest diversification in domestic fuel use, renewable energy and biofuels remain negligible in Kuwait's overall energy mix. As a result, Kuwait's energy transition challenge is less about fuel substitution within supply and more about managing demand growth, improving system efficiency, and gradually integrating non-fossil generation into a system still anchored in oil and gas.

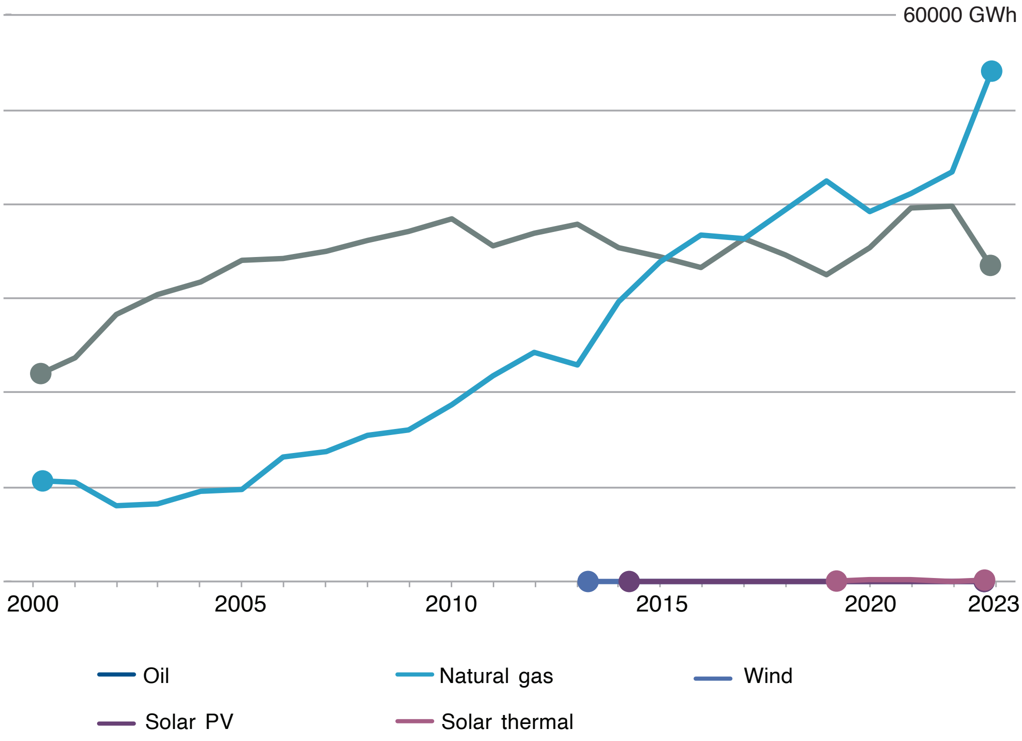
Electricity Landscape

In 2023, natural gas accounted for approximately 63 percent of Kuwait's total electricity generation, while oil contributed around 37 percent.[23] Electricity demand has risen steadily since 2000, closely tracking economic expansion, with summer peak demand particularly acute due to air-conditioning loads, placing sustained pressure on generation capacity and system reliability. Kuwait's Ministry of Electricity and Water (MEW) estimates the country's demand for energy to triple by 2030.[25]

Additionally, electricity, water, and oil products are available at heavily subsidised rates in Kuwait. The government covers around 95 percent of the electricity production cost.[25]

Figure 12.

Evolution of electricity generation sources in Kuwait since 2000



Source: IEA

Renewables currently play a marginal role in Kuwait's power system. In 2022, renewable electricity accounted for roughly 0.2 percent of total generation.[23] Of this limited renewable output, solar thermal technologies dominate, accounting for around two-thirds of renewable generation, with the remainder split between solar PV and small-scale wind installations.

Figure 13.

Renewable electricity generation by source (non-combustible), Kuwait, 2023

Source: IEA

The Shagaya Renewable Energy Park represents Kuwait's flagship clean-energy initiative and its primary vehicle for renewable deployment. Conceived as a multi-technology hub integrating solar PV, concentrated solar power (CSP), and wind, Shagaya has demonstrated technical feasibility but progressed more slowly than initially envisaged. While pilot and Phase 1 components are operational, large-scale capacity additions have faced delays linked to procurement processes, grid integration planning, and institutional coordination.

Looking ahead, most independent assessments suggest a gradual rather than rapid expansion of renewables in Kuwait. Rystad Energy projects total renewable capacity reaching around 3.3 GW by 2030, equivalent to roughly 7 percent of installed power capacity, with renewables supplying a modest share of electricity generation. Under a more extended timeline, renewable capacity could exceed 11 GW by the mid-2030s, supporting a renewables share closer to 15–20 percent of power generation. While broadly aligned with Kuwait's longer-term targets, this trajectory would still lag regional peers in deployment pace.[26]

As a result, fuel substitution from oil to gas, energy-efficiency improvements, and peak-demand management are likely to remain as critical to near-term emissions outcomes as renewable scale-up itself.

Key Developments

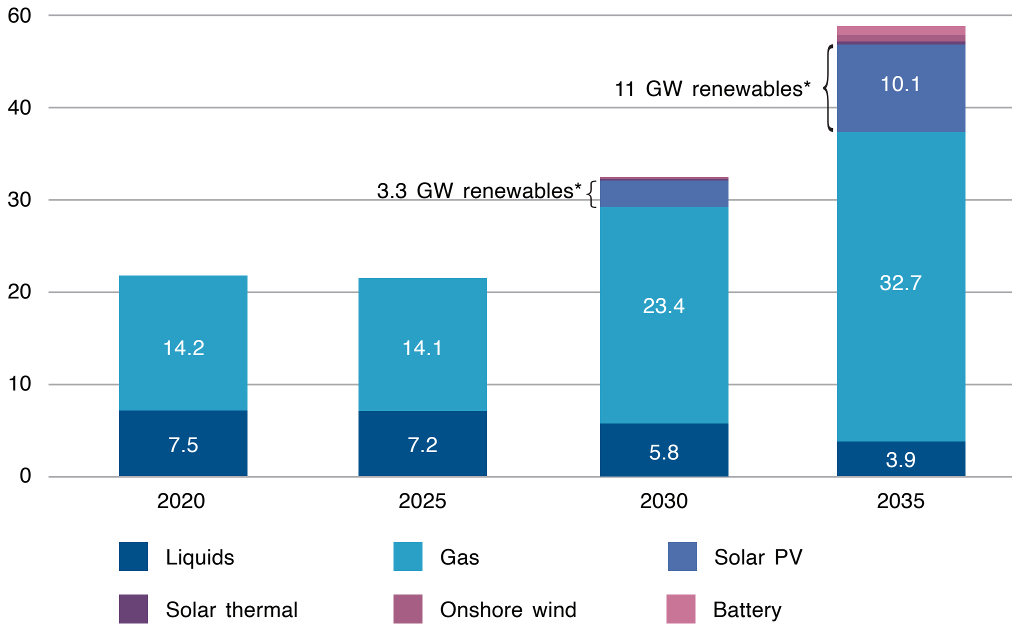
Kuwait's near-term energy transition has focused less on rapid diversification and more on fuel switching, demand management, and safeguarding export revenues. A central priority has been reducing domestic oil burn in the power sector by substituting oil-fired generation with natural gas, freeing additional crude volumes for export. Given the continued importance of oil revenues for fiscal stability, this shift is primarily driven by economic and energy-security considerations rather than emissions reduction alone.

Natural gas is therefore set to play an expanding role in Kuwait's power system. Rystad Energy estimates that gas-fired electricity generation could increase by around 17 percent to approximately 77 TWh by 2030, driven by rising electricity demand and continued substitution of oil-based generation. Over the same period, domestic gas production is projected to rise by nearly 38 percent, while total gas demand could increase by around 30 percent, reflecting the growing role of gas across power generation, industry, and desalination.[26]

To support this transition, Kuwait is planning a significant expansion of gas-fired power capacity. Five large-scale gas power plants are reportedly under planning, which together could add up to 18 GW of capacity, lifting total gas-based generation capacity from roughly 14 GW today to more than 32 GW by 2035.[26]

Figure 14.

