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# Policy Brief

# Investment Needs for Bangladesh's Renewable Energy Transition

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## Background and Rationale

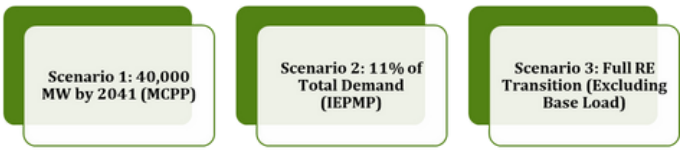
The renewable energy (RE) landscape in Bangladesh is gradually evolving as the nation seeks to diversify its energy mix and reduce dependence on fossil fuels. The country has primarily focused on solar energy, with widespread implementation of solar home systems in rural areas that contribute significantly to its renewable energy portfolio. Wind energy is also being explored, albeit on a smaller scale, with a few pilot projects in coastal regions. Despite these efforts, the overall contribution of renewables to the national energy mix remains relatively small, constrained by factors such as limited financing, regulatory challenges, and infrastructural inadequacies. Amidst rising energy demand, reducing fossil fuel dependency, to increase energy security and environmental sustainability, RE transition is a must. To do that, the country urgently needs funding but suffers from a shortage of comprehensive scientific research, data, and analysis about the financing required for the targeted RE transition.

## Scenario-Based Investment Analysis for Bangladesh's RE Transition

As Bangladesh aims to transition towards a more sustainable energy system, understanding the financial implications is crucial for policy-makers, investors, and stakeholders involved in the energy sector. Estimating investment costs for RE is essential for effective planning. A structured yearly investment plan ensures the securement of necessary funding, attracting investments and mobilizing resources efficiently. It also facilitates timely infrastruc-ture development, particularly for solar and wind power.

**Figure 1: Necessity of Yearly Investment Plan**


**Figure 2: RE Based Capacity Targets By 2041**



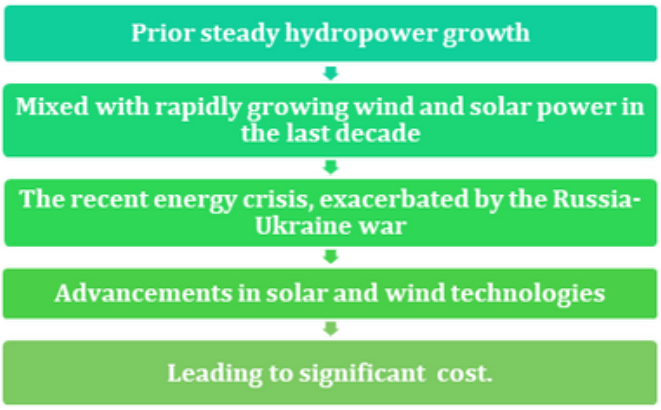

Moreover, strategic investment planning enables the formulation of effective policies and incentives, fostering RE adoption. It also ensures optimal resource allocation and project prioritization, directing funds toward the most impactful initiatives. In this context, this policy brief examines the annual investment required to achieve three distinct RE based capacity targets in the power sector (Figure 2) and conducts a comparative analysis.

It also assesses the feasibility of integrating storage systems within renewable power plants and explores financing options for implementing these investment plans. Furthermore, it focuses exclusively on the development of solar and wind power facilities, given the limited potential for expanding hydroelectric and other renewable energy sources in the country.

## Global Renewable Energy Trend

The global energy landscape has changed dramatically at the beginning of the twenty-first century, increasingly shifting towards RE. While there has been a steady growth in hydropower, RE sources such as wind and solar power have been growing rapidly in the last decade. The recent energy crisis, exacerbated by the Russia-Ukraine war, has further emphasized the urgency of this transition. Global RE investment growth is also driven by cost reductions and advancements in solar and wind technologies. Countries like China, Germany, and India, are leading in RE deployment using such advanced technologies. However, intermittency, storage, and grid infrastructure remain significant challenges for global RE adoption. Bangladesh has significant potential to capitalize on global trends in RE technologies.

