STATE OF ENERGY TRANSITION IN SOUTH ASIA 2025

Energy Transition Platform South Asia

ENERGY TRANSITION PLATFORM
SOUTH ASIA

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About

The Energy Transition Platform (ETP) is a multi-country platform that brings together energy practitioners and select Civil Society Organisations working on energy for the countries of South Asia – Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka. The ETP Secretariat is housed in Vasudha Foundation and is supported by the Heinrich Boll Stiftung, India. The objective of this project is to scale up the pace of energy transition across all countries of South Asia through a data driven approach and analysis. ETP aims at bringing together data, information, policies and trends of key indicators of energy transition across South Asia for informed discussions with policy makers. Since its inception in 2018, ETP has been tracking energy transition through a comprehensive repository of information on energy scenarios across these countries. In 2025, ETP strives to enhance engagement with the policymakers and private sector to further the agenda on energy transition in the South Asian region.

Vision & Mission

- Tracking country progress for a fossil fuel free South Asia
    - Creating a data repository on energy in member countries.
    - Identifying gaps and barriers for scaling up energy transition
- Build a constituency of stakeholders across the region for a fossil free vision through policy advocacy and dialogue
- Enhance knowledge sharing amongst member countries to enable a faster energy transition
- Facilitate regional cooperation for energy transition

Introduction and Regional Overview

According to the World Population Review, South Asia's population is ~2.08 billion[1] (as of 2022), almost 25.34% of the global population. The Asian Development Bank's (ADB) Asian Development Outlook December 2025 states that growth in South Asia is expected to remain robust, with the 2025 forecast revised upward to 6.5%, from 5.9% in 2024, and the 2026 forecast maintained at 6.0%[2]. With this economic growth trajectory, there is bound to be an increase in energy demand to fuel development, industries, transport and cooling/heating appliances across industrial sectors. Alongside rising energy demand, there has been an overall increase in the installation of renewable technologies and improvements in energy efficiency, which points to an energy transition that is already underway. For instance, India's energy intensity declined from 0.2703 megajoules (MJ) per rupee in 2014–15 to 0.218 MJ per rupee in 2023–24, indicating improved efficiency in energy use relative to economic output[3].

This report, the 'State of Energy Transition in South Asia', provides an overview of the progress of energy transition in the region along with country-specific energy scenarios and comparative insights.

Energy Overview: Dependence on fossil fuels vs non-fossil energy

Fossil fuels account for around 69.99%[4] of South Asia's primary energy mix. At the same time, there has been a gradual increase in installed capacity of non-fossil energy sources across the region. The region's most reliable non-fossil energy source continues to be large hydropower, while other renewable energy (RE) sources such as solar, wind, and hybrid systems have also seen a steady growth.

However, given the intermittency of solar and wind power, and the fact that battery storage remains at a nascent stage, fossil fuels continue to account for a larger share in energy generation. Sri Lanka offers an interesting case: it has historically relied on hydropower; however, growing electricity demand has outpaced the expansion of RE capacity. Recent developments in the country show increased penetration of Distributed Renewable Energy (DRE) systems and private sector led RE integration. Bhutan is also an important case study, where except for the transport sector, which requires fossil fuel imports, the Himalayan kingdom is powered by hydro and is gradually diversifying to other sources. Maldives is currently fossil fuel powered, but due to its geographical uniqueness - powering more than 1,000 islands – the archipelago needs to find a more feasible option, such as a "One island - One grid" infrastructure. India, for the first time in July 2025, reached its highest-ever RE generation on a single day — 51.5% of the country's total electricity demand[5]. From 2016 to 2025, the country's combined share of coal and gas declined from 69% to 48%, while renewables rose from 29% to 50%, enabling India to achieve its 50% non-fossil fuel capacity target under its NDCs five years ahead of the 2030 goal[6]. Nepal and Pakistan, too, continue to rely on high fossil fuel imports to fuel their economies but are increasingly exploring pathways to transition towards cleaner energy sources.

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[1] *Southern Asia population 2025*. World Population Review. https://worldpopulationreview.com/continents/southern-asia

[2] Bank, A. D. (2025, December 9). *Economic Forecasts: Asian Development Outlook December 2025*. Asian Development Bank. https://www.adb.org/outlook/editions/december-2025#:~:text=Growth%20in%20South%20Asia%20is,robust%20growth%20in%20domestic%20consumption

[3] *Energy Statistics India 2025*. (n.d.). https://mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2025/Energy%20Statistics%20India%202025_27032025.pdf

[4] Energy Transition Platform. (2026, January 28). *Energy Transition Platform | South Asia*. https://energytransitionplatform.org/

[5] *India achieved Historic milestone in power sector: Surpasses 500 GW and Renewable Generation Exceeds 50% of demand*. (n.d.). https://www.pib.gov.in/PressReleasePage.aspx?PRID=2183866&reg=3&lang=2#:~:text=On%2029%20July%202025%2C%20India,a%20remarkable%20sign%20of%20change

[6] *India Climate & Energy Dashboard*. (n.d.). https://iced.niti.gov.in/energy/electricity/generation/capacity

Key regional initiatives and cooperation

The South Asian Association for Regional Cooperation (SAARC) was founded in 1985. It made early progress with agreements on electricity trade, but implementation has been uneven due to political sensitivities and limited institutional follow-through. The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) - established in 1997 - presents an additional avenue for engagement, with a focus on connectivity and economic cooperation, though its energy initiatives are still in early stages.

There is a steady growth in cross-border RE trade, primarily centered around India. Countries such as Nepal, Bhutan, and Bangladesh are actively engaged in renewable power trade with India, forming the core of sub-regional electricity cooperation. Bhutan and Nepal export hydropower to India under established bilateral agreements. India and Bangladesh are advancing transmission interconnections to facilitate renewable power sharing and balance seasonal demand. Recently, Nepal has begun exporting electricity to Bangladesh via India as per a tripartite agreement thereby opening avenues for multi/cross-country engagement and regional cooperation.

Advancing energy transition in the South Asian region can be potentially carried through strengthened collaboration by leveraging the already existing SAARC or BIMSTEC frameworks or even established international initiatives like the International Solar Alliance (ISA), particularly for RE projects, which may help in cross border energy projects.

Shared challenges

South Asia is among regions most vulnerable to increasing intensity and frequency of climate-induced disasters. Being one of the most populous regions, with ~25% of global population and still pursuing development objectives, the region faces challenges in achieving socio-economic development while balancing climate goals.

Bhutan, already a carbon-negative country, aims to diversify its RE sources; Afghanistan, which meets nearly 80% of its electricity needs through imports from neighboring countries, including Uzbekistan[7], has seen growing interest in hybrid RE projects from international developers, including a $10 billion Memorandum of Understanding (MoU) with Azizi Energy[8], leveraging its vast RE potential estimated at around 300 GW[9]. Pakistan and Bangladesh are increasingly engaging with multilateral initiatives to support their transition towards RE. Nepal and Bhutan, having high dependence on large hydro thereby exporting surplus energy to India, have been aiming to diversify their RE portfolios by investing in solar and wind, supported by policy and financing frameworks. India has been a flag bearer – having achieved its NDC target of sourcing 50% of its cumulative electric power installed capacity from non-fossil fuel-based energy resources, five years ahead of the 2030 deadline.

While private-sector investment has seen an increase in certain regions, gaps remain in access to technology transfer and appropriate financing particularly in the form of concessional finance and grants

[7] Traugott, D., & Traugott, D. (2025, November 3). *Uzbekistan strengthens energy partnership with Afghanistan*. Jamestown. https://jamestown.org/uzbekistan-strengthens-energy-partnership-with-afghanistan/

[8] Bifolchi, G. (2025, August 7). Afghanistan's $10 billion energy initiative and the Taliban. *SpecialEurasia*. https://www.specialeurasia.com/2025/08/07/afghanistan-energy-taliban/

[9] IT Power Consulting Private Limited, & Osmani, A. A. (2017). RENEWABLE ENERGY ROADMAP FOR AFGHANISTAN. In *IT Power Consulting Private Limited*. https://policy.asiapacificenergy.org/sites/default/files/Renewable%20Energy%20Roadmap%20for%20Afghanistan%20RER2032.pdf

rather than loans so as to avoid additional economic burdens and enable a balanced clean energy transition with development.

The existence of regional initiatives like BIMSTEC and SAARC, yet their status being stalled due to geopolitical friction is another challenge. Leveraging these existing frameworks, as well as ISA, can help in strengthening collaboration towards advancing energy transition.

Comparative Snapshot of South Asia

The energy transition scenario in South Asia is characterised by a gradual but uneven shift from fossil fuels toward clean and affordable energy, with an emphasis on expanding RE, improving energy access across the region. Despite persistent climate risks, low per-capita electricity consumption and the imperative to meet developmental needs, efforts are underway to increase the share of renewables including solar, wind and small hydro.

The non-fossil energy landscape in South Asia is highly uneven across countries, reflecting differences in resource availability, policy pathways, geopolitical situations and developmental needs. India accounts for the largest share of regional non-fossil capacity across all sources, with large-scale RE deployment complemented by nuclear power, making India the primary driver of the region's clean energy transition. Hydropower remains the backbone of non-fossil capacity in Bhutan, Nepal and Afghanistan, where energy transition is shaped by a mountainous geography, seasonal and climate-related risks. Bangladesh's non-fossil portfolio is primarily driven by RE additions, while Pakistan exhibits a more diversified mix combining renewables with limited hydropower and nuclear capacity. Sri Lanka's non-fossil mix is anchored in hydro with growing renewable additions.

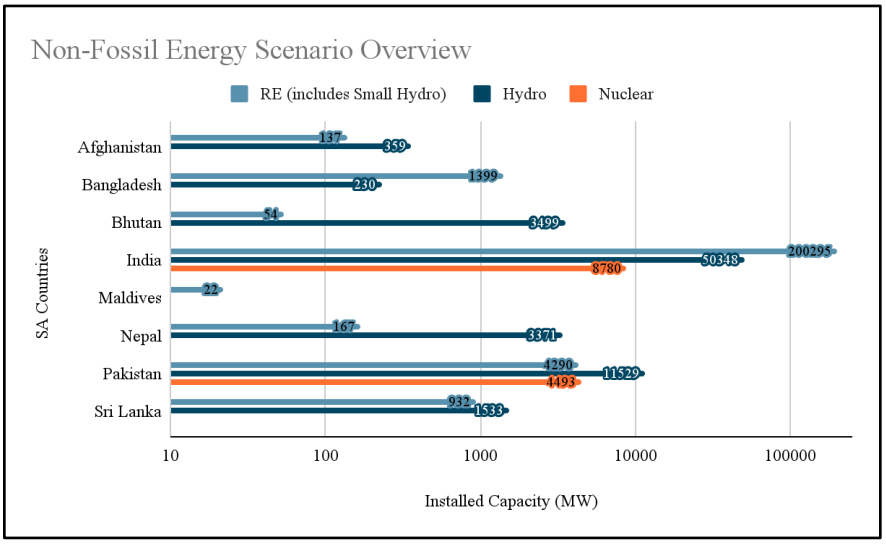


Figure 1: Non-fossil fuel energy scenario in South Asia

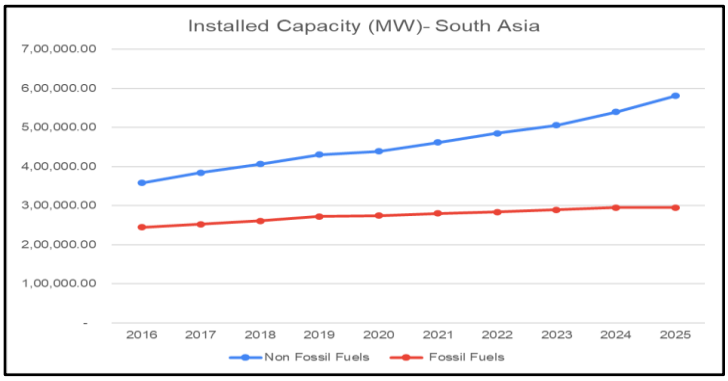


Figure 2: Year-on-year installed capacities in South Asia

Between 2016 and 2025, non-fossil capacity shows a steep increase, outpacing the growth of fossil-fuel-based capacity. While fossil fuels continue to rise in absolute terms that is driven by

the need to meet rising energy demand, the gap between non-fossil and fossil capacity widens steadily over this period. This divergence suggests that recent capacity additions are increasingly driven by renewables such as solar, wind and hydro, indicating that an energy transition is actively underway.

The source-wise breakdown of installed capacity in South Asia highlights a progressive diversification of the power mix, with RE emerging as the fastest-growing component over the period shown. While coal continues to constitute the single largest share of installed capacity, its growth is relatively moderate compared to the sharp rise in renewables, which has expanded steadily year on year. Oil and gas capacity remains broadly stable with marginal growth, indicating a gradual move away from new investments in liquid and gas-based power. Hydropower shows incremental expansion, while nuclear capacity remains limited and largely stagnant.

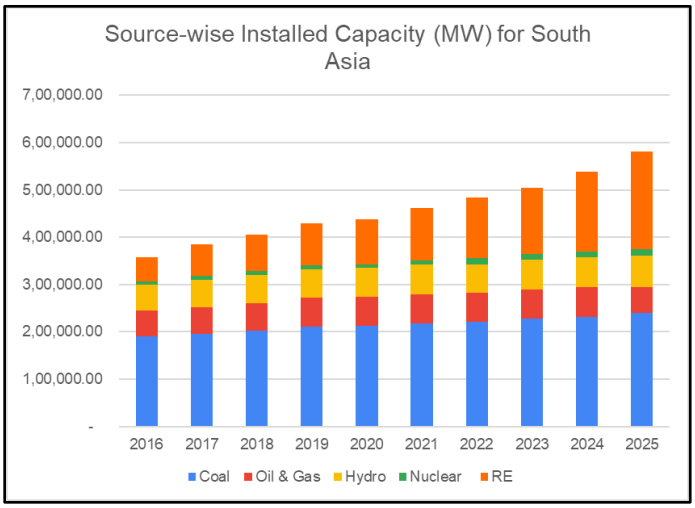


Figure 3: Source-wise installed capacity in South Asia

Overall, these trends highlight that South Asia's transition is not a single trajectory, but a mosaic of country-specific pathways where renewables are expanding rapidly.

Bangladesh: Energy Transition Scenario

Overview

Energy transition this year has been profoundly shaped by external shocks. Volatile international fuel prices, disruptions to global shipping routes, and the lingering economic impacts of El Niño-related weather patterns have forced governments in the region to re-evaluate reliance on imported fossil fuels. Bangladesh, highly exposed to LNG price swings, has responded with renewed urgency to diversify its energy mix, accelerate renewables deployment, and strengthen grid resilience.

Climate events such as prolonged heatwaves, erratic monsoon patterns, and intensified cyclones have heightened demand for cooling, strained transmission networks, and pushed policymakers toward adaptation-linked energy planning. Regionally, these climate pressures are reinforcing the shift toward decentralised renewables and demand-side efficiency, trends which Bangladesh is also beginning to prioritise. The country recognises the need for a strong policy ambition (new renewable targets) plus managing urgent short-term reliability pressures (more power imports, fuel-oil use) which means balancing scaling up of clean energy capacity fast while managing immediate security and cost risks.