Kuwait's installed capacity by energy source
Gigawatts (GW)



**Renewables includes solar PV onshore wind and solar thermal*
Source: Rystad Energy's Renewables & Power Solution, September 2025
A Rystad Energy graphic

Given Kuwait's limited domestic gas resources, supply security remains a constraint. In response, Kuwait Petroleum Corporation (KPC) has signed a 15-year LNG sale and purchase agreement with QatarEnergy, securing up to 3 mtpa of LNG imports to underpin power-sector growth.[26]

At the regional level, Kuwait participates in the GCC Interconnection Authority, providing a platform for cross-border power trade and grid resilience. However, to date, this mechanism has been used primarily for system balancing and emergency support rather than as an active tool for decarbonisation or renewable integration.

Overall, Kuwait's recent energy developments underscore a pragmatic transition pathway, prioritising oil displacement in the domestic power sector, gas infrastructure expansion, and efficiency improvements. Renewable deployment remains secondary, progressing slowly alongside these measures rather than acting as the primary driver of system transformation.

Challenges and Systemic Constraints

- **System reliability and ageing infrastructure:** Kuwait faces acute summer peak-demand stress driven by extreme temperatures, cooling loads, and desalination. Although installed capacity stands at around 21 GW, only about 17 GW is reliably available during peak months due to ageing assets, maintenance schedules, and operational constraints.[26] This persistent capacity gap has resulted in recurring system stress and unplanned outages, reinforcing a policy bias toward short-term capacity additions and grid reinforcement over structural decarbonisation
- **Infrastructure modernisation lag:** A significant share of Kuwait's generation, transmission, and distribution infrastructure dates back several decades, raising maintenance costs and limiting operational efficiency. Large-scale upgrades to substations, transmission networks, and system control architecture are now a prerequisite not only for reliability but also for integrating higher shares of renewables, increasing the fiscal and implementation burden of the transition.
- **Gas dependence as a transitional constraint:** While fuel switching from oil to gas lowers emissions intensity and improves export economics, growing dependence on gas introduces new constraints. Limited domestic gas availability, rising LNG import dependence, and the prioritisation of gas for power generation and desalination reduce system flexibility. As a result, gas increasingly functions less as a transitional bridge and more as a medium-term structural anchor, shaping capacity decisions and slowing diversification of the generation mix.

Outlook

Kuwait's decarbonisation pathway is characterised by an incremental approach, with policy sequencing shaped primarily by energy security, system reliability, and fiscal stability rather than rapid structural transformation. In the near to medium term, the transition is expected to focus on fuel switching within hydrocarbons, demand-side efficiency, and selective renewable additions, rather than a wholesale reconfiguration of the power system. This places natural gas at the centre of Kuwait's transition strategy, both as a replacement for oil in power generation and as a stabilising bridge fuel alongside limited renewable deployment.

Within the GCC, Kuwait's transition trajectory is likely to remain more domestically focused, with regional interconnections serving reliability and security objectives rather than acting as a primary channel for renewable integration or power trade.

MANAMA - BAHRAIN

Bahrain's energy system is among the most gas-dependent in the Gulf, reflecting limited domestic hydrocarbon resources, limited upstream oil and gas scale, and a power sector built almost entirely around natural gas. Electricity generation and desalination dominate domestic energy use, creating a tight coupling between gas availability, power-sector reliability, and emissions outcomes. This structure is clearly reflected in Bahrain's emissions profile: in 2023, natural gas accounted for approximately 87 percent of CO_2 emissions from fuel combustion, while electricity and heat producers contributed around 73 percent of total energy-related CO_2 emissions.27 As a net importer of natural gas, Bahrain's energy transition pathway is shaped not only by decarbonisation objectives but also by supply security considerations, fiscal constraints, and the need to manage power-sector emissions in a system with limited fuel-diversification options.

KEY TAKEAWAYS

1. Bahrain operates one of the most gas-dependent energy systems in the GCC, with natural gas supplying virtually all electricity generation and total energy demand, leaving limited scope for fuel-switching-based decarbonisation.

2. National policy ambition under the NETP targets gradual diversification rather than rapid transformation, with renewable electricity shares rising to 20 percent by 2035 and gas consumption reductions prioritised over large-scale system restructuring.

3. Given land constraints and system scale, Bahrain's transition strategy emphasises incremental deployment, centred on rooftop solar, public-sector leadership, efficiency programmes, and industrial pilots rather than utility-scale renewable expansion or clean-fuel exports.

Energy Policy and Decarbonisation Framework

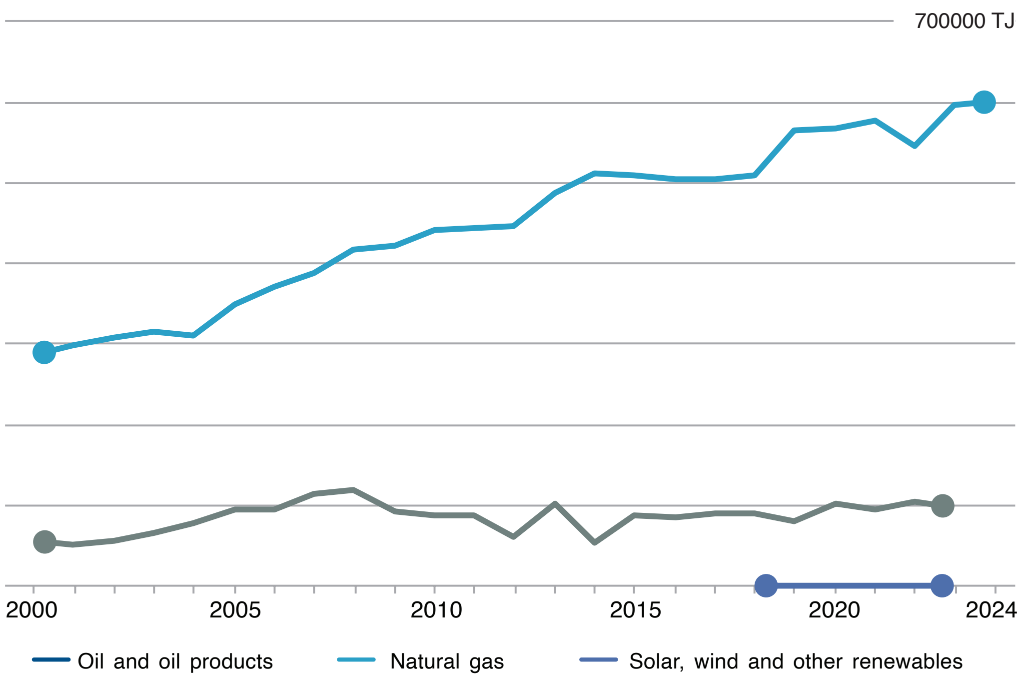
- Bahrain has announced a long-term ambition to achieve net-zero emissions by 2060.
- Under, the National Energy Transition Plan (NETP), Bahrain aims to increase the share of renewables in total electricity generation to 5 percent by 2025 and 20 percent by 2035, primarily through solar deployment. It intends to meet more than 45 percent of energy demand from clean sources.
- The NETP also targets a reduction of natural gas consumption by more than 30 percent by 2040.

Energy Mix

Bahrain's energy system is uniquely concentrated within the GCC, characterised by an almost complete reliance on natural gas. In 2024, natural gas accounted for virtually 100 percent of total energy supply, making Bahrain the most gas-dependent energy system in the Gulf.[27] This reflects limited domestic hydrocarbon diversity and the central role of gas in electricity generation, desalination, and industrial activity.

Figure 15.

