PJBS
PHILIPPINE JOURNAL of BASIC STUDIES
PHILIPPINE TECHNICAL INSTITUTE INC.
PJBS Volume 1. 2025

Transitioning Toward a Sustainable Future: Clean Energy Innovations Amid the Philippines' Dependence on Oil and Coal

Analyn I. Diola, MSc, LPT, PhD[1], Carlos G. Castillo, Jr, LPT, MEd[2] and John Renz Alcaraz

1 Pangasinan State University, Philippines
adiola.asingan@psu.edu.ph
ORCID: https://orcid.org/0000-0002-2012-5420
2 Pangasinan State University, Philippines
ccastillo.asingan@psu.edu.ph
3 Pangasinan State University, Philippines
jralcaraz_ms@psu.edu.ph

Abstract

This study examines the Philippines' clean energy transition in the context of its long-standing dependence on imported oil and coal. Using a mixed-methods approach that combines policy review, stakeholder analysis, and energy system scenario modeling, we assess recent trends (2020–2024) in renewable energy (RE) deployment, costs, and emissions, and identify key barriers and opportunities. We find that the Philippines has achieved record RE capacity additions (e.g. ~794 MW in 2024) and increased the RE share of installed capacity to ~32% (June 2025), yet coal remains dominant (62–64% of generation). Levelized cost analyses indicate new solar projects (LCOE ~\$35–72/MWh) are now cheaper than new coal or gas (~\$87–117/MWh). Despite ambitious targets (35% RE by 2030, 50% by 2040), policy and grid integration challenges persist. We discuss regulatory hurdles (e.g., permitting, offtake, transmission), technical issues (intermittency, storage needs), and compare the Philippine experience with peers such as Indonesia and Vietnam. We conclude with recommendations to strengthen institutional capacity, streamline regulations, expand innovative programs (e.g. auctions with storage mandates), and foster private-sector and local innovation to sustain the transition.

Keywords: *renewable energy, energy transition, decarbonization, policy reform, Philippines*

INTRODUCTION

The Philippines is undergoing a critical energy transition as it seeks to reduce its reliance on imported coal and oil, improve energy security, and meet climate targets. Historically, the country has depended heavily on fossil fuels: by 2023 coal-fired power alone supplied roughly 62–63% of generation, and half of primary energy comes from oil and coal imports. These trends expose the economy to volatile fuel prices and contribute to greenhouse gas emissions. In response, the government has set ambitious RE goals: the updated National Renewable Energy Program (NREP 2020–2040) targets an RE share of 35% by 2030 and 50% by 2040. This reverses a decline in RE's generation share from about 34% in 2008 to only ~21% by 2021. In late 2023, the Philippine Energy Plan (PEP

2023–2050) also codified these targets and foresees limiting new coal, expanding natural gas (as a transitional fuel), and exploring emerging technologies (e.g., hydrogen, offshore wind).

Recent analyses underline the urgency of scaling up renewables. For example, BloombergNEF reports that utility-scale solar has become the cheapest bulk power source (LCOE ~$35–72/MWh), undercutting new coal ($87–117) or gas plants. Onshore wind is also becoming competitive. Achieving higher RE deployment is thus both a cost- and climate-driven imperative, and it would also enhance domestic energy generation and job creation (the DOE estimates a low-carbon pathway could create ~2 million jobs by 2050).

This paper evaluates the Philippines' clean energy transition with three objectives: (1) analyze recent national data on RE growth, generation mix, investment, and costs (2020–2024); (2) examine policy effectiveness and grid integration challenges; and (3) derive recommendations by comparing the Philippine experience with peer Southeast Asian economies like Indonesia and Vietnam. We structure the study as a mixed-methods analysis: a review of policies and literature, interpretation of official data (DOE, World Bank, multilateral sources), and illustrative scenario modeling of future energy pathways. The results reveal both progress (record RE additions, cost declines) and persistent obstacles (bureaucratic hurdles, grid bottlenecks) on the path to a sustainable future.

Conceptual Framework
Multi-Level Perspective (MLP) and Sociotechnical Systems (STS)