**Figure 3: Global Shifting Process towards RE Transition**




## Bangladesh's Current Energy Structure and RE Potential

The country has achieved near-universal electricity access, but the energy supply still depends heavily on fossil fuels. Currently, natural gas and coal dominate in Bangladesh's energy mix in power sector, with renewables making up only a small fraction. Also, Bangladesh do not have an abundance of diverse renewable energy resources compared to some other nations. Nonetheless, it possesses considerable untapped potential of 70,000 MW in solar and wind alone. In contrast, its existing RE capacity is a mere 1219.24 MW, accounting for only 4.16 per cent of the total electricity generation (SREDA, 2024). Solar power contributes about 3% of total energy, with small contributions from wind and hydro. Whereas at least 2000 MW was supposed to be generated from RE sources by 2020. The government has taken active initiatives to promote RE installations such as solar parks, solar rooftops, and solar irrigation systems in both public and private sectors to reduce reliance on fossil fuels. However, the existing investment levels remain insufficient to fully realize the country's clean energy potential.

**Table 1: Bangladesh's RE Potential**

| RE Resources | Potential Capacity |
|---|---|
| Solar | 40,000 MW |
| Hydro | 2,228 MW |
| Wind | 30,000 MW |
| Other | 1,848 MW |

*Source: Bhuiyan and Mamur, 2021*

## Investment Scenarios and Estimation

So far, Bangladesh has developed multiple master plans for the energy and power sector, each with varying targets to guide its transition towards a sustainable energy future. Among them, the Mujib Climate Prosperity Plan (MCPP) sets a goal of 40,000 MW of RE capacity by 2041, while the Integrated Energy and Power Master Plan (IEPMP) projects that the country's total installed capacity will reach 74,300 MW by the same year. Under the second scenario, 11 percent of this total equates to approximately 8,173 MW of renewable energy capacity.

Currently, the base load is slightly less than one-third of the total capacity, for scenario design purposes, this study assumes it to be around one-third to account for investment variations. Based on this assumption, the base load in 2041 would be approximately 24,766.7 MW (one-third of 74,300 MW). This leaves the third scenario requiring approximately 49,533.30 MW of additional capacity from

renewable sources for a complete transition to renewable energy, excluding the base load.

Using the Compound Annual Growth Rate (CAGR), it is observed that to reach the capacity targets under each scenario, the required annual growth rates are 24.78% for Scenario 1, 13.65% for Scenario 2, & 26.36% for Scenario 3. Table 2 illustrates how the required capacity additions increase progressively over time, reflecting the compounding effect of growth. The figures emphasize the scale of investment and infrastructure expansion needed to achieve Bangladesh's renewable energy goals. By 2025, the required capacity addition stands at 230 MW for Scenario 1, 127 MW for Scenario 2, and 245 MW for Scenario 3. However, as the transition progresses, the yearly addition must significantly increase, reaching 7,944 MW, 981 MW, and 10,335 MW, respectively, by 2041. This underscores the need for strategic planning, consistent investment, and strong policy support to sustain the required growth trajectory and successfully transition to a renewable energy-dominated power system.

In addition to the three distinct scenarios, this study incorporates two cost considerations: the least-cost approach, which is based on the lowest reported cost values collected during data collection and field visits, and the maximum-cost approach, which accounts for the highest reported cost values for the same projects. Following the least-cost approach, this study estimates the per MW installation cost of a renewable power plant to be BDT 10.93 crore (USD 0.93 million). Under the maximum-cost assumption, this cost increases to BDT 15.7 crore (USD 1.33 million).

Under the least-cost assumption, the estimated capital investment required for Scenario 1 is approximately USD 36.3 billion, which increases to USD 52.1 billion under the maximum-cost assumption. Similarly, Scenario 2 requires an investment of USD 6.7 billion under the least-cost approach and USD 9.7 billion under the maximum-cost approach. The lower target in this scenario allows for a more gradual expansion of renewable capacity, thereby minimizing immediate capital expenditures. For Scenario 3, the required investment is significantly higher, amounting to USD 45.2 billion under the least-cost assumption and USD 64.8 billion under the maximum-cost consideration. This reflects the substantial financial commitment necessary for a complete transition to renewable energy (Table 3).