Evolution of total energy supply in Bahrain since 2000



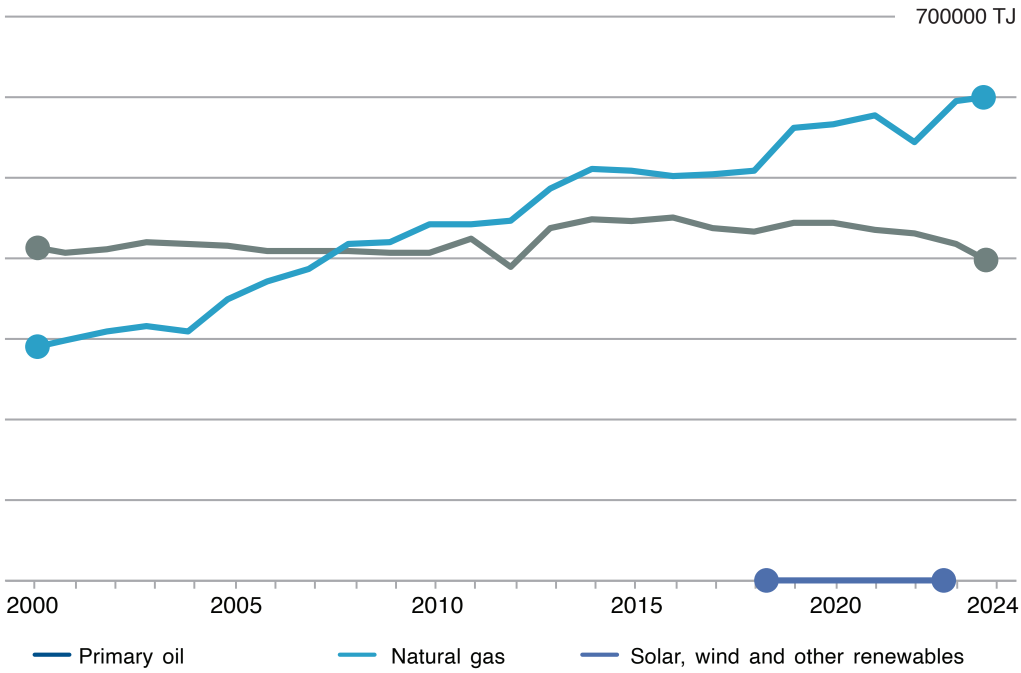
Source: IEA

Domestic energy production presents a slightly more diversified profile but remains gas dominated. In 2024, natural gas represented around 61 percent of domestic energy production, with oil accounting for most of the remainder.[27] As a small, non-OPEC Gulf oil producer, Bahrain's relatively modest hydrocarbon resource base compared to larger GCC producers has resulted in a tight balance between domestic supply and consumption, heightening sensitivity to gas availability, efficiency, and system optimisation.

These structural constraints have increasingly necessitated external supply. The Hidd Floating LNG Terminal entered operation in 2025, enabling Bahrain to import LNG to offset declining domestic gas production and strengthen energy security, with plans for long-term supply agreements and regular usage of its LNG terminal.[28]

Figure 16.

Evolution of domestic energy production in Bahrain since 2000



Source: IEA

Renewable energy plays a negligible role in Bahrain's overall energy mix. Modern renewables accounted for just 0.08 percent of final energy consumption in 2022, underscoring the early stage of renewable deployment and the continued absence of non-fossil alternatives at scale.[27]

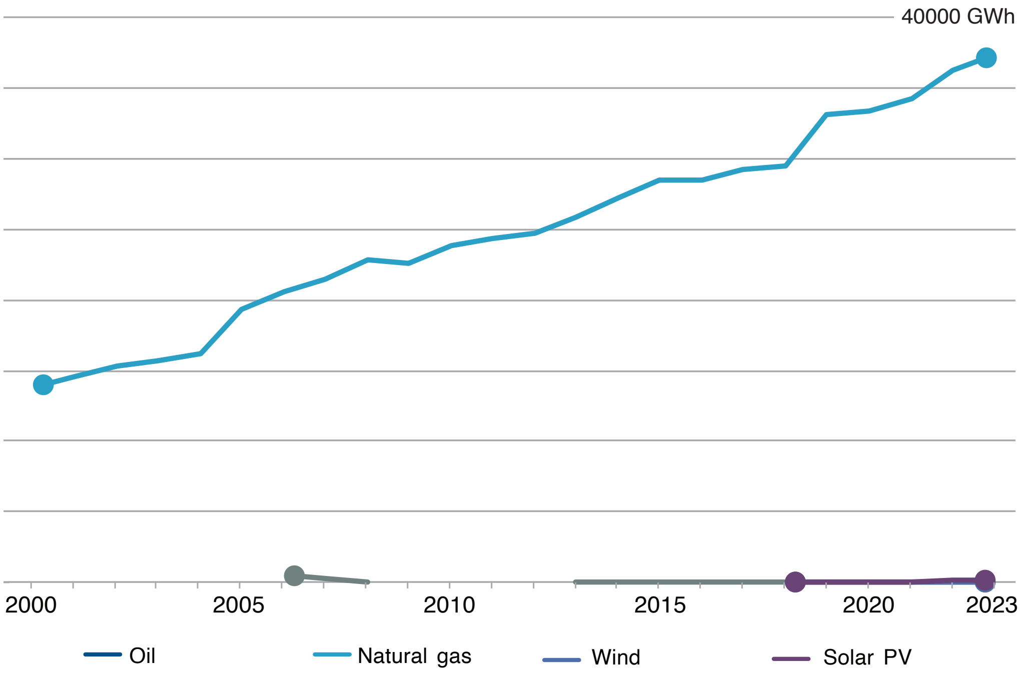
As a result, Bahrain's energy transition challenge is less about fuel switching within the existing mix and more about managing demand growth, improving efficiency, and gradually introducing clean energy into a system that remains structurally gas-dependent.

Electricity Landscape

Bahrain's electricity system is almost entirely dependent on natural gas, reflecting its highly concentrated energy structure and limited domestic fuel diversity. In 2023, natural gas accounted for approximately 99.7 percent of total electricity generation, making Bahrain the most gas-reliant power system in the GCC.[27]

Figure 17.

Evolution of electricity generation sources in Bahrain since 2000



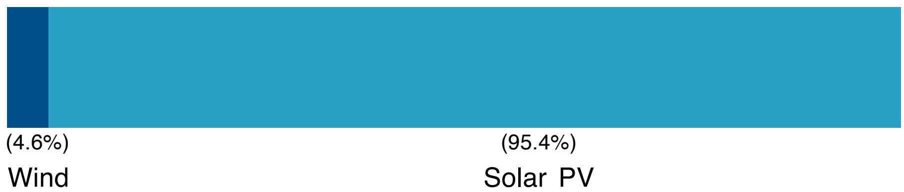
Source: IEA

Renewables play only a marginal role in Bahrain's power mix. In 2022, renewable electricity accounted for around 0.1 percent of total generation, underscoring the early stage of renewable integration.[27]

Within this limited renewable output, solar PV dominates, contributing roughly 95 percent of non-combustible renewable electricity generation in 2023, with small residual contributions from wind.[27] Deployment to date has been largely confined to pilot-scale and distributed installations rather than system-scale capacity additions.

Figure 18.

Renewable electricity generation by source (non-combustible), Bahrain, 2023



Source: IEA

As a result, Bahrain's electricity decarbonisation challenge is less about near-term fuel switching and more about introducing new generation sources into a system structurally optimised around gas. In the absence of diversification, improvements in efficiency, grid management, and demand-side measures remain as critical to emissions outcomes as the gradual scaling of solar capacity.

Key Developments

Bahrain's energy transition has begun to move from planning toward early-stage implementation, centred on flagship renewable projects, public-sector rooftop deployment, and efficiency-focused interventions rather than rapid system-wide transformation.

A key milestone is the Al Dur Solar Power Plant, for which the foundation stone ceremony took place in January 2026. The project is expected to deliver approximately 100 MW of capacity using around 135,000 solar panels and is positioned as a strategic demonstration of utility-scale renewable deployment.[29] The project aligns with the Government Programme 2023–2026, emphasising energy-source diversification, grid resilience, and the delivery of both environmental and economic benefits.

Beyond flagship projects, Bahrain's scheduled renewable pipeline encompasses a mix of solar, wind, waste-to-energy, and enabling energy technologies, with solar expected to account for the majority of near-term capacity additions. As part of this effort, the Sustainable Energy Authority (SEA) has advanced a 50 MW rooftop solar programme targeting government-owned buildings, aimed at accelerating distributed generation, reducing peak demand pressure, and building institutional familiarity with solar deployment.[25] While modest in scale, this initiative reflects Bahrain's preference for incremental, low-risk renewable integration within an otherwise gas-dominated power system.

In parallel, the National Energy Efficiency Action Plan targets economy-wide interventions, with the objective of achieving a 6 percent improvement in energy efficiency by 2025.25 These measures are particularly relevant in a system where electricity demand growth is closely linked to cooling loads and industrial activity.