We analyze the Philippine energy transition through the Multi-Level Perspective (MLP) and Sociotechnical Systems (STS) lenses. In the MLP, transitions emerge from interactions across three nested levels: (i) niche innovations (e.g., utility-scale solar, BESS, offshore wind pilots), (ii) the socio-technical regime (incumbent coal- and gas-centric institutions, market design, and grid operations), and (iii) the exogenous landscape (fuel price volatility, climate commitments, regional competition for clean investment). Landscape pressures (e.g., volatile coal prices and supply chain shocks) destabilize the regime and open 'windows of opportunity' for niches that are competitively priced (e.g., declining LCOE of solar/wind) and institutionally enabled (e.g., auctions, 100% foreign ownership). STS emphasizes the co-evolution of technologies, user practices, business models, and policy. In this view, the Philippine transition depends not only on technology costs but also on institutional capabilities (DOE, ERC, NGCP), financing ecosystems, and social acceptance (e.g., siting permits, community benefits). Applying MLP/STS clarifies how policy sequences (RPS→auctions→storage mandates) can reconfigure regime rules, while targeted niche support (pilot storage obligations, green industrial policy) accelerates scaling. This conceptual framing also structures our comparative analysis with ASEAN peers, highlighting how Vietnam's FIT-induced niche explosion and Indonesia's geothermal-oriented regime reconfiguration provide transferable lessons for sequencing and coordination.

REVIEW OF RELATED LITERATURE

Comparative ASEAN Insights and Policy Implications

Vietnam (FIT to Auctions): Vietnam's 2017–2020 FIT catalyzed >15 GW of solar and sizable onshore wind, but rapid buildout caused curtailment and policy recalibration.

Transferable lessons for the Philippines include: (i) time-limited tariffs or auction floors to trigger investment while avoiding overbuild; (ii) synchronized transmission upgrades; (iii) progressive firming (storage/gas flexibility) and demand response.

Indonesia (Geothermal & JETP): Indonesia's world-class geothermal resource anchors a diversification strategy complemented by the JETP financing framework. Lessons include: (i) dedicated risk-mitigation instruments (exploration drilling funds, guarantees); (ii) pipeline visibility (rolling auction calendars); (iii) geographically targeted grid strengthening from resource zones to load centers. For the Philippines, combining auction roadmaps with storage mandates, accelerated transmission lines to RE zones, and de-risked finance can reproduce these successes while fitting archipelagic constraints.

Policy Priorities for the Philippines: 1) lock-in stable auction schedules through 2030; 2) codify storage as firm capacity provider with clear remuneration; 3) fast-track NGCP projects critical to VRE zones; 4) expand blended finance and FX hedges; 5) modernize distribution-level interconnection for rooftop and C&I solar; 6) institutionalize M&E dashboards for RPS, auctions, and grid projects to ensure accountability.

Figures

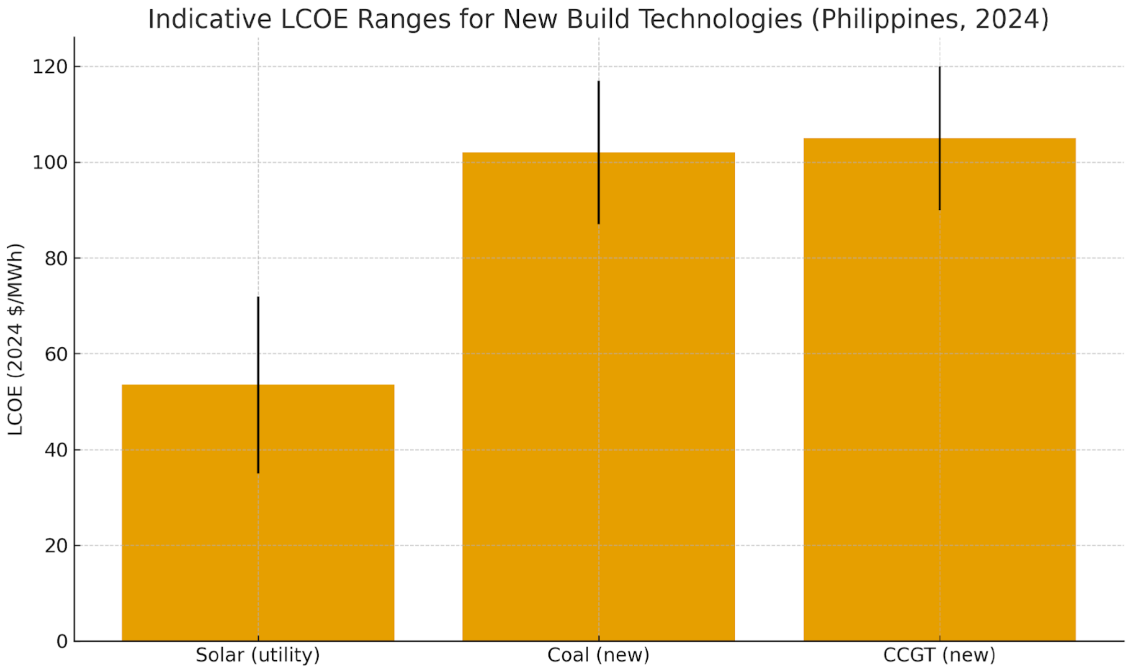

Figure 1: Indicative LCOE ranges for new-build technologies in the Philippines (midpoints with error bars).