**Table 2: Per Year Capacity Addition Required**

| Year | Scenario 1 (24.78%) | Scenario 2 (13.65%) | Scenario 3 (26.36%) |
|---|---|---|---|
| 2025 | 230 | 127 | 245 |
| 2026 | 287 | 144 | 309 |
| 2027 | 358 | 164 | 391 |
| 2028 | 447 | 186 | 494 |
| 2029 | 558 | 211 | 624 |
| 2030 | 696 | 240 | 788 |
| 2031 | 868 | 273 | 996 |
| 2032 | 1083 | 310 | 1258 |
| 2033 | 1352 | 353 | 1590 |
| 2034 | 1687 | 401 | 2009 |
| 2035 | 2105 | 455 | 2539 |
| 2036 | 2626 | 518 | 3208 |
| 2037 | 3277 | 588 | 4054 |
| 2038 | 4089 | 669 | 5123 |
| 2039 | 5102 | 760 | 6473 |
| 2040 | 6367 | 864 | 8179 |
| 2041 | 7944 | 981 | 10335 |

*Source: Authors's calculation using CAGR*

**Table 3: Year-by-Year Capital Tnvestment Pland (USD Million)**

| Year | Least Cost | | | Maximum Cost | | |
|---|---|---|---|---|---|---|
| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 1 | Scenario 2 | Scenario 3 |
| 2025 | 214 | 118 | 227 | 307 | 169 | 326 |
| 2026 | 267 | 134 | 287 | 383 | 192 | 412 |
| 2027 | 333 | 152 | 363 | 478 | 218 | 521 |
| 2028 | 415 | 173 | 459 | 596 | 248 | 658 |
| 2029 | 518 | 196 | 579 | 744 | 282 | 832 |
| 2030 | 646 | 223 | 732 | 928 | 320 | 1051 |
| 2031 | 806 | 254 | 925 | 1158 | 364 | 1328 |
| 2032 | 1006 | 288 | 1169 | 1445 | 414 | 1678 |
| 2033 | 1256 | 328 | 1477 | 1803 | 470 | 2121 |
| 2034 | 1567 | 372 | 1867 | 2250 | 535 | 2680 |
| 2035 | 1955 | 423 | 2359 | 2807 | 607 | 3386 |
| 2036 | 2439 | 481 | 2980 | 3503 | 690 | 4279 |
| 2037 | 3044 | 546 | 3766 | 4371 | 785 | 5407 |
| 2038 | 3798 | 621 | 4759 | 5454 | 892 | 6832 |
| 2039 | 4739 | 706 | 6013 | 6805 | 1013 | 8633 |
| 2040 | 5914 | 802 | 7598 | 8491 | 1152 | 10909 |
| 2041 | 7379 | 912 | 9601 | 10596 | 1309 | 13785 |
| Total | 36297 | 6729 | 45160 | 52116 | 9661 | 64842 |