Bahrain is also exploring industrial decarbonisation and circular-energy opportunities. A notable pilot initiative under consideration involves waste-heat recovery at Aluminium Bahrain (Alba), the world's largest single-site aluminium smelter outside mainland China, where excess heat could be harnessed for electricity generation.[25]

Collectively, these developments indicate a transition pathway focused on sequenced implementation, combining selective renewable projects, public-sector leadership, efficiency improvements, and industrial pilots, rather than rapid restructuring of the power system. Bahrain's approach prioritises system reliability and fiscal prudence while laying the groundwork for gradual decarbonisation within tight structural constraints.

Challenges and Systemic Constraints

- **Near-total reliance on natural gas:** Bahrain's power system is almost entirely gas-fired, leaving limited flexibility for rapid decarbonisation. With no coal, nuclear, or hydropower alternatives and constrained renewable scale, natural gas functions as both a reliability anchor and a medium-term lock-in.
- **Limited land availability and system scale:** Bahrain's small geographic footprint and dense urbanisation restrict utility-scale renewable deployment, shifting emphasis toward rooftop solar and distributed generation. Scaling these options will require grid upgrades, regulatory coordination, and sustained public-sector support.
- **Grid integration and flexibility constraints:** Integrating variable renewables into a compact, gas-dominated grid presents challenges related to system balancing, reserve margins, and operational flexibility, particularly during summer peak demand periods driven by cooling loads.

Outlook

Bahrain's transition pathway is characterised by incremental decarbonisation within a structurally gas-dependent system rather than rapid fuel substitution. In the near to medium term, natural gas is expected to remain the backbone of electricity generation, providing system reliability while selective renewable projects and efficiency measures gradually reduce emissions intensity. Progress toward National Energy Transition Plan targets will hinge on execution rather than scale and integrate renewables without compromising grid stability.

Within the GCC, Bahrain is likely to remain a system optimiser rather than a scale leader, aligning its transition with regional developments through grid interconnections, technology transfer, and shared infrastructure rather than competing in large-scale renewable or clean-fuel exports. Its transition role will therefore be shaped by efficiency gains, resilience-building, and targeted decarbonisation within tight structural constraints.

MUSCAT - OMAN

Oman's energy system is supplied primarily by domestically produced natural gas and oil, reflecting its role as a long-standing hydrocarbon producer and exporter outside OPEC, while remaining aligned with the OPEC+ framework. Natural gas underpins electricity generation, industrial activity, and desalination, and Oman operates a gas-fired power system with no coal or nuclear generation, creating a tight linkage between gas availability, power-sector reliability, and emissions outcomes. This structure is reflected in Oman's emissions profile: in 2023, natural gas accounted for roughly 76 percent of CO_2 emissions from fuel combustion, while electricity generation contributed about 22 percent of total energy-related emissions.30 As a net exporter of both oil and LNG, Oman's transition pathway is shaped by the need to balance export commitments with rising domestic demand and finite gas resources, constraining the pace and sequencing of decarbonisation.

KEY TAKEAWAYS

1. Oman operates a fully gas-fired power system, with no nuclear or coal generation, making gas availability and infrastructure reliability central to both energy security and emissions outcomes.

2. Oman's transition pathway is shaped by finite domestic gas availability and rising internal demand, which increasingly compete with LNG export commitments.

3. Policy to date has prioritised system efficiency, gas optimisation, and selective renewable deployment rather than rapid structural diversification, placing Oman among the more cautious, sequencing-focused transition pathways in the GCC.

Energy Policy and Decarbonisation Framework

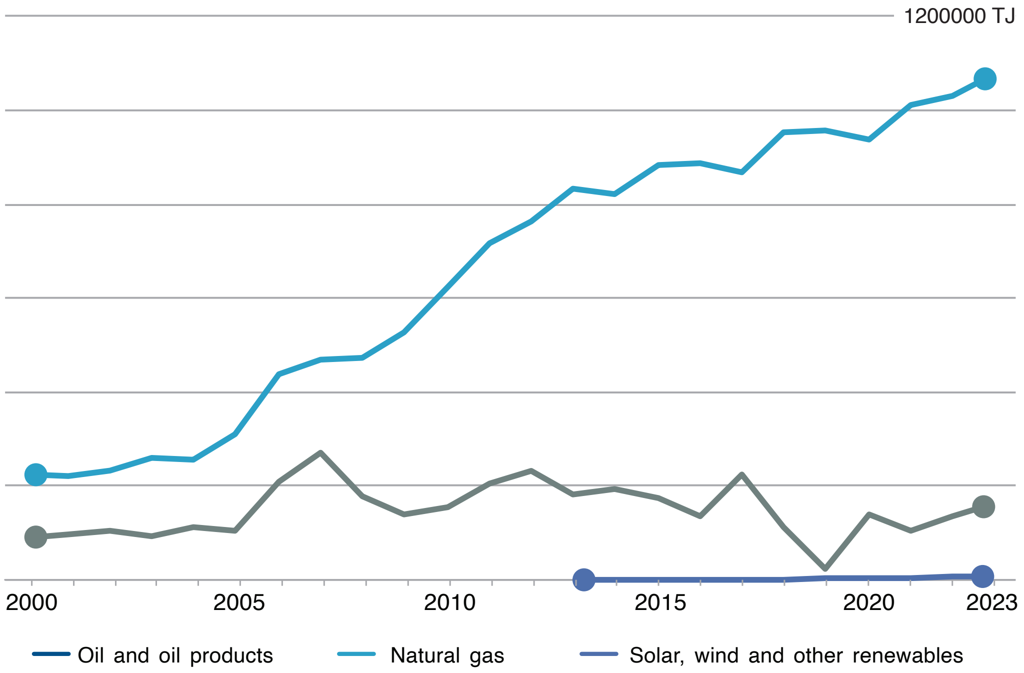
- Oman has declared its commitment to achieve net-zero emissions by 2050.
- Oman's Vision 2040 outlines an ambition to raise the non-oil share of GDP to over 90 percent, signalling the country's ambition to move away from reliance on fossil fuel exports.
- Oman's power-sector transition strategy targets 30–40 percent renewable electricity by 2030, scaling up to 60–70 percent by 2040, with the longer-term objective of moving toward a clean power system by mid-century.
- Oman intends to establish a hydrogen-based economy, targeting ~30 GW of annual green and blue hydrogen production by 2040.

Energy Mix

Oman's energy mix is dominated by natural gas, reflecting its central role in power generation, industry, and desalination. In 2023, natural gas accounted for approximately 86 percent of total energy supply.[30] This high share underscores the tight coupling between gas availability, electricity generation, and system reliability in the absence of coal or nuclear alternatives. The rapid increase in gas consumption over the past two decades mirrors Oman's shift toward gas-fired power generation and gas-based industrial activity, reinforcing it as the backbone of the domestic energy system.

Figure 19.