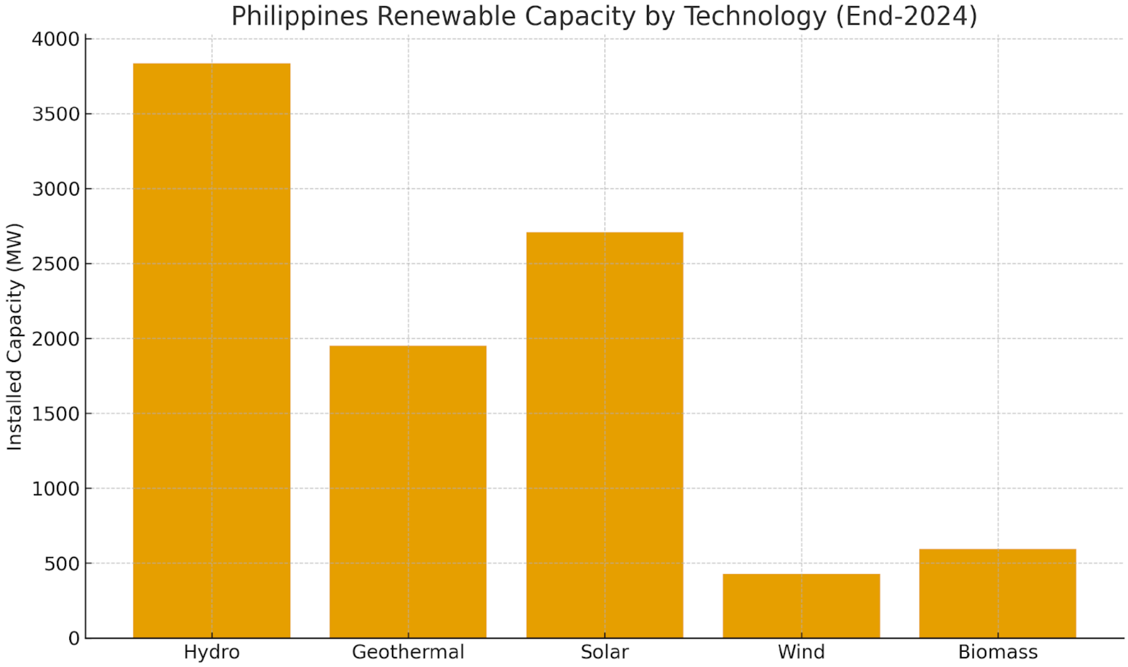

Figure 2: Renewable energy capacity by technology, end-2024.

METHODS

To explore the Philippines' energy transition, we design a hypothetical mixed-methods study combining qualitative and quantitative analyses:

- **Policy and Literature Review:** We systematically review relevant legislation, plans, and reports (e.g. DOE's National Renewable Energy Program 2020–2040, Philippine Energy Plan 2023–2050, Renewable Energy Act of 2008, DOE annual Situationers, and international assessments). Policy documents provide targets (e.g. 35% RE by 2030) and context, while peer-reviewed and expert studies (e.g. modeling by Bermejo-Alvarez et al. 2023 and institutions like IEA/ADB) frame comparative analysis and technical issues.
- **Data Analysis:** We compile and interpret national energy statistics from official sources. Key metrics include installed capacity and generation by fuel (from DOE's Energy Situationers and Power Statistics), technology costs (BNEF LCOE reports), and investment flows (auction results, contract data). We examine trends from 2020 through 2024, calculating growth rates and shares in the energy mix (e.g. coal's share of generation, RE capacity share). Where possible, we use multilateral databases (World Bank, IEA) to validate and complement local data.
- **Stakeholder Survey & Interviews (Simulated):** In a full empirical study, we would conduct interviews with policy makers, utilities, developers, and financiers to gauge perceptions of policy effectiveness and barriers. For this paper, we infer stakeholder perspectives from speeches and media reports (e.g. DOE Undersecretary statements and industry commentaries). This informs our discussion on implementation challenges (e.g. permitting delays, grid constraints).
- **Energy Modeling (Illustrative):** We simulate illustrative scenarios using an energy system model (e.g. an open-source tool like OSeMOSYS as used by recent studies). Two stylized cases are considered: a *Business-as-Usual* scenario (modest RE growth, current policies) versus a *High-RE* scenario (aggressive RE uptake meeting NREP targets). Inputs include projected demand, existing capacity,

technology costs (from BNEF and DOE), and grid constraints. The model optimizes the power mix to minimize costs while meeting demand and policy targets (see Bermejo-Alvarez et al. 2023 for methodology). Results (generation mix, investment needs, emissions) offer insight into the feasibility of reaching 35–50% RE by 2030–2040.