Energy Transition Context

Bangladesh, signaling a clearer policy pivot to accelerate clean capacity, has approved a new Renewable Energy Policy with higher renewables targets (20% by 2030, 30% by 2040). Further, large utility solar parks and Independent Power Producer (IPP) activities (e.g., multi-tens of MW solar parks) are increasing generation options and attracting foreign builders and financiers, creating opportunities for scale and local supply chains (e.g., new Pabna solar park developments project pipeline).

Given recent energy supply fluctuations, shortfalls from gas and some coal plant outages, Bangladesh was pushed to import more electricity from India and, for some months, raised fuel-oil generation, a short-term shift having cost and emissions implications. India is consolidating a central role as an electricity hub (transit and trade), which reshapes Bangladesh's options: access to cheaper seasonal hydropower imports, but also greater exposure to geostrategic dependencies and negotiable leverage for grid projects. China's regional investment footprint continues to matter for large plant financing and grid build-out (implications for procurement choices, financing terms).

However, Nepal's first regular exports to Bangladesh routed via India show the region's shift toward operational cross-border electricity commerce beyond bilateral deals and represents a tangible step forward that can benefit Bangladesh seasonally. This trilateral framework, alongside continued agreements on transmission connectivity also prove the institutional and technical feasibility of regional exchange via operational trade.

Energy Access and Demand Dynamics

Utility solar parks and rooftop programs are prioritised; several countries are pushing large MW targets and utility tenders. Bangladesh has an explicit rooftop/solar push (e.g., renewed rooftop target and net metering policies), though implementation continues to lags. At the same time, there is growing attention to flexible resources and grid modernisation. Bangladesh is seeing an increase in multilateral development bank financing for grid upgradation. While bilateral and trilateral energy exchange is underway, private sector participation remains gradual, and additional private investment is needed to scale these efforts.

Investment, Technology, and Policy Trends Shaping the Transition

Investment flows in the region have increasingly favored RE, grid modernisation, and storage technologies. Solar manufacturing capacity has expanded in India, with spillover benefits for procurement in Bangladesh. Hydropower investments in Nepal have intensified, creating new potential for regional trade corridors. Bangladesh is benefiting from these regional shifts: falling solar module prices, wider availability of utility-scale storage options, and international financing streams are aligning to support its revised renewable targets. At the same time, increased digitalisation of smart meters, automated substations, forecasting technologies is becoming central to power-sector reforms across South Asia, a trend Bangladesh is steadily adopting.

Key Challenges and Barriers

As mentioned above, volatility in global fuel markets and limited domestic gas production make Bangladesh vulnerable; when imported fuel or international coal prices rise, short-term recourse to expensive fuel-oil generation or spot imports increases fiscal and tariff pressures.

Rising temperatures and more frequent heatwave years raise peak electricity demand (cooling loads) and can disrupt hydro/water resources in neighboring supplier countries. These dynamics accelerate demand growth and increase the premium on flexible, dispatchable low-carbon resources and storage.

Grid interconnection and power trading are making progress where commercial and political interests align yet comprehensive regional market integration remains limited by transit governance, transmission bottlenecks, and divergent policy/regulatory regimes. Financing platforms for regional projects are improving but are not yet fully scaled.

Bangladesh is in the “ambitious target but implementation catch-up” cluster. Ambitious targets are often questioned by independent analysts because of existing infrastructure, financing, and supply-chain constraints. Bangladesh’s 3,000 MW rooftop target illustrates this tension between ambition and current deployment rates.

As a fuel strategy, some neighbours lean heavily on large hydro or regional hydropower exports (Nepal), while others pursue a thermal-renewables mix (India, Pakistan). Bangladesh is trying to balance reliance on domestic gas, imported LNG/coal, and a push into solar in its fuel strategy. These diverging strategies create different near-term emissions and price trajectories across the region.

Cooperation within the region is evolving more through bilateral and trilateral arrangements enabling Bangladesh’s access to hydropower from Nepal and Bhutan, routed through India. Yet, this opportunity can be constrained by infrastructure bottlenecks and policy uncertainties, underscoring the need for institutional reforms and long-term contracts to stabilize supply.

Potential Areas for Regional Collaboration, Regional Secretariat and Implications on Bangladesh

A review of regional developments reveals four major collaboration pathways capable of delivering systemic benefits.

1. **Cross-Border Power Trade and Grid Interconnection:** The highest-impact near-term opportunity lies in expanding the physical and contractual infrastructure for electricity trade. Long-term firm PPAs between hydro exporters (Nepal, Bhutan) and energy-importing or balancing countries

(Bangladesh, India) can stabilise regional systems and reduce reliance on expensive fossil imports. Building high voltage direct current (HVDC) corridors and harmonising grid codes will be essential.

2. **Regional Renewable Manufacturing and Supply Chains:** India's rapidly scaling solar manufacturing ecosystem presents an opportunity for neighboring countries to develop assembly, component manufacturing, and O&M industries. Joint ventures, technology partnerships, and preferential trade arrangements could help Bangladesh, Sri Lanka, and Nepal capture supply-chain value while reducing dependence on external suppliers.

3. **Regional Financing and De-risking Platforms:** South Asian markets share similar barriers-currency risk, inconsistent tariffs, small domestic markets, and high perceived political risk. A pooled regional de-risking facility anchored by MDB concessional finance and partial risk guarantees could unlock investment in transmission, storage, and utility-scale renewables.

4. **Technology Partnerships: Storage, Green Hydrogen, EVs:** Shared R&D hubs or pilot clusters can reduce costs and improve standardisation. For example, regional collaboration on battery testing, recycling protocols, and electrolyser standards would lower barriers to adoption and align countries with global supply chains.

To support mutually reinforcing national transitions, the regional secretariat can pursue four high-impact interventions:

1. Develop **standardised model documents** including PPAs, wheeling agreements, and grid codes to facilitate predictable, transparent, cross-border power trade.

2. Coordinate a **regional transmission masterplan** that identifies priority corridors, investment needs, and cost-sharing arrangements, ensuring interoperability and consistent operational standards.

3. Establish a **regional blended finance and guarantee platform** to reduce project risk and mobilise private investment for cross-border projects and large-scale renewables.

4. Design a **regional manufacturing and skills roadmap** linking India's manufacturing capability with neighboring countries' workforce, assembly potential, and service markets.

Bangladesh is positioned to benefit significantly from emerging regional patterns, but only with timely institutional and financial preparation.

1. Bangladesh's **geographic position allows it to import clean, seasonal hydropower** from Nepal and Bhutan, a critical source of low-carbon, dispatchable energy that can help stabilise a gas- and LNG-heavy system. The success of Nepal's initial exports via India demonstrates the viability of this model. To scale this, Bangladesh must secure long-term PPAs and invest in both domestic and cross-border transmission upgrades.

2. Bangladesh can **leverage India's manufacturing surge to reduce solar deployment costs**. Joint ventures and local assembly of PV modules and components would lower capex while building domestic technical capacity and supporting job creation. Given India's expanding supply chain, Bangladesh's incentives and industrial zones could become attractive sites for regional assembly.

3. Bangladesh alongside Sri Lanka and Nepal would benefit from advocating for a **regional de-risking platform** to address high financing costs, currency depreciation risk, and limited availability of long-term project finance for grid and utility-scale renewables.

4. Bangladesh must **proactively mitigate emerging risks** by locking in multi-year imported power contracts, securing concessional financing for grid modernization, and avoiding exposure to volatile global LNG and coal prices.

Priorities

1. **Treat the next 2–5 years as a dual challenge - accelerating clean capacity while securing short-term supply:** Utility solar and rooftop solar must scale faster, while contingency arrangements in place (imports, flexible fuel plants) to avoid outages and price shocks.

2. **Push for deeper, rules-based regional trade:** Operational imports (e.g., from Nepal via India) show the value of trilateral mechanisms. Bangladesh should negotiate predictable, long-term offtake and transit terms (firm seasonal contracts) to lower spot exposure and ensure complementary clean imports (seasonal hydro).

3. **Be realistic about rooftop targets focus on near-term deliverables:** Credible rooftop targets must be backed with deployment plans - financing windows, bankable model contracts, standards for installers, and accelerated customs/supply chain facilitation. Independent analysis suggests very fast jumps may be unrealistic without these enablers.

4. **Invest in system flexibility (storage, demand response, peaking capacity):** Heatwave years and growing cooling demand stresses the need for storage, faster-ramping of hydrogen/blending pilots, and demand-side management eventually reducing costly fuel-oil runs.

5. **Use policy clarity to crowd in private finance and local manufacturing:** A stable, predictable renewable policy (procurement rules, PPA clarity, incentives for local assembly) will reduce financing costs and encourage domestic supply chains. The Renewable Energy Policy 2025 is a step forward and must follow it with implementation roadmaps and predictable tenders.

Outlook

For Bangladesh, the next phase of the energy transition will be shaped not only by domestic policy, but by regional energy flows, costs, and infrastructure. Expanding cross-border electricity trade and declining RE costs create opportunities to access cleaner power, while also increasing pressure to modernise the power system without compromising reliability. The immediate task is to scale clean capacity while managing near-term energy security risks.

The next five years offer a unique window to secure clean regional power imports, reduce RE costs, and strengthen the grid while managing national energy security risks. With coordinated regional action and targeted domestic reforms, Bangladesh can position itself to benefit from, and contribute to, a more interconnected, affordable, and resilient South Asian energy system.

Bhutan: Energy Transition Scenario

Outline

Bhutan's energy transition is entering a pivotal phase marked by renewed policy direction, diversification of its energy mix, and stronger alignment with national priorities for energy security and sustainability. Building on its long-standing hydropower foundation, the country is now advancing a more balanced and resilient energy pathway that integrates solar, biomass, and other emerging renewable sources. The adoption of the National Energy Policy 2025, National Solar Energy roadmap (2025-2040) marks a significant shift, transitioning Bhutan's energy vision from hydro-export dependence to a domestically secure, diversified, climate-resilient system, while also supporting the energy needs of the Gelephu Mindfulness City (GMC), a flagship development vision aimed at positioning Bhutan as an economic hub while preserving its core national values.

The energy transition landscape in Bhutan is witnessing several defining trends. A notable positive development is the country's deliberate shift from a predominant dependence on hydropower toward a diversified RE portfolio, with solar energy emerging as a strategic pillar. The commissioning of the 1,020 MW Punatsangchhu hydroelectric project and 22.38 MW Sephu solar plant in 2025 underscores Bhutan's commitment to expanding clean energy access, reduce seasonal import dependency, and promote green economic growth, and large-scale solar integration into the national grid.

However, some challenges persist. Bhutan's heavy reliance on hydropower continues to expose the energy sector to seasonal and climate-related vulnerabilities, particularly during the lean winter months when river flows decline and electricity imports increase. Till 2022, the surplus energy sold would balance the electricity import in the winter. However, from 2023 onwards, the import has surpassed the quantity of the surplus sold with the domestic demand reaching 1,000 MW (Power System Information Report, MoENR, 2024). While policy ambitions are strong, the pace of diversification and implementation remains modest compared to targets, and financing for large-scale non-hydro renewables and storage systems is still limited.

Nevertheless, the adoption of the National Energy Policy 2025 signifies a clear inflection point, reframing Bhutan's energy vision from hydro-export dependence to a domestically secure, diversified, and climate-resilient energy system. The energy mix trend is envisaged to grow with Bhutan's Renewable Energy Development Roadmap 2024 that sets forth ambitious strategies to fast-track the expansion of hydropower and solar energy projects. By 2040, the energy mix will be enhanced with additional 15,000 MW hydro and 5,000 MW solar energy.

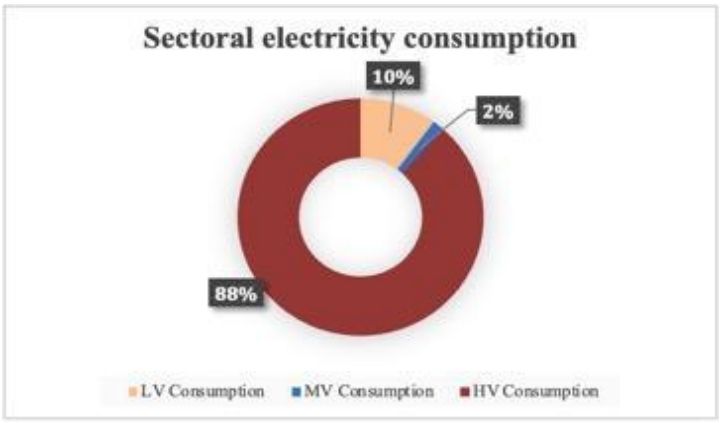
Energy Transition Context

Bhutan's energy mix continues to be dominated by hydropower, which remains the country's primary source of electricity generation and export revenue. With the commissioning of 1,020 MW Punatsangchhu-II hydropower plant and the 22.38 MW Sephu solar plant, diversification of the energy has increased which is shown in the table:

Source	Installed Capacity (MW)	Percentage Share
Hydro	3,499	98.34
Solar	28.11	0.79
Wind	0.6	0.02
Embedded Generation	7.26	0.20
Diesel Generation	22.94	0.64

The commissioning of the 22.38 MW Sephu Solar Plant in 2024 marked the country's first major step toward large-scale solar integration, with additional projects planned under the Renewable Energy Roadmap 2040, which envisions scaling solar capacity up to 25,000 MW by 2040. In addition to renewables, Bhutan is exploring green hydrogen production, distributed generation, and energy storage technologies to complement hydropower and ensure year-round energy security. Parallel efforts to promote energy efficiency and demand-side management across industries and households further support the optimisation of existing resources.

The industry sector (high-voltage consumers) dominates the electricity consumption in the country, accounting for 88% of total demand, followed by the building sector.



Recent changes in Bhutan's energy profile have largely been driven by a combination of policy, economic, and technological factors.

The Renewable Energy Development Roadmap 2040 and the National Green Hydrogen Roadmap have provided strategic direction for accelerating RE deployment and exploring emerging technologies.

Economically, rising electricity imports during lean seasons have underscored the need to strengthen energy security through diversification. On the technological front, advancements in solar PV efficiency, declining installation costs, and regional cooperation in clean energy development have created favourable conditions for scaling up solar generation.

In terms of climate commitments, Bhutan continues to reaffirm its carbon-neutral pledge with the launch of the third Nationally Determined Contribution (NDC) in October, 2025. In its NDC 3.0 (2021–2035), Bhutan reaffirms its 2009 pledge to keep national GHG emissions below the carbon absorption capacity of its forests. Bhutan's NDC 3.0 adopts an economy-wide approach, driven by RE expansion, electric mobility, energy efficiency, and circular economy initiatives, while integrating short-lived climate pollutant (SLCP) reduction and robust adaptation priorities across key sectors such as water, agriculture, health, and biodiversity. It also emphasises inclusive, gender-responsive, and socially integrated climate

actions, introduces dedicated measures for loss and damage, and outlines clear implementation mechanisms through green finance, carbon markets, and international cooperation to sustain its commitments and build long-term resilience

While Bhutan remains free from domestic fossil fuel-based power generation, the import dependency on fossil fuel still persists. Bhutan imported 8,386.66 Metric Tonnes (MT) of LPG, 264,140 Kilolitre (KL) of diesel and petrol, 3,368.95 KL of fuel oil and 113950.48 tonnes of coal to meet the thermal energy demand in the sectors[10]. Efforts to reduce this thermal energy dependency are being undertaken like the promotion of electric mobility, planning of green hydrogen piloting, and greening of industrial processes[11] represent steps toward decarbonising sectors dependent on imported petroleum products.