Evolution of total energy supply in Oman since 2000

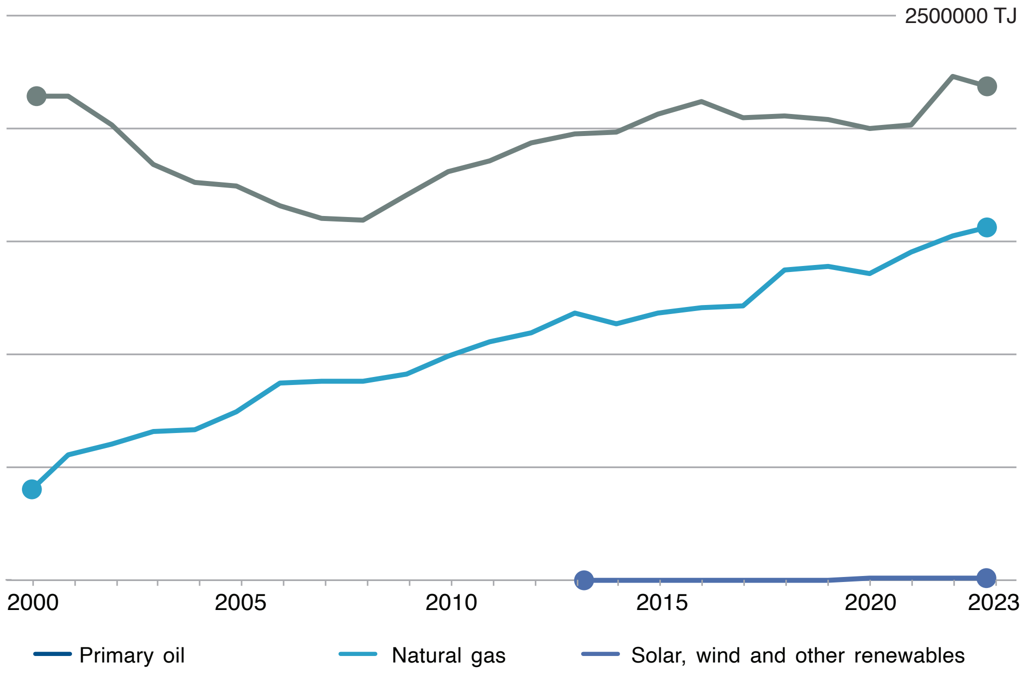


Source: IEA

Domestic energy production, however, presents a more diversified profile. Primary oil accounts for around 58 percent of domestic energy production, with natural gas making up most of the remainder.[30] This divergence between production and consumption highlights Oman's dual role as a hydrocarbon exporter and a gas-dependent domestic consumer. While oil remains central to export revenues and fiscal balances, gas is increasingly prioritised for internal use, particularly in power generation and value-added industrial sectors.

Figure 20.

Evolution of domestic energy production in Oman since 2000



Source: IEA

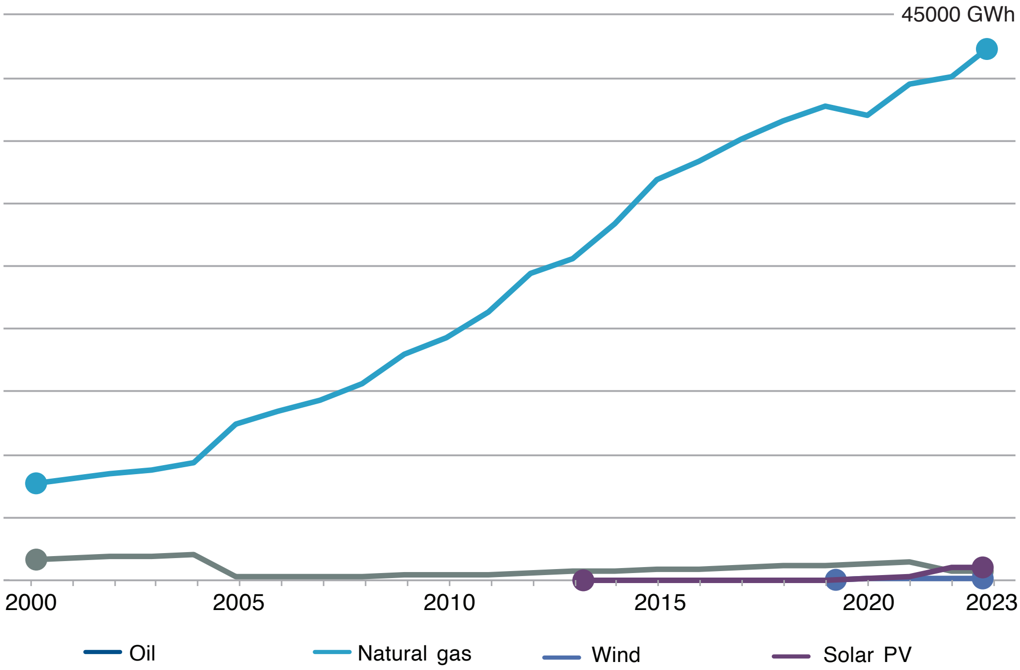
Renewable energy remains negligible in Oman's total energy supply, reflecting the early stage of deployment and the continued availability of domestically produced gas at competitive costs. As a result, Oman's transition challenge is less about immediate fuel substitution in the energy mix and more about managing gas constraints, improving system efficiency, and gradually integrating non-fossil generation into an energy system that remains structurally anchored in hydrocarbons.

Electricity Landscape

Oman's electricity system remains overwhelmingly dependent on natural gas. In 2023, natural gas accounted for approximately 96 percent of total electricity generation, reflecting the fully gas-fired nature of the power system and the absence of coal or nuclear generation. Oil plays only a marginal role, contributing around 1.7 percent of electricity generation, largely as backup or in legacy units.[30]

Figure 21.

Evolution of electricity generation sources in Oman since 2000



Source: IEA

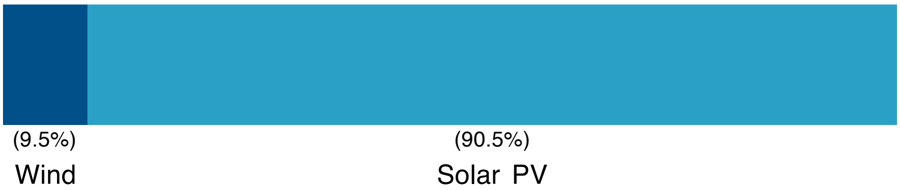
Electricity demand has increased steadily since 2000, with peak pressures particularly acute during summer months. This reinforces the importance of gas availability for system reliability and highlights the structural link between gas supply constraints and power-sector performance.

Despite recent momentum, renewables remain a small component of Oman's electricity mix. In 2022, renewables accounted for approximately 2.5 percent of total electricity generation, while modern renewables represented just 0.36 percent of final energy consumption, underscoring the early stage of system-wide decarbonisation.[30]

Within the renewable segment, solar PV dominates, accounting for around 91 percent of non-combustible renewable electricity generation in 2023, with the remainder supplied by wind.[30]

Figure 22.

Renewable electricity generation by source (non-combustible), Oman, 2023



Source: IEA

Oman's power-sector reform, including the unbundling of generation, transmission, and procurement under Nama Group and OPWP, has enabled relatively transparent renewable tendering compared to several regional peers. According to national reporting, solar and wind generation together accounted for nearly 12 percent of electricity production between January and May 2025, up from around 5 percent at end-2024.31 While this reflects strong short-term growth, it also captures seasonal effects and early commissioning impacts rather than a fully embedded structural shift.

Oman has announced a substantial renewable pipeline. Solar capacity announcements total approximately 13.5 GW, of which around 1.8 GW is operational and 2.1 GW is under construction. For wind power, announced capacity stands at roughly 13.2 GW, though deployment remains limited, with around 50 MW currently operating and 100 MW under construction.32 This gap between announced and operational capacity highlights the execution challenge facing Oman's power-sector transition.

Overall, Oman's electricity landscape reflects a system in transition: natural gas continues to dominate in the near term, while renewable deployment is accelerating from a low base. The pace at which announced solar and wind projects translate into grid-connected capacity will be critical in determining whether renewables meaningfully reduce gas dependence or remain supplementary to a gas-centred power system through the 2030s.

Key Developments

Oman's recent transition activity has shifted from pilot-scale deployment toward pipeline building, tendering, and institutional mobilisation, with a strong emphasis on solar, wind, and clean fuels rather than immediate system-wide transformation.

Wind development has gained momentum with tenders launched for five utility-scale projects exceeding 1 GW in total capacity, representing an estimated US$1.2 billion in investment.31 These projects mark Oman's first serious attempt to scale wind beyond early demonstration plants and reflect growing confidence in the country's wind resource.

On the solar side, the government has outlined the "Solar PV IPPs 2030" programme, under which around 3 GW of utility-scale solar capacity is expected to be tendered, with an estimated investment of up to US$1.5 billion. In parallel, four additional large-scale solar plants are planned over the next six years, contributing to a total solar project pipeline of approximately 4.5 GW, at a projected cost of US$2.8 billion.31

An Ember study finds that Oman's solar resource could enable delivery of near-baseload clean power, with modelling suggesting up to 99 percent availability for a 1 GW constant power profile at competitive cost levels.32 While this does not imply full baseload substitution without storage or grid support, it reinforces Oman's comparative advantage in solar-led decarbonisation pathways.

Institutional support mechanisms are also expanding. The Oman Investment Authority (OIA), in partnership with China's Templewater, has launched a US$200 million clean energy transition fund targeting renewables, energy storage, clean molecules, and smart mobility.31 This marks an effort to mobilise blended capital and accelerate private-sector participation in the transition ecosystem.