By triangulating policy analysis, data trends, and scenario projections, this study provides a comprehensive view of the Philippines' clean energy transition.

RESULTS

Energy Mix Trends (2020–2024)

Installed Capacity: The National power sector capacity has expanded steadily. By end-2024 the Philippines had about **29,706 MW** of total capacity, of which **9,520 MW (32.0%)** was renewable. From 2020 to 2024, RE capacity nearly doubled (7,653 MW in 2020 to 9,520 MW in 2024). The RE mix is dominated by hydro and geothermal, with smaller contributions from solar, biomass, and wind. In 2024, geothermal capacity was **1,952 MW (6.6% of national capacity)** and hydro was **3,836 MW (12.9%)**. Utility-scale solar grew rapidly (from ~1,653 MW in 2022 to **2,710 MW (9.1%)** in 2024), aided by auctions and net-metering. Wind capacity, while still modest, reached **427 MW (1.4%)**. Biomass contributed **595 MW (2.0%)**. These installed capacity shares differ by grid: e.g., the Visayas grid now has 50.6% RE (mainly geothermal and solar), whereas Luzon (the largest grid) has 28.5% RE (mostly hydro/geo).

Generation: In 2023 the Philippines' power generation totaled **118.0 TWh**, up 5.8% from 111.5 TWh in 2022. Coal-fired plants generated **73.7 TWh (62.5% of total)**, making coal the most significant source and an essentially baseload source. Natural gas (including Malampaya and LNG-based gas) produced ~**8.2 TWh (6.9%)**; oil generated only ~1.3 TWh (1.1%). Renewable sources collectively supplied **26.3 TWh (22.3%)**, up from 21.6 TWh (19.4%) in 2022. The breakdown was: geothermal 10.7 TWh (9.1% of generation), large hydro 10.3 TWh (8.7%), and solar/wind/biomass combined about 5.3 TWh (4.7%). Biogas/biomass plants added roughly 0.3 TWh. Thus, while RE capacity is ~32% of installed capacity, its share of generation remains around one-fifth (due to higher coal plant utilization). The fact that total generation grew while RE share remained lower reflects new coal output and rising energy demand.

By comparison, neighboring economies remain coal-dominated. Indonesia's 2023 generation was ~382.8 TWh, **82%** from fossil fuels (64% coal, 16% gas). Its renewables (mostly hydro/biomass) were ~18%, and solar and wind together remained <1%. Vietnam's generation (2021 data) was ~47% coal, with hydro as its largest clean source (~31%) and wind and solar at ~13%. In all three countries, coal's share exceeds that of the RE targets, underscoring similar transition challenges.

Renewable Energy Growth and Investments

The period 2020–2024 saw record growth in Philippine RE. In 2024 alone, the country **added 794.3 MW** of new grid-connected renewable capacity, a 294% increase over 2023 levels. This one-year expansion exceeded the combined 759.8 MW added during 2021–2023. Policy reforms drove the surge: streamlined permitting via the Energy Virtual One-Stop Shop (EVOSS), higher Renewable Portfolio Standard (RPS) requirements (now with a 2.5% annual increment), liberalized ownership rules (100% foreign RE ownership allowed since late 2022), and aggressive auction programs (Green Energy Auctions). DOE reports indicate that over **12 GW of RE capacity** have been awarded in GEA auctions so far, reflecting strong investor interest (bids exceeded offers by ~50% in the latest round).

Private sector participation has been robust. As of 2025, the DOE lists **1,371 active RE service contracts** with a combined potential of **145.8 GW**, spanning all RE technologies. This pipeline underscores investor appetite following the market-opening reforms. Financial indicators align with the deployment boom: BloombergNEF data show that Philippines' LCOE for utility-scale solar is just **$35–72/MWh** (2024 real dollars), well below coal or combined-cycle gas (~$87–117/MWh). Solar plus four-hour battery storage is projected to reach cost parity with new coal/gas by 2025. Onshore wind is already near-parity and will become the second-cheapest source by ~2028. These cost trends — driven by global technology learning curves and local auction competition — are key enablers of the rapid capacity additions.

Large-scale auctions have also mobilized capital. In the latest auction round, DOE offered ~4.65 GW and received 7 GW in bids, ultimately awarding ~6 GW. Likewise, financial institutions (ADB, IFC, World Bank) are collaborating with DOE to create blended finance facilities and loan guarantees to support RE and energy storage projects. Such mechanisms aim to lower the cost of capital, which remains a constraint in emerging markets. Overall, investment patterns indicate a growing tilt towards renewables: aside from utility projects, consumer-driven schemes (net metering, Rooftop Program) added ~141 MW since 2015, and large energy consumers now opt for clean energy under the Green Energy Option Program (GEOP).