The latest emission of Bhutan was reported in the first Biennial Transparency Report (BTR) submitted to UNFCCC in December, 2024. As per the BTR, the total emission in 2022 was estimated to be 1,742.51 Gigagrams (Gg) CO_2e, comprising 559.38 Gg from the energy sector, 673.93 Gg from IPPU, 410.18 Gg from agriculture, and 99.01 Gg from waste. In the same year, the total sequestration was estimated at 11,450.45 Gg CO_2e. With this emission and sequestration, Bhutan continues to be carbon negative, with net emission of –9,707.94 Gg CO_2e. With the past emission and the BTR emission trends, the projections of emission shows that Bhutan will continue to be carbon negative even by 2030 with net emission of –6477.71 Gg CO_2e[12]. Maintaining this status, however, remains contingent on continued mitigation efforts across sectors and access to adequate financial and technical support.

Policy and Institutional Landscape

In 2025, Bhutan made notable policy and institutional advancements to reinforce its transition toward a low-emission and climate-resilient future. The National Energy Policy 2025 provides an overarching framework for ensuring energy security, sustainability, and affordability, while guiding the integration of renewables and efficiency measures into all sectors. Complementing it, the Renewable Energy Development Roadmap 2040 sets clear generation targets up to 25,000 MW from hydropower, solar, wind, and green hydrogen underscoring diversification beyond hydropower dominance. The Climate Change Policy continues to steer cross-sectoral mitigation and adaptation efforts, anchoring Bhutan's carbon-neutral vision within broader socio-economic development plans. Together, these frameworks establish a coherent and forward-looking policy foundation for the country's clean energy and climate agenda.

The Green Tax Rules and Regulations of Bhutan 2024 establish clear procedures for the assessment, collection, exemption, and refund of green taxes on environmentally impactful goods such as vehicles, fuels, and heavy machinery. Bhutan is developing a Green Taxonomy classification framework aimed at directing investments toward sustainable, climate-resilient, and environmentally responsible projects. The initiative will be implemented in close partnership with national financial and technical institutions to ensure effective adoption and alignment with green finance goals.

[10] *Bhutan Trade Statistics – Ministry of Finance*. (n.d.). https://mof.gov.bt/pages/bhutan-trade-statistics/

[11] Ministry of Industry, Commerce and Employment. (2025). *Industrial Development Roadmap (IDR) of Bhutan 2025* [PDF]. Royal Government of Bhutan. https://www.moice.gov.bt/wp-content/uploads/2025/08/Industrial-Development-Roadmap-2025_Compressed-Ver-1.pdf

[12] Bhutan. (2024). Bhutan. 2024 Biennial Transparency Report (BTR). BTR1. UNFCCC. https://unfccc.int/documents/645293

Energy Access and Demand Dynamics

Bhutan continues to maintain near-universal access to electricity, with over 99% of households connected to the national grid. Energy remains relatively affordable due to subsidised domestic tariffs supported by hydropower revenues. However, seasonal imports during lean hydropower months pose challenges to cost stability and reliability.

To address these seasonal deficits and enhance energy security, Bhutan is diversifying its power mix by adding solar and other distributed renewable systems to complement hydropower, especially during winter months. The commissioning of the mini-grids at 33kW Solar PV at Shangsa village, Lunana Gewog under Gasa Dzongkhag and 80 kW at Aja Ney, Mongar Dzongkhag ensures reliable electricity in the highlands and community around the reserved parks.

The government is also promoting the creation of 'prosumers' in remote region. A prosumer is a consumer who also produces electricity, typically through rooftop solar, and supplies surplus power back to the grid. The Department of Energy under the Ministry of Energy and Natural Resources (MoENR) is implementing 3kW grid-connected rooftop solar systems to generate electricity and earn income by supplying surplus power to the grid. The Distributed Energy Resources (DER) guidelines allow prosumers to generate electricity for self-consumption and feed excess into the grid via a distribution license. It also lays out roles and responsibilities of prosumers, distribution utilities and other stakeholders. These guidelines set the methodology for determining the buy-out tariff for injected electricity, establishes technical and financial principles for installation of DERs[13].

On the demand side, the industrial and transport sectors are playing a growing role in Bhutan's energy transition. The government is promoting electric mobility through fiscal incentives, expansion of charging infrastructure, and the deployment of electric buses and taxis in urban centers. The number of electric vehicles (EVs) rose by 264% to 558 in 2024 from 156 in 2022[14].

Despite this growth, petrol imports increased by 95% in 2024 compared to 2022, while diesel imports declined by 13% over the same period. The surge in petrol imports can be attributed to the lifting of the vehicle import moratorium imposed in August 2022, as well as the rebound in economic activity following the COVID-19 pandemic. Despite ongoing efforts to promote electric mobility, the uptake of EVs remains limited. This is influenced by several factors, including high upfront costs, limited loan financing options, and insufficient EV-charging infrastructure.

In 2024, the High Voltage (HV) consumer category, comprising energy-intensive industries, remained the largest electricity user, accounting for 88.3% of total consumption, followed by Low Voltage (LV) consumers at 11.91% and Medium Voltage (MV) consumers at 3.43% (DoE, MoENR, 2024).

In the industrial sector, there is a gradual shift towards cleaner production and improved energy efficiency, building on previous energy audits carried out to implement the energy efficiency measures. The Energy Auditing and Reporting Guideline developed in 2019 can be instrumental once energy auditing mechanism is in place. The Industrial Development Roadmap of Bhutan 2025 envisages increasing the sector's contribution to GDP to 60% from 53% (2023), through diversified, value-added and resilient

[13] Royal Government of Bhutan, Ministry of Energy and Natural Resources, & Department of Energy. (2023). *Guideline for Development of Distributed Energy Resources Systems*. https://www.moenr.gov.bt/wp-content/uploads/2017/07/AREPP-DER-guideline-27-12-23.pdf

[14] *BCTA*. (n.d.). https://bcta.gov.bt/bctaweb/redirect.html?q=index

industrial economy, while also incorporating green industrial standards. These initiatives aim to reduce dependence on imported fossil fuels, while supporting Bhutan's broader goal of maintaining carbon neutrality and achieving long-term energy sustainability.

Key Challenges and Barriers

Despite progress in renewable energy, Bhutan continues to rely on fossil fuels such as diesel, petrol, LPG, and coal for transport, industry, and seasonal power generation, making it vulnerable to global price fluctuations and supply disruptions. According to Bhutan Trade Statistics, the country imported around Nu. 11 billion worth of diesel and Nu. 3 billion of petrol in 2024[15]. At the same time, achieving grid parity for solar energy with dominant hydropower remains a challenge, limiting the pace of solar adoption despite declining technology costs.

The rapid pace of infrastructure and industrial development have also increased stress on the national grid, highlighting the need for grid modernisation and demand-side management. Furthermore, the uptake of new technologies such as EVs, DERs, and energy-efficient industrial processes remains relatively low, constraining the potential for rapid decarbonisation. Bhutan's recent graduation from Least Developed Country (LDC) status has further reduced access to concessional grants and finance, narrowing the fiscal space available to support energy transition initiatives. Together, these factors underscore the complex economic, technical, and institutional barriers that must be addressed to sustain Bhutan's clean energy trajectory.

Emerging Case Studies / Turning Points

In 2024, Bhutan achieved a major milestone in its clean energy transition with the commissioning of the 22.38 MW Sephu Solar Plant at Wangduephodrang, the nation's first large-scale utility solar project[16]. The project represents a significant step towards diversifying Bhutan's energy portfolio and mitigating seasonal electricity shortages that occur during the dry winter months.

Developed under a government-led initiative with strong backing from local government and Sephu community participation, the project increased renewable generation capacity while delivering socio-economic benefits, including access roads, community halls, and protective infrastructure such as fencing and drainage systems. Concerns raised by local communities over grazing land access were addressed through the inclusion of designated corridors to allow safe movement of people and livestock. Furthermore, the areas located above the national highway and across the stream originally included in the project scope was excluded to enable more efficient land use[17].

The project was supported by optimised financing from ADB under Bhutan's RE investment framework, demonstrating effective mobilisation of international climate finance. Building on this momentum, the Sephu Solar Project is now advancing into its second phase, with plans to add additional capacity by the end of 2025. This expansion aligns with the Renewable Energy Roadmap 2040, which envisions scaling up solar generation to complement hydropower, enhance grid stability, and strengthen Bhutan's energy security through year-round clean energy availability. Alongside this, the forthcoming Green Hydrogen

[15] Ministry of Finance. (2022-2024). *Bhutan Trade Statistics*. Royal Government of Bhutan
[16] Ministry of Energy and Natural Resources. (2025). *Sephu Solar Project.* https://moenr.gov.bt/?p=15007
[17] Rai, M. (2024, October 28). Sephu community raises concerns over Mega Solar Project: MoENR Minister responds. *The Bhutanese*. https://thebhutanese.bt/sephu-community-raises-concerns-over-mega-solar-project-moenr-minister-responds/#:~:text=The%20Sephu%20community%20expressed%20dissatisfaction,safety%20is%20of%20top%20priority.

Roadmap signal the government's intent to expand beyond hydropower by promoting solar and hydrogen as strategic resources for future energy security and export diversification.

Outlook and Priorities (Next 3–5 years)

To sustain momentum, Bhutan's most urgent priority lies in increasing the RE generation and realising the multifaceted RE targets as planned in the Renewable Energy Development Roadmap 2040. While hydropower remains the backbone of the national energy system, seasonal generation variability and rising domestic demand call for accelerated deployment solar and wind.

In the coming years, Bhutan's financial landscape is expected to incorporate innovative financial instruments like blended finance, sustainable/green bonds, carbon finance, etc., which could play a pivotal role in mobilising capital for RE projects, energy efficiency programs, and green infrastructure development. These mechanisms are expected to enable greater public and private sector participation.

Bhutan also stands to, both, contribute to and benefit significantly from regional collaboration in the energy sector. With its abundant renewable resources, particularly hydropower and emerging solar potential, the country can serve as a reliable supplier of clean electricity to neighboring countries, helping reduce regional carbon intensity and strengthen collective energy security. Expanding cross-border power trade under initiatives like BBIN (Bangladesh, Bhutan, India, and Nepal) could enable more efficient use of resources by exporting surplus hydropower during monsoon months and importing power during winter shortages.

Bhutan continues to be carbon negative as per the recent emission report in its BTR, with projections indicating this status will be maintained through 2030, subject to continued mitigation efforts. In 2024, Bhutan also joined the Climate and Clean Air Coalition (CCAC)[18], committing to meaningful action on SLCPs such as black carbon, methane, and hydrofluorocarbons (HFCs). The country is already advancing SLCP mitigation through initiatives in waste management, clean cooling, air quality monitoring, and household energy.

[18] Climate and Clean Air Coalition. (2024). Bhutan. https://www.ccacoalition.org/partners/bhutan

India: Energy Transition Scenario

Country Energy Transition and Climate Overview

India's energy transition is taking place at an unprecedented scale, shaped by rapid economic growth, rising energy demand, and heightened climate risks. As the world's third-largest energy consumer and a major emitter of greenhouse gases, India's transition trajectory has significant global implications.

In line with its net-zero target by 2070 and 500 GW of non-fossil energy capacity by 2030, India is advancing the transition through enabling policies, generating awareness, mobilising investments and demand creation. The country has already exceeded the milestone of 50% non-fossil installed capacity, reaching 51%, achieving this NDC target five years ahead of schedule. Led by solar power, the country recorded its highest-ever RE capacity addition in 2025. According to IRENA Renewable Energy Statistics 2025, India ranks third globally in solar power installed capacity, fourth in wind power capacity, and fourth in total RE capacity[19].

Globally, after taking nearly 70 years to reach 1 terawatt (TW) of RE capacity in 2022, the world added the second terawatt by 2024 (in just two years). India is a key driver of this explosive global surge in RE. Over the past 11 years, India's solar capacity has grown from 2.8 GW to around 130 GW, an increase of over 4,500%. Between 2022 and 2024 alone, India added 46 GW of solar capacity, becoming the third-largest contributor[20] to global solar additions.

India's RE growth is driven by central policies and supporting schemes. Solar's growth is backed by flagship programmes like PM Surya Ghar: Muft Bijli Yojana, Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM KUSUM), making solar the largest source of renewable capacity. Wind power growth has been strengthened through measures such as National Offshore Wind Policy, viability gap funding mechanisms, and tariff based competitive bidding etc. To overcome the intermittency associated with wind and solar, energy storage deployment is gradually gaining momentum, with ~490 MWh of grid-connected battery storage made operational by mid-2025, supported by national Energy Storage Systems (ESS) guidelines.

India's electric mobility market has progressed from a nascent stage to a rapid growth phase, supported by comprehensive policies such as Faster Adoption and Manufacturing of Electric Vehicles Scheme (FAME) - II, PM Electric Drive Revolution in Innovative Vehicle Enhancement Scheme (PM EDRIVE), Production linked incentive (PLI) schemes and tax incentives. The market is also driven by substantial investments and increasing consumer acceptance. The national vision is to achieve 30% EV penetration by 2030. The Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India (SHANTI) Bill, 2025,

[19] *2025 marks Highest-Ever renewable Energy expansion in India's energy transition journey*. (n.d.). https://www.pib.gov.in/PressReleasePage.aspx?PRID=2209478&reg=3&lang=1

[20] *India is a key driver of the global renewable energy surge; records Highest-Ever 31.25 GW Non-Fossil addition in FY 25-26 : Union Minister Pralhad Joshi*. (n.d.). https://www.pib.gov.in/PressReleasePage.aspx?PRID=2199775&reg=3&lang=1

further supports India's clean-energy transition and the long-term objective of achieving 100 GW nuclear energy capacity by 2047.[21]

Aligned with the central vision, India's states have also introduced their own respective policies, regulatory reforms, economic incentives leveraging their RE potential to support the transition towards a cleaner and more sustainable energy system.

Key Renewable Energy and New Technologies Policy Highlights (2024-25)[22]

- On 19th June 2024, Prime Minister Narendra Modi approved the Viability Gap Funding (VGF) scheme for offshore wind energy projects at a total outlay of Rs.7453 crore[23], including an outlay of Rs.6853 crore for installation and commissioning of 1 GW of offshore wind energy projects (500 MW each off the coast of Gujarat and Tamil Nadu), and grant of Rs.600 crore for upgradation of two ports to meet logistics requirements for offshore wind energy projects.

- The Ministry of New and Renewable Energy (MNRE) has unveiled the guidelines for funding of testing facilities, infrastructure, and institutional support for development of Standards and Regulatory framework under the National Green Hydrogen Mission. The Scheme will support creation of new testing facilities and upgradation of existing testing facilities to ensure safe and secure operations

- The Ministry of New Renewable Energy (MNRE) has released the Guidelines for implementation of Component "Model Solar Village" under PM-Surya Ghar: Muft Bijli Yojana. This initiative aims to establish one Model Solar Village in each district across the country.