Beyond power generation, Oman continues to position itself in future clean-fuel markets. Hydrom, the national hydrogen orchestrator, has been established to coordinate land allocation, tendering, and infrastructure planning for large-scale green hydrogen projects, providing a central governance framework for clean-molecule development. Progress has been made on the Sur Hydrogen Cluster feasibility study, which aims to integrate large-scale solar and wind capacity with green hydrogen production and downstream export infrastructure. Oman has also signed an MoU with Belgium to build a green hydrogen project providing 250– 500 MW of capacity in Oman, with operations targeted from 2026.25

Taken together, these developments point to a transition strategy centred on pipeline creation, institutional readiness, and export optionality rather than immediate system reconfiguration. The emphasis on tendering, clean-fuel governance, and capital mobilisation reflects a sequencing-first approach, with execution over the next decade determining whether announced capacity translates into durable reductions in gas dependence.

Challenges and Systemic Constraints

- **Financing depth and public–private balance:** Scaling Oman's renewable and clean-energy ambitions will require sustained capital mobilisation and risk-sharing between the state and private investors. While public entities have played a catalytic role to date, the transition cannot be financed through public balance sheets alone.33 Oman's fiscal position has improved following the post-COVID recovery and higher hydrocarbon revenues, but medium-term uncertainty over oil and gas prices raises questions about the durability of state-led financial support. Ensuring bankable project structures, stable offtake frameworks, and investor confidence will be critical to sustaining momentum.
- **Localisation of technology and industrial capacity:** Oman remains largely dependent on imported clean-energy technologies, equipment, and specialised services. Building domestic capabilities across project development, grid integration, operations, and maintenance is essential to reduce costs, shorten deployment timelines, and maximise local economic value. Without stronger localisation strategies and skills development, the energy transition risks remaining capital-intensive and externally driven, limiting its contribution to long-term diversification and employment goals.

Outlook

Oman's energy transition pathway is defined by its ambition to reposition the power sector as a platform for broader economic diversification while preserving its role as a reliable hydrocarbon exporter during the transition. The pace of renewable integration over the next decade will be shaped by the successful execution of utility-scale solar and wind projects already in the pipeline, alongside complementary initiatives such as residential PV and grid upgrades. As renewables scale, natural gas is expected to continue playing a balancing role, enabling Oman to manage variability while gradually lowering the carbon intensity of electricity generation.

Beyond domestic decarbonisation, Oman's transition strategy increasingly intersects with its external positioning. Green hydrogen and clean fuels, anchored in projects such as the Sur Hydrogen Cluster, are central to Oman's ambition to link renewable deployment with export-oriented growth, connecting domestic energy transformation to global clean-energy value chains. As Gulf energy systems evolve, Oman's ability to align renewable scale-up, clean-molecule exports, and industrial diversification will shape its role as both a regional clean-energy supplier and a bridge between hydrocarbon and post-hydrocarbon energy markets.

RIYADH - SAUDI ARABIA

Saudi Arabia is the world's largest crude oil exporter, a central actor in OPEC+, and an emerging player in clean-energy investment. As the Kingdom undergoes its economic transformation under Vision 2030, it aims to reduce dependence on oil revenues, diversify its energy base, and establish itself as a global leader in new energy technologies. Electricity and heat production accounted for roughly 49 percent of Saudi Arabia's total energy-related CO_2 emissions in 2022, underscoring the central role of the power sector in decarbonisation.34 With electricity demand projected to grow by nearly 4 percent annually through 2027, pressure to expand generation capacity while reducing carbon intensity will continue to increase.[35]

KEY TAKEAWAYS

1. Saudi Arabia's energy transition is anchored in Vision 2030, which seeks to balance diversification, energy security, and climate commitments.

2. The Kingdom targets 50 percent of power generation from renewables by 2030, requiring more than 130 GW of new capacity—one of the most ambitious targets in the GCC.

3. Despite rapid project announcements, renewables still account for around 1 percent of total electricity generation, highlighting a wide gap between ambition and on-the-ground deployment.

4. The pace of grid integration, storage deployment, and localisation of clean-energy technologies will determine whether Saudi Arabia can sustain and reinforce its leadership position within the Gulf's transition narrative.

Energy Policy and Decarbonisation Framework

Launched in 2016, Vision 2030 underpins Saudi Arabia's diversification strategy, emphasising fiscal reform, industrial development, and clean-energy investment. Within this framework:

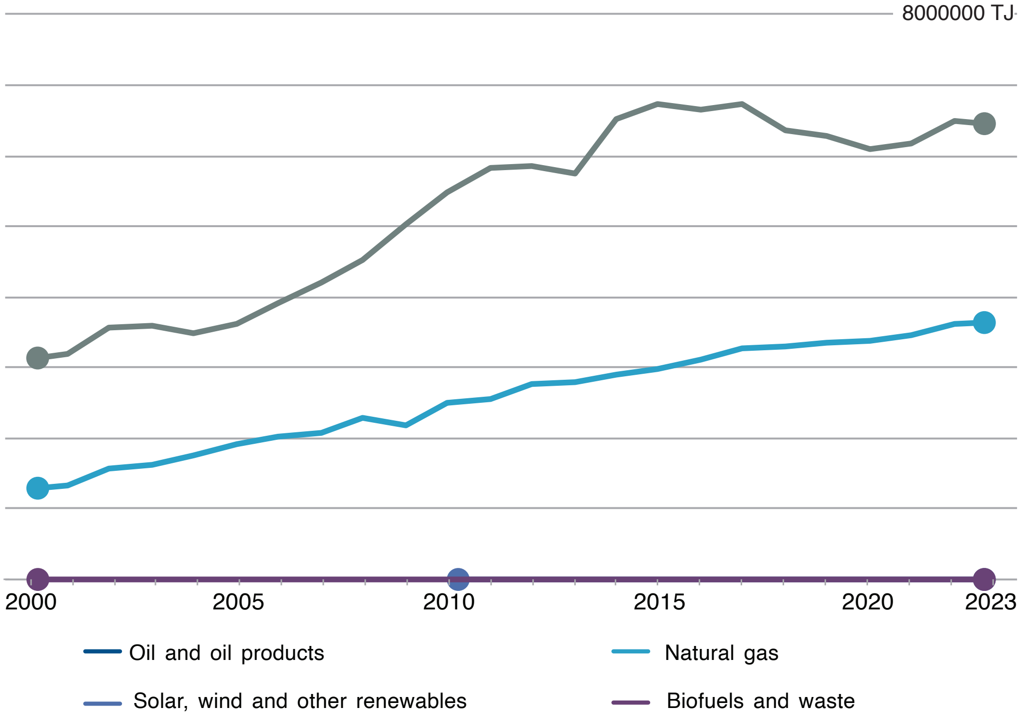
- The Kingdom aims for net-zero emissions by 2060, aligning with its updated Nationally Determined Contributions (NDCs) under the Paris Agreement.
- It targets 50 percent of electricity generation from renewables by 2030, equal to 130 GW of capacity (58.7 GW solar, 40 GW wind, remainder from other renewables).
- Near-term targets include adding 15 GW of renewables by 2028 (12 GW solar PV and 3 GW wind).
- Ministry of Energy is slated to increase its spending on power and renewable energy projects to US$293 billion by 2030.[25]

Energy Mix

Saudi Arabia's total energy supply remains dominated by oil and natural gas, which together account for over 99 percent of the Kingdom's total energy supply. Since the early 2000s, natural gas consumption has steadily increased, reflecting policy efforts to displace oil in power generation and industry.

Figure 23.