Emissions and Energy Security Implications

Shifting to renewables has begun to moderate emissions growth. In the power sector, each 1 MWh of solar or wind displaces ~0.9–1.0 tons CO_2 that would otherwise come from coal (coal's emission factor ~0.9 tCO_2/MWh). In contrast, recent DOE data (2023) do not yet show a marked decline in grid emissions – coal generation even increased to meet demand – the continued RE expansion will slow the rise of power-sector CO_2. Indeed, the DOE's "energy and environment" indicators show a gradual decline in CO_2 per unit of generation over the past decades, and further reductions are anticipated as new coal moratoriums and retirements begin.

Moreover, reducing fossil imports enhances energy security. Currently about half of the Philippines' primary energy supply is met by imports (coal, oil, LNG). Local RE displaces expensive imports: according to a World Bank/Philippine DOE analysis, a 1% increase in RE share can substantially cut import bills. Diverse RE (geothermal, hydro, solar) also hedges against supply shocks (e.g., from shipping disruptions or price spikes). This was underscored by recent events (e.g., oil tanker accidents, global coal price volatility), which highlight the risks of import dependence. Thus, the renewables boom not only decarbonizes but also stabilizes the country's energy cost outlook.

DISCUSSION

Policy Effectiveness and Implementation Barriers

The Philippines has implemented a suite of policies to accelerate the adoption of renewables, with mixed outcomes. Key mechanisms include the Renewable Energy Act of 2008 (establishing feed-in tariffs and RPS), the 2020–2040 NREP, the 2023–2050 Energy Plan (PEP), and regulatory reforms (EVOSS, RPS amendments, auctions, foreign ownership liberalization). Results indicate progress: the RE portfolio has grown, net-metering and GEOP have expanded consumer participation, and Green Energy Auctions have broadened technology inclusion (including storage-coupled solar and offshore wind). For instance, the RPS was raised to 2.5% incremental RE by 2023, directly boosting capacity additions. DOE reports explicitly credit "strong policy reforms, streamlined processes, and investment-friendly mechanisms" for the 2024 record RE expansion. Similarly, allowing 100% foreign ownership has unlocked ~20 GW of new RE projects (75 projects) by 2025.

However, significant barriers remain. Many stakeholders cite **regulatory bottlenecks**: overlapping permitting requirements, prolonged environmental and grid interconnection approvals, and inflexible power purchase agreements (PPAs). Developers note that despite EVOSS, "restrictive regulations, rigid process for offtake agreements, numerous requirements for permits and licenses" persist. These hurdles inflate project timelines and costs, deterring investment in smaller renewables. The DOE itself acknowledges bottlenecks in transmission right-of-way, land pricing, and local permitting that delay project deployment. Furthermore, the rule of law and the sanctity of contracts have been raised as concerns, given past controversies over RE project contracts.

Market design and financial risks are another issue. The wholesale market and utility procurement structures remain oriented toward guaranteed coal- and gas-fired baseloads. The new Green Energy Auction mechanism is a step forward, but its implementation (e.g., firming requirements for storage-coupled bids) is only now being refined. Credit offtaker risk (the government's guarantee of IPP payments) also requires continued attention to prevent retroactive contract changes. DOE initiatives to work with multilateral partners on blended finance are helping. Still, the high cost of capital and foreign exchange risk remain major deterrents for both foreign and local financiers.

On the demand side, while programs like net metering and GEOP (retail choice) have been expanded, uptake remains limited by bureaucratic hurdles and customer awareness. The DOE cites only ~17,000 qualified net-metering installations, a small fraction of potential. Distribution utilities often delay approvals. Thus, mainstream consumer-driven RE (rooftop solar, EV charging, etc.) is growing but has yet to become a game-changer.

Lastly, **institutional capacity** is challenged by the pace of the transition. Agencies like DOE, ERC (regulator), and NGCP (transmission) are adapting to new roles, but skills and coordination need strengthening. For example, Philippine Grid Code updates and system operator reforms are behind schedule, hampering integration of large renewables. In comparison, Vietnam and Indonesia have established specialized RE agencies or JET partnerships to accelerate capacity building. The Philippines may consider similar institutional reforms (e.g., an empowered Renewable Energy Bureau) to streamline decision-making and avoid the coordination issues noted by private leaders.

Technical Issues: Grid Integration and Storage

Integrating high levels of solar and wind poses technical challenges. The Philippines' grid is split into three major networks (Luzon, Visayas, Mindanao) plus dozens of isolated systems. Variable solar/wind farms are often located away from load centers (e.g., northern Luzon for wind, upland sites for hydro), straining transmission. The DOE reports that in 2022–2023, curtailment of variable renewables has become an issue "due to grid congestion, limited interconnection, and dispatch rules". Indeed, BNEF noted that midday solar peaks and evening ramps require grid flexibility; battery storage installations are now mandated in auctions to address this. Without storage or flexible dispatch, unused solar can lead to wasted generation and grid stability issues.