- The Ministry of Power has issued the Tariff Based Competitive Bidding Guidelines for Procurement of Storage Capacity/Stored Energy From Pumped Storage Plants (PSPs)[24]. The primary objective of these guidelines is to promote the development of PSPs while ensuring a transparent, fair, and standardised procurement framework through open competitive bidding with appropriate risk-sharing between various stakeholders.

- The Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India (SHANTI) Act, 2025, modernises the legal framework for nuclear energy, strengthens institutional oversight and creates the foundation for a more efficient, innovative, and secure nuclear ecosystem. It supports India's long-term vision of expanding clean, reliable energy while ensuring that strategic interests remain fully protected.

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[21] Press Information Bureau. (2025). *The Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India (SHANTI) Bill, 2025*. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2025/dec/doc20251219739001.pdf

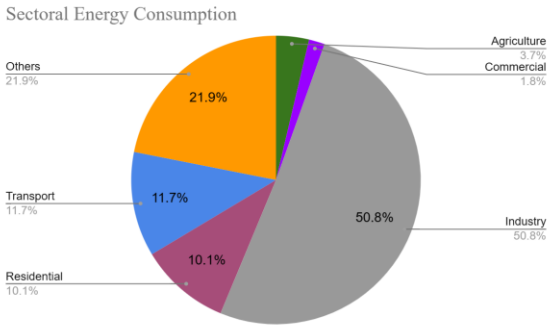
[22] *Vasudha Foundation. (2025b). India's energy overview.* https://www.vasudha-foundation.org/wp-content/uploads/Indias-Energy-Overview-year-end-report-of-FY-2024-25.pdf

[23] *Cabinet approves Viability Gap Funding (VGF) scheme for implementation of Offshore Wind Energy Projects*. (n.d.). https://www.pib.gov.in/PressReleseDetail.aspx?PRID=2026700&reg=3&lang=2

[24] Ministry of Power. (2025) *TARIFF BASED COMPETITIVE BIDDING GUIDELINES FOR PROCUREMENT OF STORAGE CAPACITY/ STORED ENERGY FROM PUMPED STORAGE PLANTS*. Government of India https://powermin.gov.in/sites/default/files/webform/notices/Guideline_for_procurement_of_storage_capacity_stored_energy_from_pumped_storage_plants.pdf

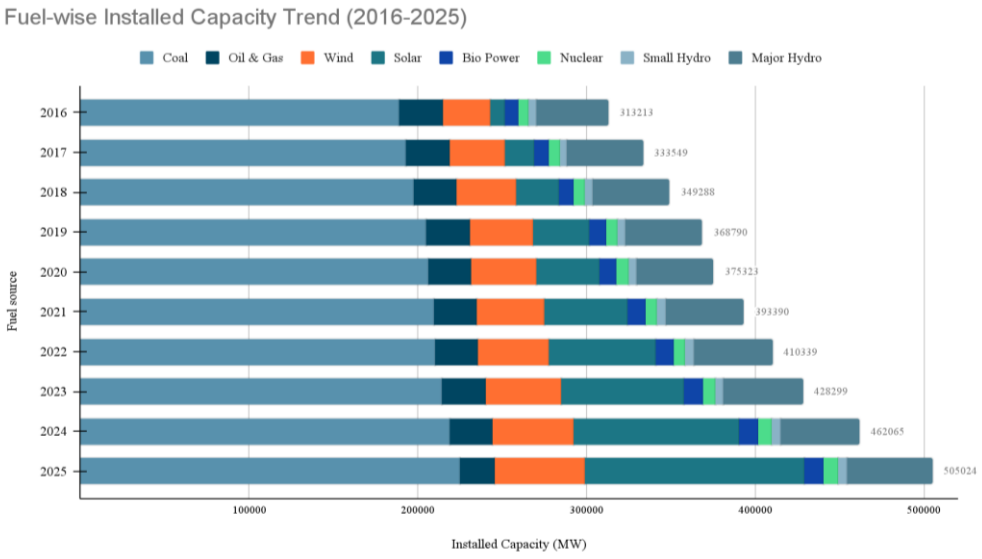
Energy Scenario:

India has achieved universal village electrification, while 99.80% of households have access to clean fuel for cooking. Although more than 50% of installed power capacity is now from renewable sources, electricity generation continues to rely on fossil fuels. Solar generation, however, is gradually increasing its share within the grid. As a fast-growing developing economy, industrial activity accounts for nearly half of the nation's energy demand.



India has planned and initiated pilots for Green Hydrogen to transition hard to abate industries like cement, steel, and transport. RE integration has accelerated remarkably since 2015, with installed capacity rising from ~89 GW to ~254 GW as of October 2025, a massive 185% jump. This includes around 130 GW of solar, 54 GW of wind, 50 GW of large hydro, 5 GW of small hydro and 12 GW of bio power. Nuclear capacity stands at around 8 GW.

Coal installed capacity is ~225 GW, while oil- and gas-based capacity totals ~21 GW, taking total fossil fuel capacity to ~246 GW. Despite a growing increase of renewables in the grid and also in generation, around 70% of electricity generation continues to come from fossil fuel. However, on 29 July 2025, India recorded its highest-ever renewable energy share in daily electricity generation, with renewables meeting 51.5% of the country's total electricity demand of 203 GW.



Key Challenges and Barriers to Energy Transition

India reaching 50% non-fossil capacity in mid-2025 is an important milestone, but capacity alone does not ensure reliable or affordable low-carbon energy supply. Currently, fossil sources account for around 70% (69.56% as of 31st October 2025[25]) of electricity generation, reflecting lower operating hours for solar and wind and limited grid flexibility.

Financial stress across distribution companies (DISCOMs) remains a major constraint. As of June 2025, DISCOMs owed power generators Rs 5.81 lakh crore (US$6.78 billion)[26], driven by persistent losses, inadequate tariffs, and weak billing and collection efficiency. These constraints limit DISCOMs' ability to sign new power purchase agreements (PPAs), delaying RE projects, and creating cashflow and financing uncertainty for developers.

India's existing grid infrastructure has limited ability to accommodate a high share of intermittent renewables, necessitating significant investment in energy storage, smart grids, and hydrogen systems to maintain grid stability and reliability.

While investment flows are increasingly shifting from fossil fuels toward RE, the pace of decarbonisation will depend on capital availability along with the ability of institutions to absorb, plan and deploy investments at scale and speed.

India's energy transition is also shaped by structural and socio-economic factors, including dependence on imported critical minerals such as lithium, cobalt, and nickel, employment risks in fossil fuel–dependent regions, and unequal access to clean energy across income groups and geographies.

Case Studies / Success Stories on energy transition

1. **PM-KUSUM:**
    - Launched in 2019, the Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM-KUSUM) scheme promotes solar energy use in agriculture by enabling farmers to become energy producers. As of October 2025, more than 9 lakh standalone solar pumps have been installed in areas with limited grid access, a total of 10,535 grid-connected solar pumps have been solarised, and 9,74,458 feeder-Level solarisation (FLS) pumps have been completed[27].
    - Having seen the success of its flagship PM-KUSUM solar pump scheme within the country, India is set to scale it up across developing nations, especially in Africa and small island states, through the International Solar Alliance (ISA)[28]. The initiative is aimed to expand

[25] *India Climate & Energy Dashboard*. (n.d.-b). https://iced.niti.gov.in/energy/electricity/generation/power-generation
[26] *DISCOMs continue to exceed their 3% fiscal deficit limit, highlighting need for state oversight | IEEFA*. (n.d.). https://ieefa.org/articles/discoms-continue-exceed-their-3-fiscal-deficit-limit-highlighting-need-state-oversight#:~:text=The%20note%20highlights%20that%20while,at%203.9%25%20of%20their%20GSDP.
[27] *India's solar momentum*. (n.d.). https://www.pib.gov.in/PressReleasePage.aspx?PRID=2199729&reg=3&lang=1
[28] Puja Das. (2025, October 8). ISA plans to replicate India's PM-KUSUM to power farms and rural homes in member countries. *Down to Earth*. https://www.downtoearth.org.in/energy/isa-plans-to-replicate-indias-pm-kusum-to-power-farms-and-rural-homes-in-members-countries

irrigation access, energy security and deliver clean power to millions in off-grid communities, reinforcing India's role as a leader in distributed renewable energy.

2. **PM Surya Ghar: Muft Bijli Yojana (PMSG: MBY):**
    - The PMSG: MBY is demand driven rooftop solar scheme open to all grid-connected residential through a national online portal. Against a target of covering one crore households by FY 2026-27, a total of 23,96,497 households have installed rooftop solar systems, representing 23.96% of the target[29].

Outlook and Recommendations

1. **Near-term priorities (next 3–5 years) and long-term opportunities**
    - India appears well positioned to meet its quantifiable NDC targets, having already achieved one key milestone ahead of schedule.
    - However, addressing renewable intermittency through storage deployment, grid upgrades, and flexible resources remains urgent. Emerging clean energy vectors such as green hydrogen, though still at a nascent stage, require faster scaling and clearer demand signals.
    - Over the longer term, India has substantial opportunities to decouple emissions and growth. Green hydrogen and low-carbon industrial processes offer pathways to decarbonise hard-to-abate industries, while positioning India as a competitive supplier in emerging global clean energy value chains. India's large domestic market and manufacturing push also create potential for cost reductions that could benefit the wider South Asian region.

2. **Potential for regional collaboration**
    - There is regional coordination between India, Nepal and Bhutan in energy cooperation and trade. India has already signed several energy agreements with Bangladesh, Bhutan, and Nepal. India's cooperation with Bhutan on hydropower has resulted in the development of several new hydropower projects in Bhutan, which not only generates revenue for Bhutan but also provides clean energy to India.
    - To unlock broader regional gains, platforms like ISA, SAARC, BIMSTEC need renewed political momentum, with a focus on collective development and sustainability as target.
    - Deeper regional energy cooperation, drawing lessons from the European Union's integrated power markets, could support both national and collective clean energy goals.

[29] *PM Surya Ghar reaches 23.96 lakh households; nearly One-Fourth of target*. (n.d.). https://www.pib.gov.in/PressReleasePage.aspx?PRID=2200441&reg=3&lang=1

Nepal: Energy Transition Scenario

Energy Transition Context

Nepal's overall energy consumption in FY 2022/23 was 532.42 PJ, a 16.81% decline from the previous year (640 PJ), reflecting slower economic activity alongside improvements energy efficiency. Energy use in Nepal is classified into traditional sources (fuelwood, agricultural residue, animal dung), commercial sources (coal, petroleum products, electricity), and renewable sources (solar, wind, micro-hydro, biogas). Consumption shares were 63.87% traditional (340 PJ), 33.03% commercial (175.87 PJ: 137.38 PJ fuels and 38.49 PJ grid electricity), and 3.1% renewable (16.5 PJ). Notably, coal consumption decreased by 41.5%, while petroleum product use fell by 16.14%. Electricity consumption, however, rose by 21.18%, signalling a gradual shift away from fossil fuels toward electrification, particularly in transport. RE utilisation also increased by 2.39%, indicating steady growth in clean energy deployment[30].

Electricity generation in Nepal remains predominantly hydropower-based. Total installed capacity reached 3,591 MW in FY 2024/25, with 456 MW added through18 hydropower projects and two solar projects, and over 200 MW in the pipeline. The Nepal Electricity Authority (NEA) remained a net exporter of electricity, achieving record cross-border exports of 699 GWh. Expanded transmission infrastructure and 98% population electricity access (96.7% grid-connected) support this transition, with per-capita consumption reaching 369.58 kWh[31].

However, Nepal's hydropower-heavy system is increasingly exposed to climate-related risks. Flash floods in 2024 damaged more than 30 hydropower plants, while glacier retreat and seasonal variability pose long-term threats to reliability. Despite these risks, the higher efficiency of electricity and renewables compared to coal and petroleum, coupled with their growing share in the energy mix, underscores Nepal's gradual shift toward a more sustainable and resilient energy system.

Progress toward NDC and net-zero targets

Nepal has strengthened its NDC implementation by setting clearer and more ambitious quantitative targets across major sectors as follows:

Priority / Target	Baseline	Target (2030 / 2035)
Electricity Generation and Supply		
Expand renewable generation capacity	3,500 MW (mostly renewable; 5% mini/micro-hydro, solar, wind, bio-energy)	14,031 MW / 28,500 MW (10% / 15% mini/micro-hydro, solar, wind, bio-energy)
Reduce transmission and distribution losses	12.73%	11.50% / 10.50%
Cooking and Heating		
Electric cookstoves	400,000 households	– / 2.1M households + 15,000 institutions
Improved cookstoves (ICS)	127,703 households	750,000 / 1,000,000 households
Metallic ICS (MICS)	18,068 households	48,068 / 100,000 households

[30] Water and Energy Commission Secretariat (WECS). (2024). *Energy sector synopsis report 2024 (FY 2079/80)*. Government of Nepal. https://wecs.gov.np/content/56/energy-sector-synopsis-report-2024--fy-2079-80/

[31] Nepal Electricity Authority. (2025). *Annual report 2024/2025* (40th anniversary ed.). https://www.nea.org.np/admin/assets/uploads/annual_publications/Annual_Report_40_Anniversery.pdf

Household biogas	450,770 households	500,000 / 652,770 households
Large-scale biogas plants	357 units	550 / 750 units
Transport		
Battery electric vehicles (BEVs) – private/public	2 - 12.38% private, 29% public	90% private (inl. two-wheelers) / 70% public ; 95% private / 90% public
Integrated electric bus/trolley/light rail	0 km	50 km / 100 km
Electric rail network	0 km (112 km track bed laid, 52 km l diesel-electric)	200 km / 300 km
Industry		
Electricity-based furnaces – iron and steel	20% plants	– / 100% plants
Bioenergy use in cement industries	0%	– / 35% fuel use
Convert boilers to electricity	0%	30% / 70%
Phase out fixed chimney brick kilns	95% Fixed Chimney Bull's Trench Kiln (FCBTK)	– / convert to hybrid kilns
Pilot medium-sized electric tunnel kiln	0	1 kiln (100M bricks/year) / –

Overall, these expanded targets and clearer conditional/unconditional pathways represent meaningful progress toward Nepal's long-term net-zero commitment.

Use of traditional fuels (including coal and petroleum products) decreased by **17.2%**, while petroleum products alone fell by **24.27%** year-on-year. Coal use saw a particular sharp contraction: imports declined from 1,974,357 tonnes to 1,383,000 tonnes, while domestic coal production fell from 6,927 tonnes to 2,948 tonnes. On the petroleum side, data from the national customs/ trade statistics show that in FY 2023-24 the overall oil import bill dropped by about NPR 15.36 billion compared to previous years. For the first months of fiscal year 2024/25, import of diesel, petrol and kerosene has reportedly dropped compared to the same period last year. Meanwhile, in the same 2024 period, electricity consumption largely from grid and renewables increased significantly.

Policy and Institutional Landscape

Key policy developments include:

Policy / Strategy	Description / Key Changes
NDC 3.0	Submitted 2025; updates climate targets through 2035 with a commitment to net-zero CO_2 by 2045, covering energy, transport, industry, forestry, and waste sectors[32].
Energy Development Roadmap 2081	Targets 28,500 MW of installed electricity capacity by 2035, with legal and institutional reforms for energy production, trade, and financing[33].