Evolution of total energy supply in Saudi Arabia since 2000

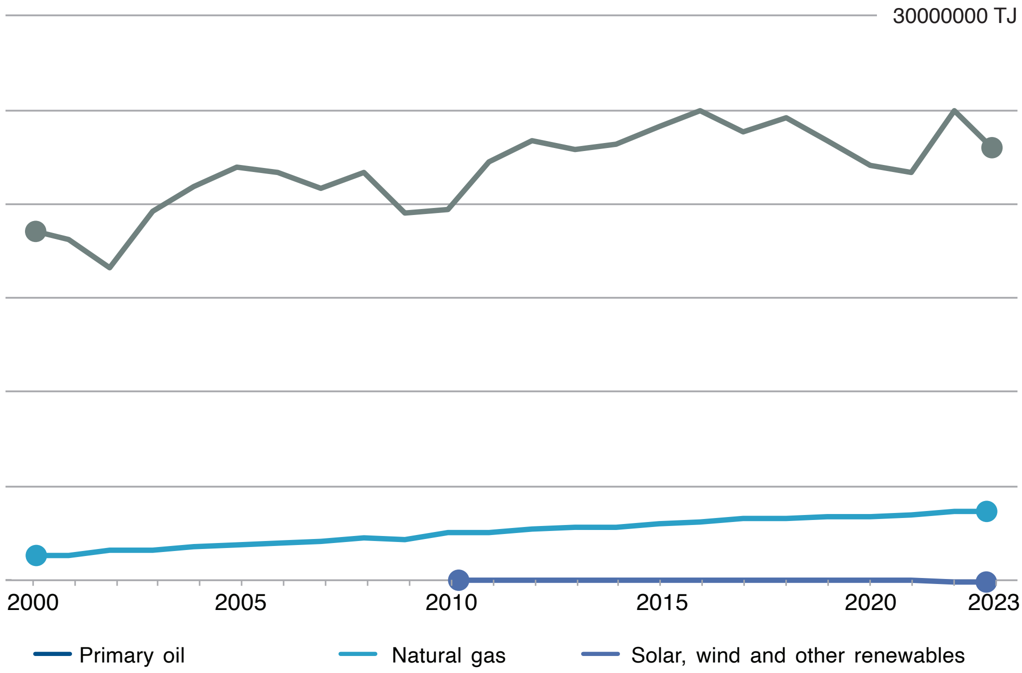


Source: IEA

Domestic energy production mirrors this pattern. Oil remains the core export commodity, while gas supports growing domestic demand for electricity, desalination, and petrochemicals. As the world's largest crude oil exporter and a central actor in OPEC+, Saudi Arabia plays a pivotal role in global oil markets, often acting as the de facto swing producer and price stabiliser.

Figure 24.

Evolution of domestic energy production in Saudi Arabia since 2000



Source: IEA

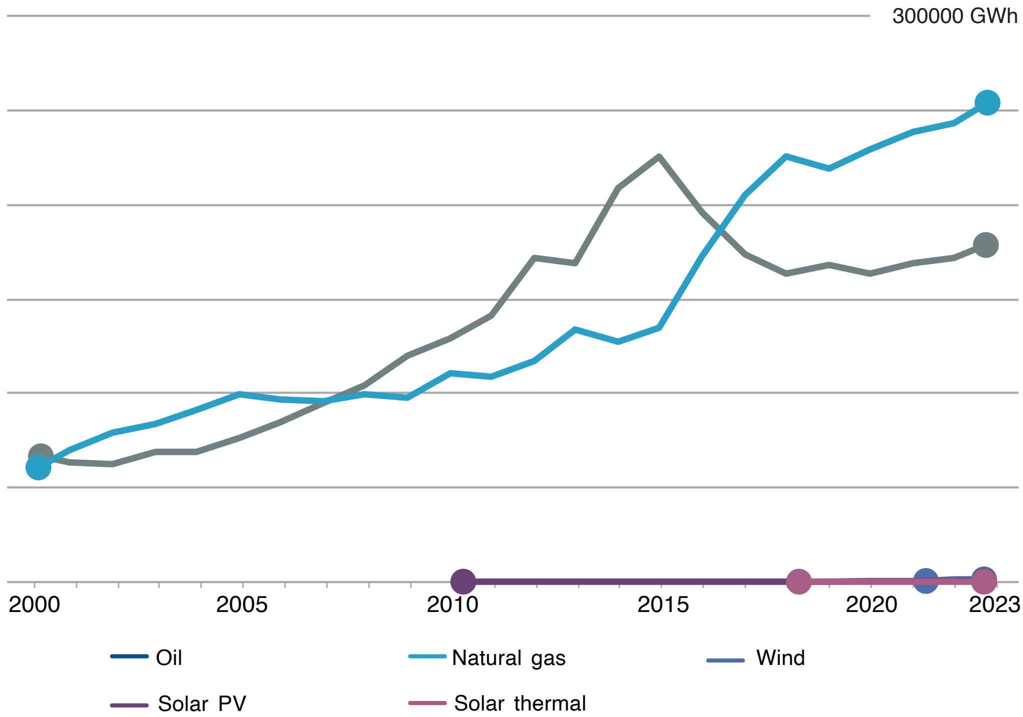
Electricity Landscape

Saudi Arabia's electricity system is the largest in the Middle East and continues to expand. Installed capacity stood at around 90 GW in 2020, with continued additions since then. The power sector is central to decarbonisation, targeting a 55 percent by 2030.36 Electricity demand growth is driven by population increases, industrial expansion, desalination loads, and rising cooling needs, intensifying the challenge of decarbonising supply.

As of 2023, natural gas accounted for 58.2 percent of total electricity generation, with oil contributing the remainder. Renewables, though expanding quickly, still make up less than 1 percent of total generation, highlighting the steep challenge of transitioning away from hydrocarbons.

Figure 25.

Evolution of electricity generation sources in Saudi Arabia since 2000



Source: IEA

Figure 26.

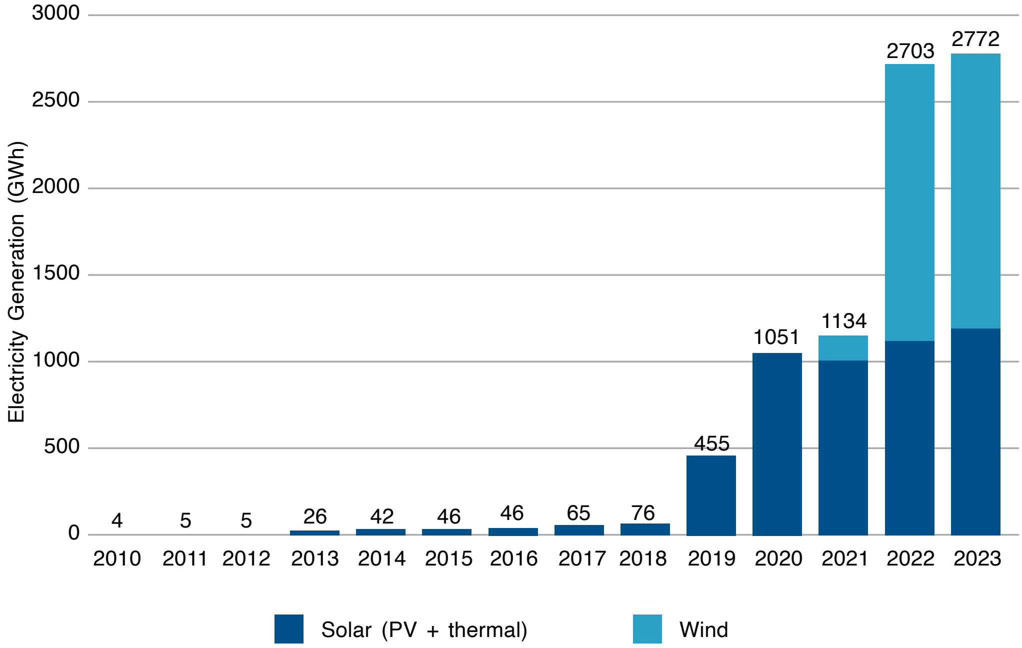
Renewable electricity generation by source (non-combustible), Saudi Arabia, 2023

Source: IEA

Between 2019 and 2022, renewable electricity generation increased by almost 500 percent, reaching 0.6 percent of the total mix (IEA). Since 2022, connected renewable capacity has grown by over 300 percent, reaching 2.7 GW37, and is projected to nearly double to 12.7 GW by the end of 2025.35 As of 2024, the Kingdom had an estimated 4.34 GW of installed solar capacity, signalling early momentum in diversifying the supply base.[38]

Figure 27.

Renewable Electricity Generation in Saudi Arabia (2010-2023)



Source: Author using IEA Data

Dumat Al Jandal, which entered commercial operation in 2021, is considered Saudi Arabia's first utility-scale wind project. Given that the country had virtually no wind generation beforehand, commissioning a project of this scale produced a pronounced statistical increase in wind output, largely explaining the surge recorded between 2021 and 2022.