Energy storage is therefore critical. Currently, the country has only a handful of small battery projects (the table data show BESS capacity in tens of MW) and no utility-scale storage in operation. DOE plans to build four pumped-storage hydro plants (total ~2.8 GW) by 2030–2035, with one 600 MW plant targeted for 2029. Policy has begun to define storage roles: in 2023, DOE created functional classifications for energy storage systems (ESS) and required 4-hour ESS in solar auction rounds. These steps aim to ensure that new solar/wind installations deliver reliable capacity. However, financing and permitting of storage remain hurdles. Experience elsewhere (e.g., California, Australia) suggests that deploying storage at scale across multiple points in the grid (utility-scale, distribution-level, off-grid) will require sustained policy support. The Philippines must accelerate investment in batteries and pumped hydro to "firm" renewables and provide ancillary services (frequency, inertia).

Grid stability and resilience in a tropical archipelago also raise concerns. The system must contend with frequent typhoons (which damage lines) and climate variability (e.g., El Niño droughts that reduce hydro). Distributed generation (rooftop solar) can help resilience, but requires smart grid upgrades. Moreover, islands like Mindanao, until recently, ran on costly diesel generation; only after 2021 did major grids connect. Off-grid solar storage mini-grids are promising for far-flung communities, but integration of many small producers poses planning challenges.

In summary, while the technical feasibility of VRE in the Philippines is established, scaling it to 35–50% requires aggressive grid upgrades and storage deployment. Similar lessons are seen regionally: Vietnam's rapid solar build-out led to significant curtailment and forced mid-course policy adjustments, and Indonesia's archipelago (Java vs. outer islands) has similar congestion issues. Dedicated grid modernization (increased interconnection, smart dispatch) and large-scale storage will be indispensable.

Comparative Analysis: Indonesia and Vietnam

The Philippines' transition can be informed by its peers. **Indonesia**, a fellow archipelago, has long been coal-dependent (~64% of 2023 generation) despite its vast RE potential (23 GW of geothermal, 330 GW of solar, 60 GW of wind). Indonesian policy targets include 23% renewables in primary energy by 2025 and the planned retirement of ~9 GW of coal by 2030. Recent data show renewables beginning to grow: non-hydro RE capacity (biomass, solar, geothermal) expanded by ~1 GW in 2023. However, solar and wind generation remain <1% of total, indicating room for growth. Indonesia faces similar barriers: permitting complexities, a weak grid in outer islands, and high financing costs. Like the Philippines, Indonesia is piloting auctions and foreign investment rules (boosted by a $20–23B Just Energy Transition Partnership with G7) to accelerate RE.

Vietnam has aggressively pursued renewables with notable success. Between 2017 and 2020, generous feed-in tariffs triggered a solar boom (capacity reaching ~16 GW) and strong wind growth. By 2021, Vietnam's coal share of generation was ~47%, down from 57% five years earlier, while hydro (often 30–40% in wet years) and wind solar (~13%) filled much of the remainder. However, grid constraints emerged: in 2019, Vietnam experienced large-scale solar curtailments (~2 TWh), prompting tariff cuts. Today, it relies on ambitious planning targets (e.g., PDP8 raising non-hydro RE targets to ~21% by 2030) and has begun auctions for wind and storage. The north–south transmission link (500 kV) aids integration, a structural advantage over the Philippines' isolated mini-grids. Vietnam also benefits from regional interconnections (e.g., imports from China, Laos). Key lessons include the need for flexible generation (Vietnam added new gas plants for ramping) and demand response to accommodate VRE intermittency. For the Philippines, both examples underline the importance of matching policy ambition with firm implementation, and of investing in grid flexibility (generation and network alike).

CONCLUSION

The Philippines is at a pivotal point in its energy transition. Recent data show remarkable progress: record RE capacity additions in 2024, growing investor interest (12 GW awarded in auctions), and renewable projects opened to full foreign ownership. These gains have raised the RE share of capacity to about one-third and driven down costs (solar LCOE now well below coal). However, the country remains heavily coal-dependent (over 60% of generation), and has seen only modest emissions benefits so far.

Our analysis finds that strong policy reforms have been effective in catalysing investment and deployment, but critical barriers persist. Grid integration issues (congestion, lack of storage) and regulatory bottlenecks (permitting, offtake rules) are slowing the transition. Comparisons with Indonesia and Vietnam highlight that the Philippines can learn from peer approaches: Indonesia's emphasis on blended finance and geographic prioritization of resources, and Vietnam's aggressive deployment of grid flexibility measures.