[32] Government of Nepal. (2025). *Nationally Determined Contribution (NDC) 3.0*. https://unfccc.int/sites/default/files/2025-05/Nepal%20NDC3.pdf

[33] Ministry of Energy, Water Resources and Irrigation [MoEWRI]. (2025). *Energy Development Roadmap and Action Plan-2081* [Unpublished report]. Government of Nepal.

Green Hydrogen Policy 2080	Promotes hydrogen from renewable electricity for cleaner industrial fuels[34].
Solar Thermal Roadmap	Scales up solar-heat technologies for domestic, commercial, and industrial use[35].
Removal of Hydropower Capacity Restrictions	Allows hydropower projects without prior capacity limits to accelerate generation and exports[36].
EV Charging Infrastructure Master Plan	Plans deployment of public EV chargers on highways, with GIS-based site selection and technical standards[37].

In recent years, institutional arrangements in Nepal have shown improvement in coordination and accountability. Inter-ministerial cooperation is strengthening, with government agencies increasingly collaborating on policy, planning, and implementation. Good coordination across all relevant sectors and ministries during the preparation of NDC 3.0, for example, resulted in a more coherent and effective climate action plan, aligning with other national plans.

What near-term policy, financing, or technology levels are emerging?

- **Regional power markets and commercial frameworks:** Expand the tripartite trade pilots into formal power-exchange mechanisms and medium-term bilateral contracts to stabilise demand for Nepal's exports. The June 2025 pilot exports[38] are proof of concept.
- **EV Transition:** Push EV incentives and charging-infrastructure linked to cheap hydropower to shift transport away from imported oil reducing import bills and GHGs in parallel with electrification of the IC vehicles. NDCs include transport measures aligning tariffs and charging infrastructure is necessary.
- **Scaling RE:** Rooftop solar, mini-grids, and alternative use of energy (Agri-irrigation, cold chains) support rural communities and lower local fossil fuel use. Subsidised programs and projects can scale quickly on the use of solar energy.

Financing instruments

In 2024–25, Nepal introduced several major financing instruments through officially published frameworks and programmes. Under the Integrated National Financing Framework (INFF) Strategy 2025–2030[39], the government adopted national mechanisms to scale up green bonds, blended finance, viability-gap funding, and climate-risk financing.

Nepal issued its first-ever public green bond in 2025, a NPR 5 billion issue by Nepal Infrastructure Bank Limited (NIFRA), developed under an official Green Bond Framework aligned with ICMA principles and

[34] Ministry of Energy, Water Resources and Irrigation. (2024). *Green Hydrogen Policy, 2080* [Green Hydrogen Policy]. Government of Nepal.
[35] Weiss, W., Moschik, R., Malla, A., Dhananjayan, P., Gautam, K., & Ghimire, L. P. (2025). *Solar Thermal Roadmap and Implementation Plan for Nepal*. https://doi.org/10.53055/icimod.1083
[36] Government mulls removing hydro capacity restrictions. (2024, January 23). *The Kathmandu Post*. https://kathmandupost.com/national/2024/01/23/government-mulls-removing-hydro-capacity-restrictions
[37] Water and Energy Commission Secretariat (WECS). (2025). *Master Plan for EV Public Charging Infrastructure* [Government Report]. Ministry of Energy, Water Resources and Irrigation, Government of Nepal. https://wecs.gov.np/content/181/master-plan-for-ev-public-charging-infrastructure/
[38] Nepal begins historic power export to Bangladesh via India. (2024, November 16). *The Kathmandu Post*. https://kathmandupost.com/money/2024/11/16/nepal-begins-historic-power-export-to-bangladesh-via-india
[39] United Nations Development Programme. (2025, February 12). *MoF and UNDP jointly launch Nepal's Integrated National Financing Framework (INFF) strategy*. https://www.undp.org/nepal/stories/mof-and-undp-jointly-launch-nepals-integrated-national-financing-framework-inff-strategy

Nepal's Green Taxonomy 2024[40]. Additionally, the Sustainable Energy Challenge Fund (SECF)[41], established through AEPC's Nepal Renewable Energy Programme, expanded the use of blended finance, grants, and de-risking instruments to mobilise private investment in distributed renewable energy (DRE) and clean-cooking technologies.

Taken together, these measures signal a shift toward more structured, transparent, and scalable green financing architecture in Nepal.

Energy Access and Demand Dynamics

Access, affordability, and reliability

Nepal's national electrification rate reached 97.7% in 2024–25, as reported in AEPC's *Progress at a Glance FY 2080/81*, supported by a total installed electricity capacity of 3,157 MW and a 21.18% rise in grid-electricity consumption year-on-year[42]. Despite these gains, access remains uneven: of 753 local levels, only 539 are fully electrified, while 196 are partially electrified and 18 remain completely off-grid, highlighting persistent reliability and last-mile access gaps[43].

Clean-cooking uptake remains low: around 51% of households still use fuelwood, 44.3% rely on LPG, and a very small share uses electricity or other renewable options, underscoring ongoing challenges in affordability and transition to modern energy in rural and mountainous regions[44]. Overall, there is significant national progress in electricity access, but continued disparities in reliability, affordability, and clean-cooking adoption remain.

Distributed renewables and rural electrification

Nepal has experienced substantial growth and diversification in DRE, mini-grids, and rural electrification. According to AEPC data, 390 kilowatt-peak (kWp) of solar mini-grids were installed, with an additional 293 kWp under construction, alongside solar-powered irrigation and water-pumping systems, solar home systems, and 2,622 kWp of institutional and rooftop solar PV. Over 500 private companies are actively delivering these distributed energy solutions.

WECS reports that mini- and micro-hydro capacity has reached 38.8 MW, while electricity access and per-capita consumption have increased significantly. Together, these developments highlight a clear trend toward decentralised energy solutions, combining mini-grids, off-grid solar, mini/micro-hydro, to improve rural electrification and support productive energy use in remote areas.

Industrial and transport demand

The industrial sector accounts for 20.91% and the transport sector for 10.43% of total energy consumption. In FY 2023/24, Nepal's internal electricity sales reached 9,358 GWh, marking a 21.18% increase year-on-year, with per-capita electricity consumption at approximately 370 kWh/year.

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[40] *Nepal's First Public Green Bond Issued with GGGI and KOICA Support*. (n.d.). GGGI - Global Green Growth Institute. https://gggi.org/nepals-first-public-green-bond-issued-with-gggi-and-koica-support/#:~:text=Nepal's%20first%20publicly%20listed%20green%20bond%20was,6%25%20*%20**Proceeds**%20Support%20renewable%20energy%20initiatives

[41] *What is SECF – NREP*. (n.d.). https://nrep.aepc.gov.np/se-challenge-fund/#:~:text=What%20is%20SECF%20%E2%80%93%20NREP,for%20Vendor%20Finance%20Challenge%20Fund:

[42] Government of Nepal, Khadka, D., Acharya, S., Acharya, B., Adhikari, M., Ghising, K. M., Gurung, K., Dhungana, S. P., Khanal, D. R., Dhakal, N. R., Acharya, M., & Bichha, R. P. (n.d.). Progress at a glance: year in review FY 2080/81 (2023/24). In *Progress at a Glance: Year in Review FY 2080/81 (2023/24)*.

[43] *539 local levels fully electrified | The Annapurna Express*. (n.d.). The Annapurna Express. https://www.theannapurnaexpress.com/story/50235/#:~:text=By:%20The%20Annapurna%20Express,percent%20rely%20on%20alternative%20sources.

[44] *51% Nepali households still rely on firewood for cooking*. (n.d.). Khabarhub. https://english.khabarhub.com/2025/15/444639/

Within industry, electricity accounts for only 11.57% of total energy use, with the remainder coming from coal, fuelwood, diesel, and other fuels, indicating significant latent potential for electrification through electric boilers, machinery, and other processes. Industrial electrification could therefore emerge as a major driver of power demand in the coming decades.

In transport, electricity currently comprises a very small share, with most energy coming from diesel, petrol, and Aviation Turbine Fuel, suggesting that electrification is still nascent. However, with the increasing import of EVs (up to 70% of new vehicle sales), rising EV adoption, and expansion of charging infrastructure, the transport sector presents a huge potential for electricity demand growth in the coming years, supporting the transition toward cleaner energy and low-carbon transport[45].

Key Challenges and Barriers

Despite exceptionally large capacity additions in recent years – primarily hydro, with some solar – Nepal continues to face transmission bottlenecks, seasonal mismatches (wet-season surplus/dry-season constraints), and distribution upgrades that lag generation. These constraints limit the ability to use domestic generation for industrial growth and exports unless grid modernisation and new substations/transmission lines keep pace[46].

Hydropower continues to account for more than 90% of generation, creating pronounced seasonality of supply: wet-season surpluses and dry-season shortfalls. Without faster deployment of storage, flexible thermal/gas backup, demand-side management, or regional trade arrangements that reliably import in the dry season, Nepal continues to suffer reliability and economic costs from seasonal imbalance. This risk is called out in sector assessments and underpins the need for grid/integration solutions.

Nepal's recent electricity exports to Bangladesh (40 MW via India, with other exports to Bihar, India) illustrate export potential but also show how dependent Nepal is on cross-border transmission capacity hosted by neighbours. Large power export markets (like this tripartite commercial agreement) require reliable cross-border infrastructure. Every year, Nepal is expected to sell 144,000 MWh (megawatt-hours) of electricity in the wet season.[47] For this market to function seamlessly, Nepal will have to invest and build high-capacity and high-reliability transmission corridors and set guidelines in place to overcome institutional barriers.

The government has been reforming and considering phased removal of LPG/cooking gas subsidies and other fuel supports. Such reforms are technically warranted for fiscal sustainability and to align incentives with clean energy, but are politically and socially sensitive and require careful targeting to protect poor households. Recent policy moves and committee recommendations show momentum but also implementation risk.[48]

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[45] Water and Energy Commission Secretariat (WECS). (2024). *Energy sector synopsis report 2024 (FY 2079/80)*. Government of Nepal. https://wecs.gov.np/content/56/energy-sector-synopsis-report-2024--fy-2079-80/

[46] *NEPAL ELECTRICITY AUTHORITY GENERATION DIRECTORATE FISCAL YEAR 2024/2025 (2081-2082)*. (n.d.). https://www.nea.org.np/admin/assets/uploads/annual_publications/Generation_2081_82.pdf

[47] Nepal begins historic power export to Bangladesh via India. (2024, November 16). The Kathmandu Post. https://kathmandupost.com/money/2024/11/16/nepal-begins-historic-power-export-to-bangladesh-via-india

[48] *NepalEnergyForum*. (2024, June 20). NepalEnergyForum. http://www.nepalenergyforum.com/?s=tax+reform+committe

Large hydropower projects (900 MW class and other cascade projects) need long-tenor finance and risk mitigation where political, currency, and contract risks are perceived as high. Financing exists (regional developers and state investors), but remains contingent on predictable power purchase agreement (PPA) regimes, transmission guarantees, and clear land/environment/social approvals. NDC implementation is a continuous reminder of the need for a financing roadmap with mobilisation strategies[49].

Major hydro projects often face policy barriers, local opposition, and environmental/social safeguard processes which delays, increases costs, uncertainties and substantial risk to investors. Strengthening institutional capacity for planning and safeguards is necessary. NDC documents emphasise institutional strengthening and financing roadmaps as preconditions for implementation.

Some past bottlenecks are being tackled, where the Nepal Electricity Authority (NEA) and partners are actively upgrading grid infrastructure (substations, transmission) and signing deals (India MOUs) to boost exports and manage energy surplus, tackling past congestion; however, progress is slow, localised, and challenges remain in system reliability, loss reduction, and completing key cross-border lines like the Butwal-Gorakhpur and Inaruwa-Purnia[50].

Emerging Case Studies / Turning Points

Case study A: First commercial cross-border exports (June 2025): Nepal → Bangladesh via India Rapid expansion of domestic generation (new hydro capacity) created a seasonal power surplus, enabling commercial cross-border electricity trade among three South Asian countries. In June 2025, Nepal exported its first commercial electricity volume to India (~80 MW) and Bangladesh (40 MW), via India's grid, under a tripartite commercial and transmission framework negotiated in 2024.

The arrangement involved NEA, India's Power Grid and a central power trading entity, Bangladesh Power Development Board, public and private hydropower developers, and transmission-financing partners. This operation used recently agreed transmission arrangements and demonstrated operational cross-border trade.

Why it matters / replicable lessons:

- Demonstrates Nepal's ability to monetise surplus hydropower while positioning India as a regional grid hub and transit route, a model that can be applicable for South Asian trade corridors.
- Highlights the importance of synchronising generation expansion with simultaneous investments in cross-border transmission and commercial frameworks.
- Shows that targeted political agreements and enabling infrastructure can unlock short-term export opportunities, improving bankability, reducing investor risk, and laying the groundwork for scaled-up regional power trade.

[49] Singh, P. M., Khadka, M., & Ministry of Energy, Water Resources and Irrigation. (2020). *Nationally determined contribution in Nepal*. https://prc.org.np/wp-content/uploads/2024/12/f0c17922124c0b3da8053dc5c16d9cb3.pdf

[50] *Distribution and Consumer Services Directorate (DCSD): A Year Book - F.Y. 2081/82 (2024/25)*. (n.d.). Nepal Electricity Authority. https://www.nea.org.np/admin/assets/uploads/annual_publications/NEA_DCSD_Maganize_2082.pdf

Case study B: LPG / cooking-gas subsidy reform: debates and policy shifts

Policy reviews bodies and line ministries have advanced proposals and pilots to gradually phase down broad LPG subsidies[51] in favour of targeted support mechanisms such as VAT-linked refunds, National ID-based transfers, or direct cash support for low-income households. State-owned suppliers have also tested differentiated pricing schemes. These moves followed fiscal pressures and recommendations from tax reform committees.

The success of these reforms will depend largely on execution. Strong administrative systems, clear communication with the public, and reliable support for low-income households are all critical. Without these, the reforms could face political resistance, confusion, or unintended hardship for vulnerable groups, outcomes that could delay, dilute, or reverse policy changes.

Why it matters / replicable lessons:

- Fuel-subsidy reform must be coupled with strong social protection, transparent communication, and phased pilots.

- When tied to fiscal savings that are ring-fenced for energy system investment, subsidy reform can accelerate transition financing but only if political economic risks are managed.

Outlook and Priorities (Next 3–5 years)

1. **Accelerate grid and transmission build-out to match generation ambitions.** Prioritise high-capacity international and domestic transmission corridors (including cross-border lines and interconnection upgrades) and substation/building programs so newly commissioned generation can be evacuated, used domestically, and traded regionally. Sector assessments consistently identify transmission as the single most critical enabler of Nepal's export potential and industrial growth.

2. **Operationalise NDC3.0:** Nepal's NDC 3.0 sets conditional and unconditional priorities up to 2035; these must now be translated into costed, implementable action pipelines with clearly identified funding sources. The NDC itself highlights institutional strengthening and finance mobilisation as priorities.

3. **Implement targeted fuel-subsidy reforms with social protection.** Broad-based LPG subsidies should be gradually phased down in favour of targeted support for vulnerable households, while redirecting fiscal savings toward grid upgrades, distributed renewables, and climate-adaptation measures. Pilot projects and digital targeting can help manage political and social risks.

4. **Invest in flexibility to manage seasonal imbalances.** Battery-storage pilots, peaking-capacity incentives, and demand-side management measures are needed to manage wet/dry seasonal imbalances. This reduces reliance on costly thermal backup and makes exports more dependable.