Key Developments

The National Renewable Energy Programme (NREP), launched in 2017, has tendered 64 renewable energy projects totalling 57.5 GW, marking a major leap in clean energy ambition.[39]

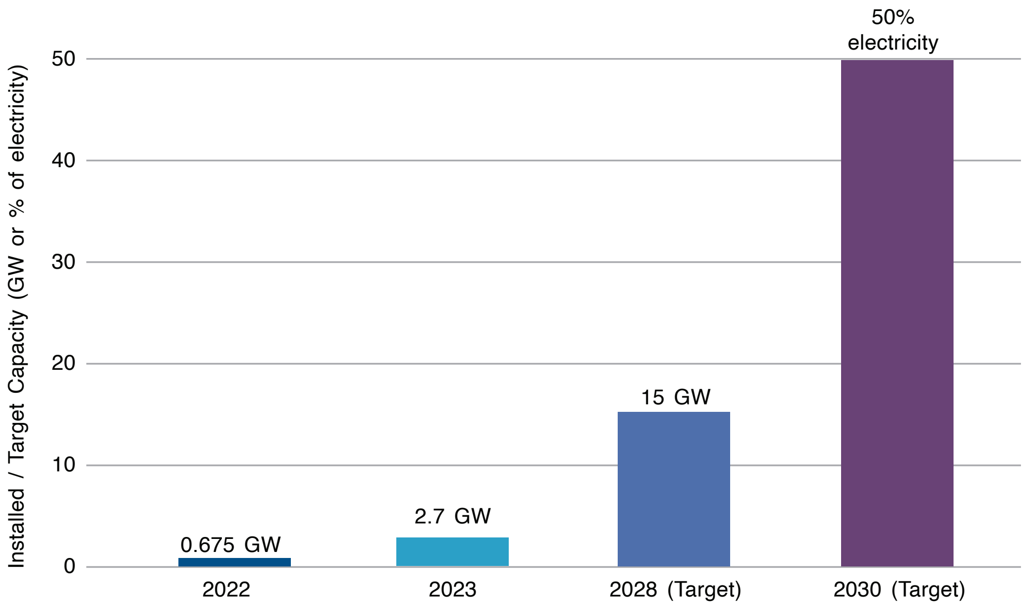
The first large-scale project under NREP, Sakaka PV IPP (300 MW), began operations in 2019 under ACWA Power, inaugurating Saudi Arabia's entry into grid-connected solar. Since then, it has connected over 10.2 GW of renewable capacity and has over 33 GW in different stages of the development pipeline.[40]

The renewable energy sector is estimated to generate US$40–60 billion in export revenues from products and services, create 137,000 new jobs, and add US451 billion to Saudi GDP.[36] Power Purchase Agreements (PPAs) signed to date represent approximately SAR 93 billion (US$24.8 billion) in investment, forming long-term partnerships that anchor the Kingdom's renewable future.[39]

IRENA scenarios indicate that Saudi Arabia could emerge as a major market for Concentrated Solar Power (CSP) and wind by 2030, with potential installed capacities reaching of up to 9.5 GW for CSP and around 3.5 GW for wind under high-renewables pathways.[36]

Figure 28.

Saudi Renewable Energy Transition (Capacity Growth)



Source: Saudi Energy Consulting

Hydrogen development is also a central pillar of the transition. The Saudi Green Hydrogen Strategy envisions producing 4 million tons of green hydrogen annually by 2035, requiring more than 50 GW of renewable capacity. The flagship NEOM Green Hydrogen Project, valued at US$8.4 billion, will produce 650 tons per day by 2026, this facility alone would have to be powered by over 4 GW of solar and wind generation.[41]

Saudi Arabia is also pursuing localisation across the renewable energy value chain, supported by partnerships with international manufacturers, including Chinese firms. These collaborations are aimed at developing domestic manufacturing capacity for solar modules, wind components, and related technologies, supporting Vision 2030 objectives around industrial diversification, job creation, and supply-chain resilience.

Challenges and Systemic Constraints

- **Infrastructure readiness:** Grid expansion and storage deployment continue to lag behind project announcements. Saudi Arabia targets 48 GWh of battery energy storage (BESS) by 2030, with around 8 GWh operational and over 30 GWh tendered to date.[39]
- **High power demand growth:** Rapid electrification and population growth add pressure to decarbonise without compromising reliability.
- **Policy execution:** Despite strong vision documents, project implementation often faces bureaucratic and coordination delays.
- **Water-energy nexus:** Large-scale solar and hydrogen projects face water-resource constraints, necessitating integrated planning.

Outlook

Energy Minister Prince Abdulaziz bin Salman has framed the Kingdom's transition around three pillars: energy efficiency enhancement, energy mix transformation, and emissions management.[35] The guiding vision is to export "all forms of energy," not just oil, this encapsulates Saudi Arabia's shift from an oil exporter to a diversified energy supplier.

As it invests in low-carbon technologies and international partnerships, the Kingdom is positioning itself not only as a regional leader but as a geopolitical energy pivot between East and West. Its success in balancing economic diversification, climate goals, and energy security will shape the broader trajectory of the Middle East's transition in the coming decade. Whether Saudi Arabia can translate scale and ambition into sustained delivery will depend on execution discipline, grid readiness, and the ability to synchronise renewable deployment with rapidly rising electricity demand.

SYSTEM-LEVEL TRANSITION PATHWAYS ACROSS THE GCC

Energy systems across the GCC remain central to regional economic performance and global energy markets. As Abu Dhabi, Doha, Kuwait City, Manama, Muscat, and Riyadh chart their respective transition pathways, the region's energy landscape continues to be shaped by a shared reliance on hydrocarbons, alongside increasingly differentiated national strategies for diversification and decarbonisation.

Power systems remain overwhelmingly fossil-fuel based, with natural gas serving as the primary fuel in most countries. Bahrain, Kuwait, Oman, and Qatar generate nearly all electricity from fossil fuels, while Saudi Arabia continues to rely heavily on oil alongside gas. The United Arab Emirates stands apart with a more diversified power mix, supported by large-scale nuclear deployment and rapidly expanding solar capacity.

Natural gas is expected to retain a central role across GCC power systems in the medium term, even as renewables scale. In several countries, gas increasingly functions as a balancing fuel alongside solar and wind, rather than as the sole backbone of electricity supply. These dynamics point to transition pathways characterised by sequencing and optimisation, rather than abrupt fuel substitution.

Despite these common structural features, the pace and form of transition vary markedly. Some capitals have prioritised large-scale clean-energy deployment and diversification of the power mix, while others have focused on system efficiency, fuel switching within hydrocarbons, and demand management. The share of low-emissions electricity remains negligible in Bahrain and Kuwait, modest in Oman and Qatar, and substantially higher in the UAE, underscoring the uneven starting points across the region.

The Gulf's long-term transition potential is nonetheless significant. Solar and wind resources across the region are increasingly becoming more competitive, with technical potential exceeding projected domestic electricity demand. Saudi Arabia's vast solar and onshore wind resources, alongside offshore wind potential in Qatar and the UAE, position the region to scale renewables rapidly should policy execution, grid integration, and investment frameworks align.2 At the same time, several GCC countries are incorporating carbon capture, utilisation, and storage (CCUS) into national strategies, particularly to address emissions from gas processing, industry, and other hard-to-abate sectors. While deployment remains limited, announced projects signal growing momentum.

Regional coordination is emerging as an important enabling factor. The GCC Interconnection Grid provides a foundation for enhanced system resilience and future power trade, even if its use to date has focused primarily on emergency support rather than large-scale renewable integration. As energy transitions advance, deeper coordination across grids, clean-fuel supply chains, and technology standards may shape how individual national strategies interact.

Taken together, the energy transitions unfolding across the Gulf are neither uniform nor linear. They reflect the priorities, constraints, and strategic choices articulated at the level of national capitals, within systems still anchored in hydrocarbons. By mapping current energy structures, policies, and trajectories, this report establishes a baseline for understanding how GCC energy systems are evolving, and how their pathways may converge, diverge, or intersect as the region moves from ambition to execution.

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