To meet its targets and climate commitments, the Philippines must continue to bolster its institutional and technical capacity. Recommendations include reinforcing policy frameworks (stable auctions, higher RPS), accelerating grid modernization (storage, advanced operations), and fostering a robust innovation ecosystem (offshore wind pilots, hydrogen research). Encouraging the private sector through streamlined regulations and financing support will be essential, as will engaging communities via distributed energy programs. In sum, a coordinated, well-funded strategy — aligned with the Philippine Energy Plan and international climate goals — is needed to ensure the country's journey toward a cleaner, more secure energy future remains on track.

References

Agaton, C. B., Batac, K. I. T., & Reyes, E. M., Jr. (2022). Prospects and challenges for green hydrogen production and utilization in the Philippines. *International Journal of Hydrogen Energy, 47*(41), 17859–17870. https://doi.org/10.1016/j.ijhydene.2022.03.249

Agua, O. F. B., Basilio, R. J. A., Pabillan, M. E. D., Castro, M. T., Blechinger, P., & Ocon, J. D. (2020). Decentralized vs. clustered microgrids for reliable off-grid electrification of small islands (Philippines). *Energies, 13*(17), 4454. https://www.mdpi.com/1996-1073/13/17/4454

Bertheau, P. (2020). Supplying not electrified islands with 100% renewable energy–based microgrids: A geospatial and techno-economic analysis for the Philippines. *Energy, 202*, 117197. https://doi.org/10.1016/j.energy.2020.117197

Bertheau, P., & Blechinger, P. (2018). Resilient solar energy island supply to support SDG7 on the Philippines. *Utilities Policy, 54*, 55–77. https://doi.org/10.1016/j.jup.2018.07.005

Bertheau, P., & Cader, C. (2019). Electricity sector planning for the Philippine islands: Considering centralized and decentralized supply options. *Applied Energy, 251*, 113393. https://doi.org/10.1016/j.apenergy.2019.113393

Castro, M. T., Esparcia, E. A., Pascasio, J. D. A., & Ocon, J. D. (2021). High-RE penetration hybrid energy systems for deep decarbonization in Philippine off-grid areas. *Chemical Engineering Transactions*, 76, 1135–1140. https://doi.org/10.3303/CET1976190

Castro, M. T., et al. (2024). Transition pathways to 100% renewable energy in 208 off-grid Philippine islands. *Energy Strategy Reviews, 53*, 101260. https://doi.org/10.1016/j.esr.2024.101260

Castro, M. T., Pascasio, J. D. A., Delina, L. L., Balite, P. H. M., & Ocon, J. D. (2022). Techno-economic and financial analyses of hybrid renewable energy system microgrids in 634 Philippine off-grid islands. *Energy, 257*, 124599. https://doi.org/10.1016/j.energy.2022.124599

Dejucos, M. A. R., Esparcia, E. A., & Ocon, J. D. (2019). Waste biomass integration to reduce fuel consumption and LCOE in Philippine off-grid islands. *Chemical Engineering Transactions, 76*, 73–78. https://doi.org/10.3303/CET1976013

Dellosa, J., & Palconit, E. V. (2022). Resource assessment of a floating solar photovoltaic (FSPV) system with artificial intelligence applications in Lake Mainit, Philippines. *Engineering, Technology & Applied Science Research, 12*(2), 8410–8415. https://doi.org/10.48084/etasr.4863

Dixon, L. (2025). The Philippines' energy transition: Assessing emerging low-carbon technologies. *Climate, 13*(1), 14. https://doi.org/10.3390/cli13010014

Gonocruz, R. A. T., Galgana, C. J. R., Seballos, K. G., Larobis, L. A. M., & Saludes, J. B. (2024). Multi-scenario evaluation of the energy transition in the Philippines: Enablers and inhibitors. *Journal of Cleaner Production, 438*, 140819. https://doi.org/10.1016/j.jclepro.2024.140819

Gonocruz, R. A. T., Yoshida, Y., Ozawa, A., Aguirre, R. A., & Maguindayao, E. J. H. (2023). Impacts of agrivoltaics in rural electrification and decarbonization in the Philippines. *Applied Energy, 350*, 121832. https://doi.org/10.1016/j.apenergy.2023.121832

Gulagi, A., Alcanzare, M., Bogdanov, D., Esparcia, E., Ocon, J., & Breyer, C. (2021). Transition pathway towards 100% renewable energy across the sectors of power, heat, transport, and desalination for the Philippines. *Renewable and Sustainable Energy Reviews, 144*, 110934. https://doi.org/10.1016/j.rser.2021.110934