5. **Strengthen de-risking frameworks to attract private capital.** Standardised PPA frameworks, streamlined land and environmental due-diligence processes, and clearer local benefit-sharing mechanisms can improve investor confidence to attract long-term finance to large hydro and

[51] OnlineNEF@Nepal. (2024, June 20). Tax Reform Committee proposes phased removal of LPG subsidy within three years. NepalEnergyForum. http://www.nepalenergyforum.com/tax-reform-committee-proposes-phased-removal-of-lpg-subsidy-within-three-years/

transmission. NDC implementation plans should emphasise long-term finance and capacity building.

Regional collaboration

- **Power exports and regional grid services:** By strengthening baseload and peaking capacity plus transmission, Nepal can supply surplus seasonal electricity to neighbouring nations creating export revenues that can support Nepal's transition. The June 2025 exports to Bangladesh through India exemplify the tangible early benefits.

- **Regional manufacturing and supply chains:** Collaboration on solar panel assembly, storage manufacturing, or hydropower equipment supply could localise value chains and create jobs.

- **Joint financing and risk-sharing platforms:** Pooling regional guarantees or a South Asia de-risking facility could unlock long term private capital for large infrastructure projects.

Risks and mitigations

Risk	Mitigation
Political resistance to subsidy reform	Phased pilots combined with targeted social protection.
Transmission expansion lags generation growth	Ring-fenced financing, public-private transmission models, and prioritised corridor planning
Financing gaps for large projects	Blended finance, credit guarantees, and stronger PPA creditworthiness

Pakistan: Energy Transition Scenario

Executive Snapshot

Pakistan's RE landscape is evolving rapidly, driven by shifting policies, rising consumer adoption, and growing private sector interest. Hydropower remains the largest renewable source in RE generation, supplying over 11.5 GW, followed by 2.4 GW of wind and about 1.4 GW of utility-scale solar. The country also maintains a significant nuclear programme that provides more than 4.5 GW of stable baseload power to the national grid.

The most transformative change, however, is occurring in distributed and rooftop solar, which has surged to nearly 5 GW as households and businesses increasingly adopt self-generation to offset high tariffs and unreliable grid supply.

Despite this progress, thermal power still dominates Pakistan's energy mix. Electricity generation remains heavily dependent on fossil fuels such as natural gas, imported coal, furnace oil, and re-gasified liquefied natural gas (RLNG). Domestic gas reserves have declined sharply, increasing reliance on volatile and expensive LNG imports. Coal-fired generation has expanded in recent years to strengthen energy security but has raised environmental concerns and complicated national climate commitments. Furnace oil plants, although costly and inefficient, still operate intermittently as backup during shortages or peak demand, reflecting ongoing challenges in retiring outdated thermal capacity.

The government has outlined ambitious plans to boost renewable penetration, targeting 60% renewable electricity by 2030. Private investment is growing, including in hybrid solar–wind projects and bagasse-based cogeneration. However, several systemic issues continue to slow progress. Transmission bottlenecks limit the movement of power from resource-rich provinces to major demand centers, while circular debt and payment delays to IPPs undermine investor confidence. Uneven adoption of rooftop solar is also creating equity concerns.

Policy frameworks have played a central role in driving renewable development. The Alternative and Renewable Energy (ARE) Policy 2019 set national targets for scaling up RE, while the National Electricity Policy (NEP) 2021 emphasised affordability, sustainability, and diversification of the power mix. National Electric Power Regulatory Authority (NEPRA) has supported the sector through tariff determinations, generation licensing, and the introduction of competitive bidding frameworks. Federal and provincial governments have developed solar parks, mapped wind and solar zones, and undertaken feasibility studies to attract private developers. International institutions, including the World Bank, ADB, and various bilateral partners continue to support grid modernisation, integration of variable RE (VRE), and expansion of transmission capacity.

Still, significant hurdles remain. Transmission constraints across the North–South corridor lead to curtailment and delays in connecting new renewable plants. Frequent policy changes, such as adjustments in net-metering rules, and uncertainty around future tariffs, create additional market instability. Meanwhile, the rapid growth of rooftop solar is impacting the revenue base of distribution companies (DISCOMs), raising concerns about cost allocation, tariff restructuring, and long-term grid sustainability.

Energy Transition Context

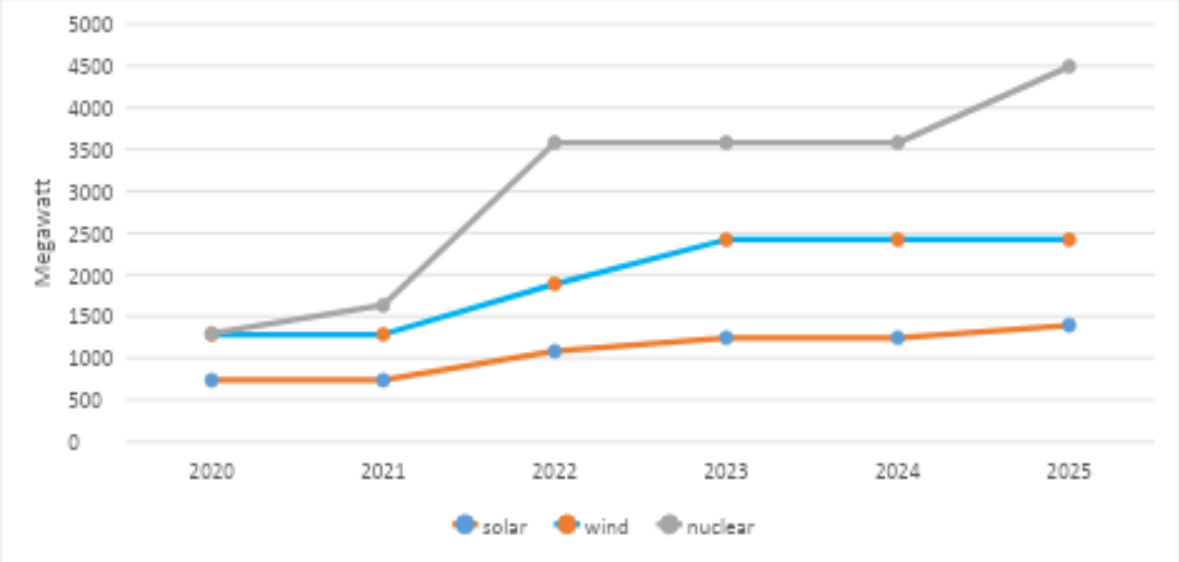
Current Energy Mix & Power Profile (2025)

As of July 2025, Pakistan's total installed generation capacity stood at 43,721 MW. The energy mix comprises of thermal power (including fossil fuels, coal, and gas) at around 52.9%, hydropower at 26.5%, nuclear at 10.3%, and other renewables, including solar, wind, and bagasse at 9.7%. Between July 2024 and June 2025, the country generated roughly 126,755 GWh of electricity, with hydropower, nuclear, and renewables collectively contributing about 66.5% of total generation, a shift toward cleaner and lower-carbon generation. During FY2025, nuclear capacity saw a notable rise from 3.5 GW to ~4.5 GW. In addition to utility-scale solar, net-metered rooftop solar installations have reached 5 GW, with approximately 1 GW of new applications still pending approval from DISCOMs.

Generation Source	Share (%)
Thermal (Fossil, Coal, Gas)	52.95%
Hydro	26.47%
Nuclear	10.28%
Renewables	9.71%

Installed Renewable Capacity (MW)

	2020	2021	2022	2023	2024	2025
SOLAR	737	737	1083	1243	1244	1395
WIND	1285	1285	1890	2419	2419	2419
NUCLEAR	1295	1635	3580	3580	3580	4493



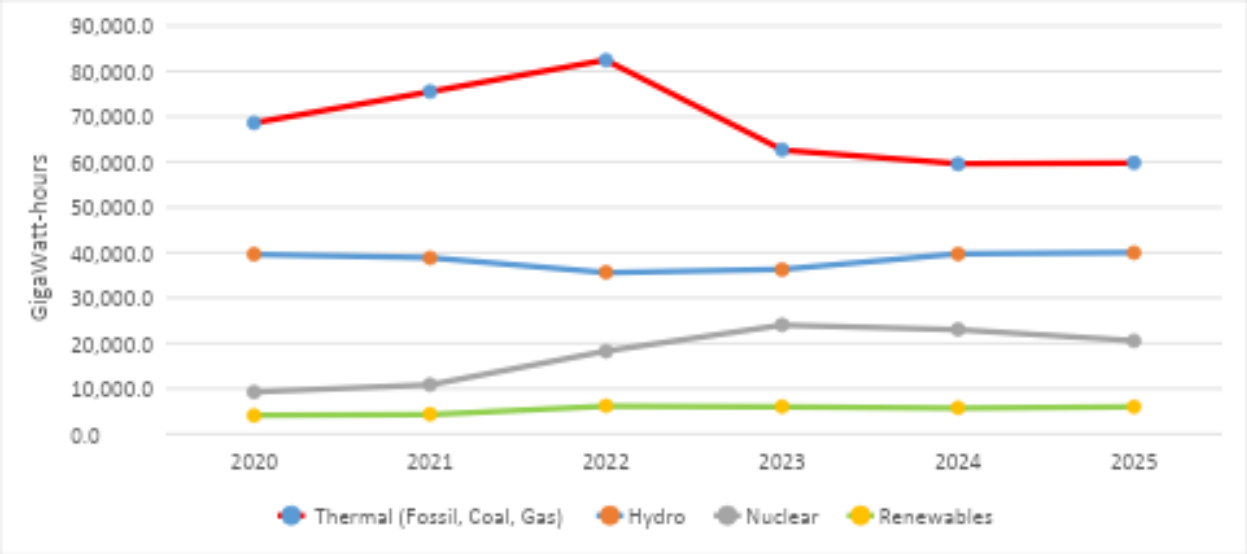
Pakistan is increasingly relying on indigenous clean energy sources (hydro, solar, nuclear) reducing dependence on imported fossil fuels. The rising share of renewables enhances energy diversification, resilience, and sustainability. Distributed solar (rooftop/net-metered) is proving a fast and scalable solution to meet demand which may help with grid stress. The growth in renewables capacity (particularly rooftop/solar net-metered) represents a major shift towards diversified, indigenous energy sources.

However, thermal plants remain a substantial part of capacity, signaling that transition is gradual, not immediate and effectiveness will depend on how much renewable generation is actually dispatched and grid-integrated.

Hydropower capacity also increased (from 10,600 MW to 11,572 MW). While thermal remains the largest share with over 50%, a gradual structural shift in the thermal energy mix is witnessed as inefficient thermal power plants are being converted to LNG based power plants.

Source Wise Electricity Generation – (GWh)

Source	2020	2021	2022	2023	2024	2025
Thermal (Fossil, Coal, Gas)	68,611.2	75,500.7	82,455.4	62,639.0	59,562.0	59,771.0
Hydro	39,628.3	38,823.2	35,634.0	36,254.8	39,674.2	39,969.4
Nuclear	9,242.5	10,871.1	18,247.9	24,054.6	23,035.4	20,570.0
Renewables	4,069.9	4,337.7	6,192.0	6,014.3	5,770.9	5,988.2



From FY2023–2024 to FY2025, the combined share of renewables, nuclear power, and hydropower has risen whereas reliance on thermal capacity has decreased. The scale and pace of renewables adoption, especially solar via net metering, is significantly higher than previous years. The increasing energy demand has been partly met by distributed solar systems, which have added more than 5GW installed capacity over the past four years.

At the same time, frequent policy reversals have created a perception of regulatory uncertainty, discouraged long-term investment, and contributed to inefficiencies in the energy sector. These reversals often stem from political transitions, fiscal pressures, debt accumulation in the power sector, and changing priorities between affordability, energy security, and climate commitments. Such interventions have also slowed progress towards a diversified, sustainable, and cost-effective energy mix. A stable, transparent, and predictable policy environment is essential for Pakistan to build investor confidence and achieve its clean energy and affordability goals and climate change commitments.

Policy Landscape

Pakistan's recent energy planning reflects a clearer shift toward cleaner and more secure power sources. The National Electricity Plan (NEP 2023-2027) and subsequent updates emphasise reducing dependence on imported fuels by expanding solar and wind generation, giving utilities and investors a more stable direction. Government-led solarisation programmes covering public buildings, agricultural tube wells, and domestic consumers along with continued support for net-metering, have helped accelerate the country's rooftop and distributed solar market.

At the same time, long-term energy planning has prioritised large hydropower projects such as Dasu, Mohmand, and Karot, as well as dependable nuclear additions like K-4, strengthening Pakistan's low-cost baseload capacity. Stronger coordination with development partners, including the World Bank, ADB, Japan International Cooperation Agency (JICA), and Chinese investment under the China-Pakistan Economic Corridor (CPEC) has supported VRE integration, transmission expansion, grid modernisation, and broader financial reforms, unlocking significant funding for solar parks, new transmission corridors, and advanced metering systems.

The Indicative Generation Capacity Expansion Plan (IGCEP) 2024–2034 outlines Pakistan's revised 10-year power-sector roadmap, rationalising the project pipeline by reducing committed additions to about 7,017 MW and dropping nearly 8,000 MW of high-cost or surplus projects. It emphasises on large hydropower, solar, wind, and nuclear over imported-fuel thermal plants, aligns new projects with least-cost planning principles, and supports the transition toward a more competitive electricity market. The plan also projects demand growth of 46–74% by 2034, with total installed capacity expected to rise to around 57,000 MW, while highlighting the need for improved grid infrastructure and careful demand forecasting to avoid overcapacity and ensure long-term system sustainability.

The future of the energy landscape in Pakistan would be transformed through the Competitive Trading Bilateral Contract Market (CTBCM), aimed at transforming the electricity sector from a single-buyer, centrally-controlled system into a competitive market where generators and consumers can directly trade electricity through bilateral contracts. Under CTBCM, DISCOMs, large consumers, and private suppliers will become active "market participants", promoting transparency, efficiency, and cost reduction by allowing competition rather than relying solely on regulated tariffs.

In 2025, the government amended net-metering regulations (for rooftop/distributed solar). The changes include lowering the electricity buy-back (export) rate for new solar-net-metering users, reflecting a recalibration to manage financial strain on the grid and utilities.

The New Energy Vehicle (NEV) Policy (2025–2030), launched in August 2025 positions electric mobility as a core element of Pakistan's environmental and energy-reform agenda and seeks to cut fossil-fuel dependence, reduce emissions, save foreign exchange (import bills), and incentivise adoption of cleaner transport contributing to broader energy transition and climate commitments.

In September 2025, Pakistan submitted "NDC 3.0," committing to reduce its projected greenhouse-gas (GHG) emissions by 50% by 2035 relative to a business-as-usual (BAU) scenario. Of that 50%, 17% is unconditional (i.e. achievable using domestic resources and policies) and 33% is conditional on international climate finance, technology transfer, and capacity support. In NDC 3.0, Pakistan has not committed to a net-zero emissions date. The document outlines a comprehensive strategy across various

sectors and combines mitigation, adaptation, resilience, and sustainable development. The total investment requirement for NDC 3.0 is ~US$ 566 billion, and without this external support, Pakistan may struggle to meet the full target.