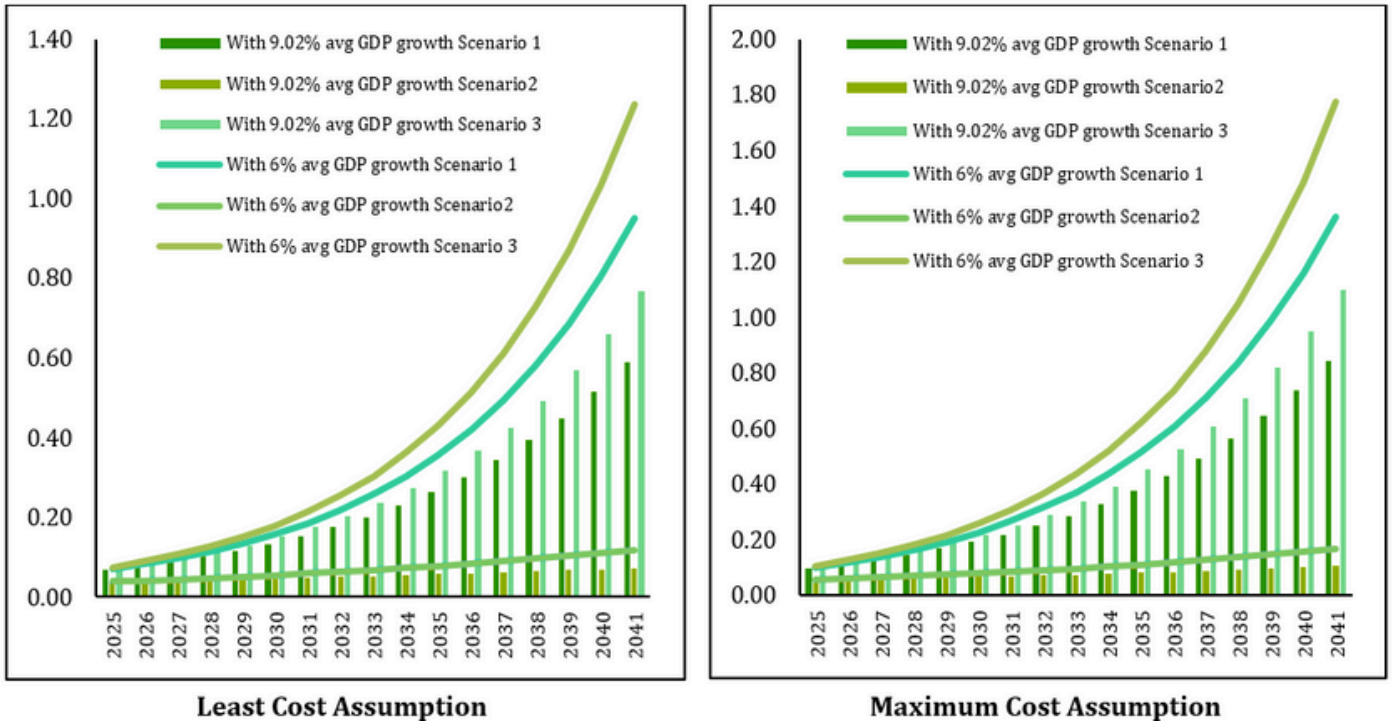
*Source: Authors' Calculation*

## GDP Projections and Financial Feasibility

Although the 2nd Perspective Plan projects that Bangladesh's GDP will grow at a rate of 9.02%, the current growth rate remains significantly lower, hovering around 6%, with the exact rate recorded at 5.82% for FY 2023-24. If the country were to achieve the projected growth, the capital investment requirements for RE under each scenario would represent a relatively small fraction of the GDP. For the beginning year, 2025, the required investment as a percentage of GDP would be only 0.07% (0.10%) for Scenario 1, 0.04% (0.05%) for Scenario 2, and 0.07% (0.10%) for Scenario 3 ,under the least-cost (maximum-cost) consideration.

Even at the peak investment requirement in 2041, the necessary investment would remain at 0.59% (0.85%) of GDP for Scenario 1, 0.77% (1.10%) for Scenario 3, and 0.07% (0.10%) for Scenario 2. Furthermore, under the least-cost (maximum-cost) approach, the investment requirements do not exceed 0.2% (0.3%) of GDP until 2032 and remain below 0.5% (0.7%) of GDP until 2038. These figures indicate that despite the substantial capital required for Bangladesh's renewable energy transition, the financial burden remains manageable relative to the country's overall economic growth.

**Figure 4: RE Capital Investment Share to GDP (%)**




**Least Cost Assumption** **Maximum Cost Assumption**

*Source: Authors' Calculation*

However, if the current low growth trends persist in the coming years, the investment required for Scenario 1 and Scenario 3 in 2041 would rise to 0.95% (1.36%) and 1.23% (1.77%) of GDP, respectively. These figures are substantial, especially considering that the country currently allocates only around 2% of its GDP to overall expenditures. Nevertheless, even if the economy maintains a 6% growth rate, the required investments in the initial years remain relatively low, staying below 0.50% of GDP under all scenarios until 2032. Furthermore, none of the investment requirements exceed 1.00% of GDP until 2040, ensuring a manageable financial burden. Notably, Scenario 2 remains highly feasible, requiring just 0.12% (0.17%) of GDP even at its peak investment year, 2041, reinforcing its financial viability.

## Total Investment

Additionally, RE power plants do not incur variable costs; however, they require fixed operating costs (FOC). For instance, Scenario 1 will accumulate a lifetime FOC of USD 24.01 billion under both least-cost and maximum-cost assumptions. Similarly, the FOC for Scenario 2 amounts to USD 4.45 billion, while Scenario 3 requires USD 29.88 billion over its lifetime.