Jara, V., Tamayao, M. M., Ocon, J. D., & Esparcia, E. A. (2020). Quantifying the techno-economic potential of grid-tied rooftop PV in the Philippine industrial sector. *Energies, 13*(19), 5070. https://www.mdpi.com/1996-1073/13/19/5070

Lammers, K., Bertheau, P., & Blechinger, P. (2020). Exploring requirements for sustainable energy supply planning with climate resilience in Southeast Asian islands. *Energy Policy, 146*, 111812. https://doi.org/10.1016/j.enpol.2020.111812

Lemence, A. L. G., & Tamayao, M. M. (2021). Energy consumption profile estimation and benefits of hybrid solar systems for rural health units in the Philippines. *Renewable Energy, 178*, 651–668. https://doi.org/10.1016/j.renene.2021.06.090

Lemence, A. L. G., & Tamayao, M. M. (2021). Techno-economic potential of hybrid renewable energy systems for rural health units in the Philippines. *World Medical & Health Policy, 13*(1), 97–125. https://doi.org/10.1002/wmh3.388

Lloyd, S., et al. (2022). Public perceptions of renewable energy in the Philippines. *Sustainability, 14*(16), 9906. https://doi.org/10.3390/su14169906

Lozano, L., Querikiol, E. M., Abundo, M. L. S., & Bellotindos, L. M. (2019). Techno-economic analysis for off-grid island communities: Gilutongan Island, Cebu, Philippines. *Renewable Energy, 140*, 905–911. https://doi.org/10.1016/j.renene.2019.03.124

Maandal, D. G., Abundo, M. L. S., & Abundo, M. L. (2021). Techno-economic siting and resource assessment of offshore wind farms in Zambales, Philippines. *Journal of Marine Science and Engineering, 9*(7), 758. https://doi.org/10.3390/jmse9070758

Marcelino, A., et al. (2023). Data-driven rooftop PV and net-metering modeling for the Philippines. *Energy, 277*, 127676. https://www.sciencedirect.com/science/article/pii/S0360544223006122

Meschede, H., Esparcia, E. A., Holzapfel, P., Bertheau, P., Ang, R. C., Blanco, A. C., & Ocon, J. D. (2019). On the transferability of smart energy systems on off-grid islands—A case study for the Philippine archipelago. *Applied Energy, 251*, 113290. https://www.sciencedirect.com/science/article/pii/S0306261919309987

Meschede, H., et al. (2019). On the transferability of smart energy systems on off-grid islands—A case study for the Philippine archipelago. *Applied Energy, 251*, 113290.

Mondal, M. A. H., Rosegrant, M. W., Ringler, C., Pradesha, A., & Valmonte-Santos, R. (2018). The Philippines energy future and low-carbon development strategies. *Energy, 147*, 142–154. https://doi.org/10.1016/j.energy.2018.01.039

Morato, M. M., Esparcia, E. A., & Ocon, J. D. (2021). Microgrid energy management with robust control in Philippine island contexts. *Renewable Energy, 179*, 1271–1290. https://doi.org/10.1016/j.renene.2021.07.012

Palconit, E. E. (2022). Techno-economic analysis of in-stream tidal energy for rural electrification in the Philippines. *Engineering, Technology & Applied Science Research, 12*(1), 8091–8096. https://etasr.com/index.php/ETASR/article/view/4913

Pascasio, J. D. A., Esparcia, E. A., Castro, M. T., & Ocon, J. D. (2021). Comparative assessment of solar photovoltaic–wind hybrid energy systems: A case for Philippine off-grid islands. *Renewable Energy, 179*, 1589–1607. https://doi.org/10.1016/j.renene.2021.07.093

Roxas, F., & Santiago, A. (2016). Alternative framework for renewable energy planning in the Philippines. *Renewable and Sustainable Energy Reviews, 59*, 1396–1404. https://doi.org/10.1016/j.rser.2016.01.084

Silang, K. Z., Escoto, M., Tuando, M., et al. (2014). Wind energy projection for the Philippines by dynamic linear model. *Energy Procedia, 61*, 2549–2552. https://doi.org/10.1016/j.egypro.2014.12.162

Sussman, D. (1993). The Philippine geothermal industry: A progress report. *Geothermics, 22*(5–6), 443–451. https://doi.org/10.1016/0375-6505(93)90035-P

Tubalinal, H. O. S., Castro, M. T., Alcanzare, M. T., Matienzo, D. J. D. C., Paraggua, J. A. D. R., Chuang, P. Y. A., & Ocon, J. D. (2024). Prospects of green hydrogen production in the Philippines from solar PV and wind: Techno-economic analysis (present & 2030). *Renewable Energy, 235*, 121286. https://doi.org/10.1016/j.renene.2024.121286