Technological Drivers

Advanced Metering Infrastructure (AMI) in Pakistan is expanding steadily as part of broader power-sector reforms aimed at cutting losses, improving billing accuracy, and supporting a future competitive electricity market. Smart meters enable real-time consumption monitoring, remote readings, automated theft and fault detection, and time-of-use tariffs. With support from partners such as the World Bank, ADB, and USAID, utilities including LESCO, IESCO, PESCO, and K-Electric are rolling out large-scale installations. Regulators view AMI as essential for reducing technical and commercial losses, enhancing revenue recovery, and enabling rooftop solar integration and demand-side management under CTBCM. Despite progress, adoption still faces hurdles such as high upfront costs, community resistance, cybersecurity risks, and the need for reliable communication networks.

Institutional Landscape

The National Electric Power Regulatory Authority (NEPRA) plays a central coordinating role in Pakistan's energy sector by regulating, monitoring, and facilitating efficient functioning of the electricity system. NEPRA sets tariffs for generation, transmission, and distribution, ensuring prices are fair for consumers while allowing investors and utilities to recover costs. It oversees licensing for generators, distributors, and competitive suppliers, providing a framework for private-sector participation and market development. NEPRA also coordinates with the Ministry of Energy, the Central Power Purchasing Agency (CPPA-G), transmission operators (NTDC), and DISCOMs to align generation planning, grid stability, and market operations. Through these roles, NEPRA acts as a key mediator among government, utilities, investors, and consumers, fostering coordination, transparency, and long-term sustainability in Pakistan's energy sector.

Financing Instruments

In recent years, Pakistan has introduced several financing instruments and incentives to support RE and green infrastructure. The State Bank of Pakistan (SBP) has implemented RE refinancing schemes, disbursing approximately PKR 94.7 billion by funding more than 4,500 clean energy projects on solar, wind, and small hydropower. These are complemented by green banking guidelines to encourage environmentally responsible lending.

The government has also launched its first sovereign Green Sukuk and a broader Sustainable Financing Framework, enabling issuance of green, social, and sustainability-linked bonds for eligible projects, including renewable generation, energy efficiency, and climate-resilient infrastructure. Additionally, credit-guarantee mechanisms have been established to reduce lending risks for green startups, Small and Medium Enterprises (SMEs), and distributed energy projects. Together, these instruments aim to lower the cost of capital, attract both domestic and Islamic investors, scale up renewable and climate-resilient projects, and align financing with national climate and energy targets, while ongoing challenges include ensuring transparency, policy stability, and equitable access to funds.

Energy Access and Demand Dynamics

Pakistan's energy access scenario reflects a mix of achievements, gaps, and regional disparities across electricity, gas, and clean cooking fuels. As of 2025, around 90% of the population has access to electricity,

with urban areas nearly fully electrified, while rural coverage lags slightly due to remote locations and infrastructure limitations. Peak demand in rural grids often outstrips local supply, leading to load shedding.

Access to natural gas is more limited, about 55% of households are connected, primarily in Punjab and Sindh. Many households in Balochistan and Khyber Pakhtunkhwa continue to rely on LPG cylinders, wood, or biomass for cooking and heating. The government has launched programmes such as electrification of off-grid villages, promotion of rooftop solar systems, and subsidies for clean cooking fuels, aiming to reach universal access and reduce the energy poverty gap.

While large-scale distributed solar dominates urban/commercial uptake, targeted mini-grids and solar home systems continue in off-grid pockets, supported by donor programmes and provincial schemes for rural electrification, but scale remains limited compared with rooftop growth in urban areas.

The NEV Policy 2025–30 aims for 30% of all new cars, buses, trucks, and two-/three-wheelers to be electric by 2030 and 90% by 2040, offering incentives like reduced customs duties on EVs, lower sales tax (1% on EVs), and tax exemptions on charging equipment. Demand for urban mobility is also accelerating, the rollout of electric buses, with pilots underway in Islamabad, Karachi, and Lahore to cut emissions and reduce diesel costs. The two- and three-wheeler segment is seeing the fastest change, as EV scooters and rickshaws offer significantly lower running costs compared to petrol vehicles. Meanwhile, several private companies are investing in charging stations, battery swapping, and localised EV assembly to meet rising demand.

Key Challenges and Barriers

Pakistan's energy landscape is constrained by a combination of financial, technical, and governance challenges. The power sector remains burdened by a circular debt exceeding PKR 2.7 trillion, driven by low recoveries, high system losses, and expensive capacity payments to IPPs, while dependence on imported fuels keeps the country vulnerable to global price volatility.

Despite surplus installed capacity, weak transmission infrastructure, ageing distribution networks with high distribution losses, and policy inconsistencies hinder the integration of cheaper renewable and hydropower sources. Slow progress on solar and wind projects, regulatory uncertainty, delays in project approvals, and fragmented institutional coordination further discourage private investment. Meanwhile, around 20 million people still lack reliable electricity access, exposing rural regions to persistent load shedding.

Off-grid and rooftop solar in Pakistan has expanded at an exponential pace, driven by high grid tariffs, unreliable supply, and sharply falling solar prices. With nearly 5 GW of net-metered rooftop capacity already installed and thousands of additional applications under review, households, businesses, and industries are rapidly shifting towards self-generation to cut electricity bills and reduce dependence on the grid. Though this surge is transforming the energy landscape, it is also creating significant challenges for DISCOMs. As high-paying consumers migrate to solar, DISCOMs face revenue erosion, shrinking their ability to recover fixed costs and maintain infrastructure. The mismatch between declining daytime demand and existing take-or-pay power purchase agreements is also straining system economics, contributing to rising capacity charges for remaining consumers. The rapid and uncoordinated growth of rooftop solar combined with weak grid modernisation and limited storage raises concerns about system

stability, cost-sharing fairness, and the long-term financial sustainability of the power sector. This underscores the need for careful planning, regulatory foresight, and grid modernization before scaling distributed solar. Weak metering, two-way flow management, and limited storage capacity highlight the importance of investing in smart grids and Advanced Metering Infrastructure (AMI) to maintain system stability. Policy uncertainty, frequent changes in net-metering rules, tariffs, and approval procedures demonstrates that consistent, transparent, and predictable regulatory frameworks are critical to foster investor confidence while protecting the financial health of utilities. Together, these structural challenges create a complex environment that makes it difficult for Pakistan to achieve affordability, energy security, and a smooth transition to a cleaner energy future.

Socio-political and fiscal constraints continue to shape Pakistan's energy transition by shaping investment decisions, policy continuity, and the affordability of reforms. Persistent fiscal stress driven by limited revenue generation, high subsidies, and mounting circular debt restricts the government's capacity to invest in RE projects, grid upgrades, and modern technologies integration. High interest rates and macroeconomic instability make financing costly for both public and private developers, discouraging long term renewable and clean energy investments.

Emerging Case Studies / Turning Points

- The **Competitive Trading Bilateral Contract Market (CTBCM)** represents one of Pakistan's most important energy sector reforms towards accelerating the country's clean energy transition. Developed by NEPRA, CTBCM shifts Pakistan from a single buyer, government dominated electricity market to a competitive structure where generators and consumers, especially large industrial and commercial buyers can directly negotiate power supply contracts. This reform enhances transparency, encourages cost efficiency, and reduces dependence on expensive long-term take-or-pay contracts that have historically contributed to circular debt. By enabling market-based procurement, CTBCM creates new opportunities for RE developers, who can now offer competitively priced solar, wind, and hybrid solutions directly to bulk power consumers. As Pakistan moves toward phased implementation, including competitive auctions and retail competition, CTBCM is expected to unlock greater private sector participation, stimulate innovation, and accelerate the shift toward cleaner, more affordable electricity, making it a critical milestone in the country's energy transition.

- Pakistan's first Sovereign Green Sukuk, launched in 2025 under the Sustainable Investment Sukuk Framework, marks a major step in mobilising domestic green finance. The issuance originally planned at PKR 30 billion but increased to PKR 31.98 billion after being oversubscribed by more than five times, uses an Ijarah structure and is fully tradable on the Pakistan Stock Exchange, attracting retail, institutional, and overseas investors. The proceeds are dedicated to climate aligned infrastructure, including hydropower and water storage projects such as Garuk Dam, Nai Gaj Dam, and the Shagarthang Hydropower Project, all of which support RE expansion and climate resilience. By combining Islamic finance with international sustainable finance standards, the Green Sukuk broadens the investor base, strengthens market confidence, and establishes a long-term mechanism for funding Pakistan's clean-energy and environmental priorities.

Outlook and Priorities (Next 3–5 years)

By 2030–2035, Pakistan is likely to achieve a more diversified and sustainable energy mix, with renewables and hydropower contributing around 50–55%, nuclear 10–15%, and thermal 30–35%, while EV adoption and industrial efficiency measures drive cleaner demand.

To sustain the energy transition, Pakistan must prioritise policy stability, financial reforms, and grid modernisation. Key actions include resolving circular debt, ensuring timely payments to IPPs, and maintaining consistent net-metering and renewable procurement policies to sustain investor confidence. It can leverage CTBCM to foster transparent, competitive electricity procurement and green sukuk, bonds, and SBP refinancing schemes to mobilize domestic capital for renewable projects. Strengthening transmission and distribution networks, particularly the North–South corridor, is critical to integrate utility-scale solar and wind from resource-rich regions like Sindh and Balochistan. Rapid deployment of AMI and grid management tools will help manage two-way flows from rooftop solar, while scaling up EV charging infrastructure and industrial energy-efficiency programs will balance growing demand. Ensuring equitable cost-sharing mechanisms to protect non-solar consumers is also urgent to prevent financial stress on DISCOMs.

Sri Lanka: Energy Transition Scenario

Executive Snapshot

Solar energy dominated Sri Lanka's energy-transition narrative over the year, with developments across policy, capacity additions, and storage. At the centre was the reform of the feed-in tariff (FiT) regime for solar power projects, which triggered widespread debate among energy stakeholders. The revised tariff framework resulted in a 20–40% reduction in rates compared to earlier levels for rooftop, ground-mounted, and floating solar installations.

This decision was challenged in court by a group of solar power generators, who argued that the government had not obtained prior approval of the Public Utilities Commission of Sri Lanka, reflecting industry concern over regulatory process and predictability. Parallel to the legal challenge, a broader debate has emerged over grid absorption capacity, particularly whether system-stability constraints linked to high rooftop solar penetration partly informed the tariff reductions.

These developments happened with record rooftop-solar growth in 2024. The number of rooftop installations increased from 39,827 units at the end of 2023 to 73,050 units at the end of 2024; an increase of 83% during the year, adding approximately 489 MW to installed solar capacity.

In a related move, the State utility called for tenders for 16 battery energy storage systems (BESS) of 10 MW/40 MWh each, totalling 160 MW/640 MWh, on a build-own-operate basis at grid substations, with participation open to both local and foreign investors.

Meanwhile, the construction of Sri Lanka's pioneering battery storage system reached its peak during the year. The 5MW/10.7 MWh system is designed for storing solar energy during the daytime hours and dispatch it during the evening peak demand. This is being closely watched by sector stakeholders as a potential solution to grid-stability challenges arising from higher solar penetration.

Decentralised innovation also drew attention, including a first-of-its-kind 2 MW rooftop solar installation integrated with a poultry farm, developed by young entrepreneurs. Such models combine on-site renewable generation with productive economic use, easing pressure on the grid while supporting local economic activity.

The most recent development in energy transition is the government's interest to include hydrogen in enhancing the utilisation of the RE potential in the country. In September 2025, stakeholder consultation conducted on the draft Renewable Hydrogen Policy was seen as a significant step towards expediting the energy transition.

Comparative Trends Over the Past 2–3 Years

Between 2023 and 2024, Sri Lanka's renewable installed capacity showed a steady increase. According to the state-owned Ceylon Electricity Board (CEB), renewable installed capacity has increased from 2794 MW to 3332 MW over the past three years. While additions stood at 180 MW in 2022 and 130 MW in 2023, capacity growth accelerated sharply in 2024, with an addition of 408 MW.

During the year 2025, a 10 MW solar plant in Baticaloa in the Eastern province and a 5 MW solar plant in Matara of the Southern province have been completed, while three more plants of 25MW, 50 MW and 100 MW in Eastern and Uva provinces are in the pipeline.

During the year, marking an important milestone in the regional energy cooperation, India and Sri Lanka agreed on a joint venture to develop a 150 MW power plant in Trincomalee of the Eastern province of Sri Lanka[52].

For the first time since the 1990s, the CEB announced reaching 70% RE generation during the month of June 2025. It is seen as a significant achievement in clean energy.

Energy Transition Context

According to the CEB, the country's total generation in 2024 stood at 16,802 GWh; an increase of 7.9% over the previous year. The share of renewables [(major hydro and Non-Conventional Renewable Energy (NCRE)] stood at 53% which showed no significant improvement in renewable generation share compared to previous years: 2021-51%, 2022-52%, 2023-50%.

CEB's annual statistical data shows a significant fuel cost reduction in 2024 compared to 2023; it has come down from US$ 0.13/kwh to US$ 0.082/kwh. Amidst this reduction, the country has managed to maintain the 50% share of renewable generation through absorbing power from renewable sources. Notably, electricity exported from rooftop solar systems reached 867 GWh in 2024, a 37% increase over the previous year, underscoring the growing contribution of distributed solar generation.

While Sri Lanka has not managed to phase-out any of the existing fossil fuel-based power plants during 2024, it has made a commitment to not to build new fossil fuel-based power plants. Plans are in place to increase wind and solar energy generation while focusing on energy storage to enhance utilization of RE, especially solar, and has made progress both at ground and policy levels.

Progress toward NDC and net-zero targets

Sri Lanka submitted its third NDC to UNFCCC in September 2025, with significant carbon reduction commitments for the period of 2026-2035, especially in the energy sector. It increased its reduction targets to 12.6% unconditional and 20.89% conditional in the energy sector by 2035. Updated sectoral targets include transport (1.5% unconditional; 3.3% conditional), industry (7.2% unconditional; 5.8% conditional), waste (8.6% unconditional; 12.2% conditional), and agriculture (5.6% unconditional; 4.8% conditional). Apart from enhancing RE contribution, the NDC 3.0 communicates the country's plans to introduce grid-integrated energy storage systems (ESS), such as pumped storage and BESS, to increase absorption of RE and reduce thermal generation as a conditional measure. Conversion of existing fuel oil-based combined cycle power plants to natural gas are among the other measures. Working on improving energy efficiency remains a priority.

Policy and Institutional Landscape

The most significant new development at the policy level is the enactment of the amendment to the Electricity Act 14 in August 2025. This provides the legal basis for unbundling the CEB into three separate

[52] Ing. Büro Hans Thoma. (n.d.). *Sri Lanka solar power: Remarkable growth essential by 2025 - PVknowhow*. PVKnowhow. https://www.pvknowhow.com/news/sri-lanka-solar-power-remarkable-growth-essential-by-2025/

state-owned enterprises to manage electricity generation, transmission and distribution separately. The government is of the view that this can lead to more reliable and affordable power supply while promoting RE production. Some believe this will lead to improved quality of services, while achieving efficiency, accountability and cost transparency in all three operations. However, some concerns were raised by CEB workers unions, private sector, and regulatory bodies on the implementation process of the act.