**Table 4: Scenario-wise Total Investment Requirement (USD billion)**

| Scenarios | | Lifetime generation (tWh) | Lifetime FOC | Capital Investment | Total investment |
|---|---|---|---|---|---|
| Least-cost | Scenario 1 | 1644.27 | 24.01 | 36.3 | **60.31** |
| | Scenario 2 | 304.80 | 4.45 | 6.7 | **11.15** |
| | Scenario 3 | 2045.76 | 29.88 | 45.2 | **75.08** |
| Maximum-cost | Scenario 1 | 1644.27 | 24.01 | 52.1 | **76.13** |
| | Scenario 2 | 304.80 | 4.45 | 9.7 | **14.11** |
| | Scenario 3 | 2045.76 | 29.88 | 64.8 | **94.72** |

*Source: Authors' Calculation*

When combining both capital investment and fixed operating costs, the total investment requirement for Scenario 1 stands at USD 60.31 billion under the least-cost assumption and USD 76.13 billion under the maximum-cost scenario. Table 4 provides a detailed breakdown of the total investment requirements for the other scenarios as well.

## Sensitivity Analysis

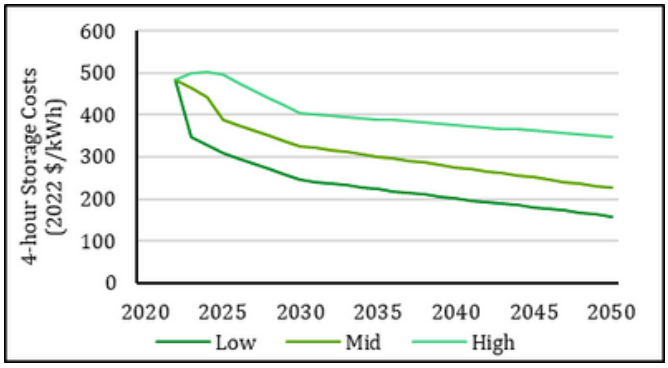
The estimations underscore significant yet manageable investment requirements within projected economic growth scenarios. Even under a pessimistic scenario with a 6% GDP growth rate, the required capital investments remain a small fraction of GDP, reinforcing the feasibility of the transition. Among the three scenarios, Scenario 2 stands out as highly viable, regardless of macroeconomic conditions. However, Scenarios 1 and 3 would require strong macroeconomic growth to be effectively implemented. Additionally, technological advance ments and supportive policies will be essential in minimizing costs and ensuring a sustainable energy transition.

Furthermore, energy demand has been estimated using the Energy-GDP elasticity ratio, based on the assumption that the country will grow at an average rate of 9.2% until 2041. If actual growth falls below this projection, energy demand will also decrease, making the implementation of revised Scenarios 2 and 3, based on new demand projections, more financially feasible. Moreover, as renewable energy (RE) power plants require high upfront installation costs, these costs can be significantly reduced by introducing lower tariff rates for RE equipment, making the transition more affordable and sustainable.

## Feasibility of Integrating Energy Storage Systems

One of the key challenges in adopting RE is storage integration, which is essential for managing the variability of solar and wind energy, as they are intermittent sources. These Variable Renewable Energy (VRE) and their higher injection to the grid will likely pose threats to the stability of the grid. At comparatively earlier stages of VRE penetration, measures such as modifying grid operation practices, enhancing system flexibility, and matching demand with supply by shifting the demand curve may prove to be sufficient. However, at more advanced implementation stages, large-scale storage along with reliable forecasting facilities are more suitable and tend to be economically viable. Solar PV power plants with integrated storage systems can diminish the variability quite effectively, and thus they can be utilised to supply the base load.

**Figure 5: Battery Cost Projections for 4-hour Lithium-ion systems**




*Source: NREL (2023)*

The National Renewable Energy Laboratory (NREL) report by Cole et. al. (2023) underscores varying cost reduction projections for battery storage, based on an analysis of 14 sources published in 2021 and 2022. Cost projections were divided into three scenarios based on the degree of technological innovation: High, Median, and Low, showing differing rates of cost decline from 2022 through 2050 (Figure 5)

**Table 5: Per kWh Battery Installation Cost**

| Scenario | Per kWh cost (USD) | Per kWh cost (BDT) |
|---|---|---|
| High-Cost Scenario | 0. 17 | BDT 20 |
| Median-Cost Scenario | USD 0. 15 | BDT 17.62 |
| Low-Cost Scenario | USD 0. 11 | BDT 13 |

*Source: Authors' Calculation*

However, the cost of battery installations currently surpasses the Levelized Cost of Electricity (LCOE) for most renewable energy technologies in Bangladesh, posing a significant challenge to the overall transition. For instance, the LCOE for small-scale and large-scale rooftop solar energy is already competitive at BDT 10.17/kWh and BDT 5.16/kWh, respectively.