The new government of Sri Lanka is in its first year in office and making a reasonable effort to improve inter-agency coordination and stakeholder engagement in the government. In particular, the energy sector consultation of general public, private sector and development agencies in policy development and implementation has seen positive changes. The Public Utilities Commission of Sri Lanka (PUCSL) conducted a public consultation on the challenges faced by RE developers in the country. The consultation gathered proposals from the representatives of RE producers, financing institutions, industry associations, government agencies, and consumer representatives to address identified issues that hinder RE development. Similarly, PUCSL also conducted public consultation on the electricity tariff revisions proposed by the state utility CEB in June 2025[53].

In September 2025, the Ministry of Energy, in partnership with the United Nations Development Programme (UNDP) in Sri Lanka, convened a stakeholder consultation workshop on the country's green hydrogen strategy. Consultation was attended by policymakers, representatives from the private sector and financial institutes, academia, and international experts. The Ministry clarified the objective of the consultation was to convert the strategy into action towards creating a green hydrogen economy[54].

Financing Energy Transition

With the support from UNESCAP, the finance ministry of Sri Lanka completed the green and blue bond frameworks in 2023. The frameworks are aligned with the International Capital Market Association (ICMA)-administered Green Bond Principles (GBP) and ASEAN Green Bond Standards (GBS). The government says it plans to raise more than US$ 11 billion by 2030.

Among domestic financial institutions, the Commercial bank of Ceylon managed to issue one round of green bonds raising US$ 50 million and the Development Finance Corporation of Ceylon (DFCC) bank was able to issue one round of green and blue bonds by September 2025. DFCC managed to raise US$ 9.9 million in its debut green bond[55] issue; the blue bond result is yet to be seen. Further DFCC bank has received a loan of US$ 12 million from the Swiss impact investment platform Symbiotics for green investment[56].

Energy Access and Demand Dynamics

Sri Lanka has achieved and continues to maintain 100% electrification of households. With an island wide blackout in February 2025 ('Sunny Sunday' blackout), the reliability of the electricity supply has been questioned by the energy stakeholders. CEB attributed the outage to the high penetration of non-synchronous solar PV generation, which it said increased grid vulnerability. While this explanation remains

[53] PUCSL. (2025, September 17). *PUCSL*. https://www.pucsl.gov.lk/

[54] *Sri Lanka Charts Course For a Renewable Future With Launch of Green Hydrogen Policy, INFF Strategy and Just Energy Transition Study*. (n.d.). [Press release]. https://www.undp.org/srilanka/press-releases/sri-lanka-charts-course-renewable-future-launch-green-hydrogen-policy-inff-strategy-and-just-energy-transition-study

[55] Commercial Bank Issues Rs. 15 b debut Green Bond supported by GGGI. (n.d.). GGGI - Global Green Growth Institute. https://gggi.org/commercial-bank-issues-rs-15-b-debut-green-bond-supported-by-gggi/#:~:text=The%20Commercial%20Bank%20of%20Ceylon%20PLC%20(CBC),for%20sustainable%20financing%20instruments%20in%20Sri%20Lanka.

[56] Tech in Asia. (n.d.). Tech in Asia - Connecting Asia's startup ecosystem. https://www.techinasia.com/news/sri-lankas-dfcc-bank-12m-swiss-loan-green-projects

under debate, steps are now being taken to strengthen system resilience, including grid modernisation measures and the introduction of battery energy storage systems.

Sri Lankan electricity consumers faced a series of tariff increases during the last 3 years and Sri Lanka has the highest household electricity charges in South Asia. As Sri Lanka is under a bail out loan, the IMF is pushing the government to implement electricity cost recovery pricing and the automatic electricity price adjustment mechanism[57].

While the country has not made any significant move towards establishing mini-grids to promote renewables it has maintained its focus on grid modernization with an aim to absorb clean energy more while increasing reliability and reducing cost. In a bid to assist Sri Lanka achieving these targets the World Bank announced US$ 150m program named; "Sri Lanka Power System Reliability and Clean Energy Integration Project". Under this program it is expected to facilitate grid modernization, promote private sector investments, and direct investment on RE generation plants through its International Finance Corporation (IFC). The Multilateral Investment Guarantee Agency (MIGA) of the World Bank is expected to provide political risk insurance to boost the investor confidence[58].

Key Challenges and Barriers

Energy transition has been one of the major commitments made by the country to the international community as submitted in its NDC 3.0. Sri Lanka is reeling with the following: the new government settling in (which means restructuring and changes in erstwhile regulatory frameworks); the ongoing foreign exchange crisis already burdening the economy; need for cutting down on fuel imports to ease the economy; the climate crisis pushing towards cleaner fuels; existing grid constraints requiring investment and modernisation to absorb cleaner fuel transmission eventually easing finances and burden on discoms. All these economic and environmental challenges are urging the government towards aligning development and energy transition.

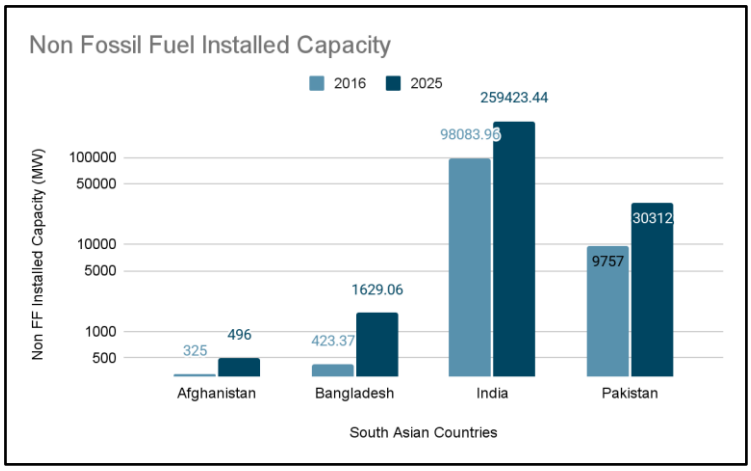
So far during its first-year government has made policy decisions and given cabinet approvals to many RE projects. 100 MW solar plant, hiring consultants for floating solar, 2 more wind power plants totaling 70 MW in the island of Mannar, opening tenders for BESS are among some of the major approvals. However, in November 2025 the cabinet of Sri Lanka decided to halt new wind power projects in Mannar due to pressure from the environmental groups and the local community.

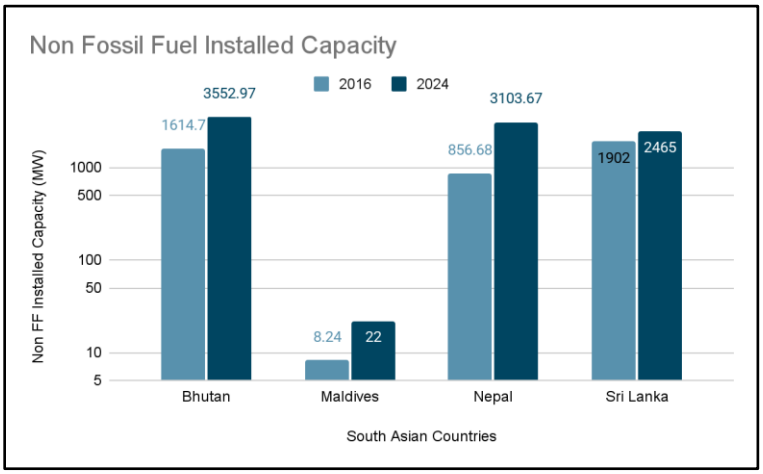
[57] IMF demands Sri Lankan government increase electricity tariff by nearly 20 percent. (2025, June 2). World Socialist Web Site. https://www.wsws.org/en/articles/2025/06/02/ukrx-j02.html

[58] World Bank Group. (2025, June 20). World Bank Group to Support Sri Lanka's Clean Energy Transition with $150 Million Program. World Bank. https://www.worldbank.org/en/news/press-release/2025/06/20/world-bank-group-to-support-sri-lanka-s-clean-energy-transition-with-150-million-program#:~:text=WASHINGTON%2C%20June%2020%2C%202025%E2%80%94,private%20investors%20and%20energy%20producers)

ENERGY TRANSITION PLATFORM
SOUTH ASIA

Comparative Insights and Way forward for the South Asian Region





As a general trend, solar energy has outperformed conventional fuels and emerged as the primary driver of RE growth across much of South Asia, including Bangladesh, India, Nepal, Pakistan, and Sri Lanka. Even in countries where expansion has been slower, such as Afghanistan, Bhutan, and the Maldives, solar power has steadily secured a place in the grid despite differing political and economic contexts. This growth has been enabled through diverse pathways: multilateral bank–funded projects, private sector investment supporting Afghanistan's energy diversification and grid upgrades, Bhutan's political commitment—despite being a carbon-negative country—to reduce reliance on hydropower, and pilot floating solar installations across the Maldivian archipelago to test the feasibility of one-island-one-grid systems. India has been a flagbearer in integrating RE within its power system having seen an exquisite growth of 24 GW in just 2024-25, while in the first 10 months of calendar year 2025, clocked a massive 40 GW growth. Led by solar, while wind tailed a second, the country achieved its NDC of 50% non-fossil capacity five years ahead of the 2030 deadline.

Regional cooperation among countries in South Asia can lead to enhancing energy security, achieving climate goals and unlocking the full potential of energy trade and integration in the region. For example, Himalayan mountainous countries like Bhutan & Nepal have abundant hydropower potential, especially during the summer monsoon months, which can help meet the rising cooling demand in countries like India and Bangladesh. India and Bangladesh are advancing transmission interconnections to facilitate renewable power sharing and balance seasonal demand. Sri Lanka and India have explored HVDC connectivity for future power exchange, especially from renewables.

Despite progress, there are gaps in system integration (DRE or clean energy absorption within the grid), regional coordination and cooperation, financing, standardisation of guidelines, clean energy usage for adaptation, among others. A few way forward approaches are given below:

Way Forward

1. **From Targets to Delivery: Operationalizing the Transition:** South Asian countries have set ambitious RE and decarbonization targets. However, challenge lies in translating these targets into on-the-ground delivery, ensuring that policy ambitions are matched by robust implementation frameworks.
   a) **Develop National and Regional Delivery Roadmaps:** Each country should create actionable, time-bound delivery plans that break down targets into annual milestones, with clear accountability for ministries, utilities, and private sector partners.
   b) **Establish Monitoring and Feedback Loops:** Set up independent monitoring bodies to track progress, identify bottlenecks, and recommend course corrections in real time.
   c) **Prioritize Capacity Building:** Invest in training for regulators, utilities, and local governments to manage new technologies, procurement models, and regulatory frameworks.

2. **System Integration: Managing Complexity and Reliability:** As renewables, especially DRE, scale up, grid integration and system stability are emerging as critical challenges. Issues include intermittency, lack of storage, and grid congestion.
   a) **Accelerate Grid Modernization:** Invest in smart grids, advanced metering, and digital control systems to enable two-way power flows and real-time balancing.
   b) **Promote Flexible Resources:** Scale up storage (batteries, pumped hydro), demand response, and peaking capacity to manage variability.
   c) **Regional Grid Codes and Standards:** Harmonize technical standards and grid codes across countries to facilitate cross-border power flows and system resilience.

3. **Distributed Renewables: Balancing Growth and System Health:** DRE is growing rapidly, especially rooftop solar, but its uncoordinated expansion can destabilize utility finances and grid operations.
   a) **Integrate DRE into Grid Planning:** Require utilities to include DRE forecasts in their network expansion and investment plans.
   b) **Reform Tariff and Incentive Structures:** Design tariffs that reflect the true value of distributed generation, including grid services and avoided costs, while ensuring fair cost-sharing among all consumers.
   c) **Support Utility Business Model Innovation:** Encourage utilities to evolve from traditional supply roles to become “platform operators” that enable and manage distributed resources.

4. **Clean Energy for Development: Linking to Socio-Economic Goals:** Clean energy is often framed as a climate or technology issue, but its greatest value lies in supporting affordability, resilience, and productivity—especially for cooling, agriculture, MSMEs, and urban services.
   a) **Targeted Deployment:** Prioritize renewables for sectors with high development impact—such as solar for cold storage in agriculture, or mini-grids for MSMEs.
   b) **Cross-Sectoral Coordination:** Align energy transition plans with national strategies for health, education, and urban development to maximize co-benefits.

c) **Inclusive Policy Design:** Ensure that policies address the needs of vulnerable groups, including women, rural communities, and informal sector workers.

5. **Institutions Over Infrastructure: Building the Foundations:** While infrastructure investment is essential, the report emphasizes that institutional capacity—regulatory, financial, and technical—is the true enabler of sustainable energy transition.
   a) **Strengthen Regulatory Agencies:** Equip regulators with the authority, skills, and resources to oversee complex, evolving energy markets.
   b) **Foster Regional Knowledge Sharing:** Create platforms for peer learning, joint R&D, and exchange of best practices across South Asia.
   c) **Promote Transparent, Predictable Policy Environments:** Reduce regulatory uncertainty to attract long-term private investment.

6. **Financing and Technology Transfer: Closing the Gaps:** Private investment is rising, but access to concessional finance, grants, and technology transfer remains uneven, especially for smaller economies and riskier projects.
   a) **Establish Regional De-Risking Facilities:** Pool resources to provide guarantees, insurance, and concessional loans for cross-border and high-impact projects.
   b) **Leverage Regional Manufacturing Hubs:** Build on India's solar manufacturing ecosystem to develop supply chains and skills in neighbouring countries.
   c) **Promote Joint Technology Platforms:** Collaborate on R&D for storage, green hydrogen, and EVs, with shared standards and pilot projects.

7. **Regional Power Trade: Unlocking Collective Benefits:** Regional power trade is evolving, with India, Nepal, Bhutan, and Bangladesh making progress on bilateral and trilateral deals. However, trade volumes remain limited by infrastructure, regulatory, and political barriers. Regional platforms such as SAARC and BIMSTEC have also contributed to dialogue and technical cooperation, but their overall impact on energy integration has been limited. To be more effective, these platforms will need stronger political backing, clearer implementation structures, and a shift toward project-driven collaboration.
   a) **Expand Cross-Border Infrastructure:** Prioritize HVDC corridors and interconnections, supported by joint investment and cost-sharing agreements.
   b) **Standardize Contracts and Procedures:** Develop model PPAs, wheeling agreements, and dispute resolution mechanisms to reduce transaction costs and risks.
   c) **Strengthen Regional Institutions:** Empower a regional secretariat to coordinate planning, investment, and policy alignment, ensuring that trade benefits are equitably shared.

8. **Regional Secretariat: Driving Collective Action:**
   a) **Develop Standardized Model Documents:** For PPAs, wheeling, and grid codes to streamline cross-border projects.
   b) **Coordinate a Regional Transmission Masterplan:** Identify priority corridors and investment needs, ensuring interoperability.
   c) **Establish Blended Finance Platforms:** Mobilize private capital for large-scale and cross-border renewables.
   d) **Design a Regional Manufacturing and Skills Roadmap:** Link manufacturing strengths with workforce development and service markets across the region.

A successful energy transition in South Asia requires a decisive shift from setting targets to building robust delivery systems, with a strong emphasis on system integration, regional cooperation, institutional capacity, and inclusive finance. By operationalizing these recommendations, South Asia can move from ambition to action—delivering affordable, resilient, and productive clean energy for all.