Moreover, the per capita cost of battery installations remains substantially higher, making the shift to renewable energy more expensive and less financially viable in the short term (Table 5). Nonetheless, on a global scale, the decreasing trend in battery costs offers some optimism.

## Financing Options: Evidence from India and Vietnam

| India's Renewable Energy Financing Strategies | Vietnam's Renewable Energy Financing Model |
|---|---|
| India's solar power capacity expanded 30 times in nine years, reaching 74.30 GW by January 2024, largely due to private financing and innovative funding mechanisms. Commercial banks and non-banking institutions led investments, while green bonds raised USD 8.6 billion by 2019, with 80% allocated to renewable projects. Institutions like IDFC provided major funding, and IREDA was established as a dedicated financial body for renewables.<br><br>India also implemented Accelerated Depreciation (AD), Generation-Based Incentives (GBI), and Viability Gap Funding (VGF) to attract investment. Additional mechanisms such as crowdfunding, green banks, and infrastructure debt funds further mobilized capital. | Vietnam's solar and wind capacity surged from 0 GW in 2017 to over 22 GW by 2021, the fastest growth in ASEAN. This rapid transition was largely driven by Feed-in Tariffs (FiTs), which provided long-term price certainty and attracted significant private investments in renewable projects. Besides, land rental exemptions significantly reduced costs, offering three-year exemptions during construction and full exemptions for difficult regions.<br><br>To further incentivize investments, Vietnam introduced a preferential corporate tax rate of 10% for 15 years, compared to the standard 20%, along with a full tax exemption for the first four years and a 50% reduction for the next nine years. |

Bangladesh can learn and utilize many of these strategies to attract investment, reduce financial barriers, and drive its RE transition effectively.

## Policy Recommendations

### Diversify Financing Options

- Leverage government subsidies, tax exemptions, and incentives to attract investors.
- Secure low-interest loans and grants from international organizations such as the World Bank, Asian Development Bank (ADB), and bilateral donors.
- Encourage local banks to develop renewable energy-specific loan schemes.

### Enhance Green Bonds

- Issue sovereign or corporate green bonds to finance renewable energy projects.
- Align bond proceeds with Bangladesh's climate goals to attract global investors.
- Develop transparent reporting mechanisms to enhance investor confidence.

### Access Concessional Finance

- Collaborate with multilateral institutions like the World Bank, ADB, and Green Climate Fund to secure concessional loans.
- Negotiate lower interest rates and longer repayment periods to reduce upfront project costs.
- Utilize concessional finance to fund research and development in renewable energy technologies.

### Strengthen Public-Private Partnerships (PPPs)

- Develop clear policies and frameworks to reduce bureaucratic hurdles for private investors.
- Offer risk-sharing mechanisms, such as guarantees and co-investment opportunities.
- Facilitate joint ventures between public institutions and private companies to mobilize large-scale investment in renewable energy projects.

### Reduce Investment Risks

- Provide policy guarantees to ensure stable and predictable returns on investment.
- Introduce policy support such as Accelerated Depreciation (AD), Generation-Based Incentive (GBI), and Viability Gap Funding (VGF).
- Establish credit enhancement mechanisms, such as partial risk guarantees and political risk insurance.
- Provide long-term tax benefit.
- Invest in grid upgrades and energy storage solutions to improve renewable energy integration into the national grid.

### Update the IEPMP and MCPP Master Plans

- Revise targets under the Integrated Energy and Power Master Plan (IEPMP) and Master Plan for Coal Power (MCPP) to reflect practical goals in line with renewable energy expansion.
- Incorporate short-term milestones to assess progress and ensure accountability.
- Emphasize renewable energy as a central focus, reducing reliance on coal and imported fossil fuels.

### Ensure Technological and Financial Collaboration

- Foster partnerships with technologically advanced countries for knowledge transfer and capacity building.
- Introduce training programs to develop local expertise in renewable energy.
- Create platforms to facilitate dialogue among stakeholders, including private investors, government agencies, and multilateral donors.

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