

PAVING THE WAY FOR A JUST ENERGY TRANSITION IN MALDIVES

ROAD MAP FOR THE ENERGY SECTOR 2024 - 2033



Ministry of Climate Change,
Environment and Energy
Republic of Maldives



ASIAN DEVELOPMENT BANK

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FOREWORD by the President of Maldives



I am pleased to present the Energy Road Map of Maldives, a crucial blueprint for our nation's sustainable energy future. As we navigate the challenges posed by climate change, I am proud to announce our commitment to the ambitious goal of generating 33% of our electricity from renewable sources by the year 2028.

During the recent COP28 conference, I had the honor of announcing this bold target as part of our steadfast commitment to combatting climate change and transitioning towards a more sustainable energy landscape. This commitment reflects our dedication to reducing greenhouse gas emissions, enhancing energy security, and fostering economic growth and social inclusiveness through renewable energy technologies.

Achieving our goal will require coordinated efforts and collaboration from all sectors of society. It is an opportunity for us to showcase our leadership in embracing clean energy solutions and setting an example for other nations to follow.

I call upon local and international partners to support our collective efforts in realizing this vision. Together, we can harness the power of renewable energy to build a more resilient, inclusive and prosperous future for our nation and protect the pristine beauty of our islands for generations to come.

Let us work hand in hand to make the Energy Road Map a reality and lead the way towards a sustainable and bright future for Maldives.

H.E. Dr. Mohamed Muizzu

President of the Republic of Maldives



FOREWORD by the Minister of Climate Change, Environment and Energy



The rapid development of the country has led to a significant increase in energy demand. Contributing factors include the growing population and the expansion of industries such as construction, transportation and tourism. Achieving universal access to electricity in 2008 was a historic milestone for us. However, energy security remains a challenge, as we rely almost entirely on imported fossil fuels.

The Maldives' energy sector is transitioning towards an environmentally friendly and sustainable model by adopting greener and more innovative technologies. In line with this strategy, President Dr. Mohamed Muizzu has declared the government's commitment to developing renewable energy systems to meet 33% of the nation's electricity needs by 2028.

Increasing the share of renewable energy will reduce our dependence on imported fossil fuels, lower government expenditure on subsidies, cut harmful emissions, and enhance the country's energy security. The Energy Road Map is crucial for achieving our sustainable development goals. This road map will guide Maldives in transforming its energy sector and expanding economic activities.

The Energy Road Map outlines a plan to achieve a 33% renewable energy share in the electricity sector by 2028, ensuring energy that is sufficient, reliable, sustainable, secure, and affordable. It also suggests ways to increase renewable energy use in other sectors. Beyond 2028, exploring additional renewable energy technologies will be crucial. These initiatives aim to enhance energy security, create jobs, stimulate economic growth, and mitigate climate change, showcasing the government's commitment to sustainable development and carbon neutrality. Achieving these targets will require collaborative efforts from our institutions, international donor agencies, and development partners.

I would like to express my gratitude to the multilateral development banks, other donor agencies, and relevant stakeholders for their continuous support to Maldives in developing and transforming its energy sector. I am confident that, with the support of all parties, we will achieve the goal and targets outlined in the Road Map.

Thoriq Ibrahim

Minister of Climate Change, Environment and Energy



ABBREVIATIONS

ARISE	Accelerating Renewable Energy Integration and Sustainable Energy
ASPIRE	Accelerating Sustainable Private Investments in Renewable Energy
ASSURE	Accelerating Sustainable System Development Using Renewable Energy
BESS	battery energy storage system
CO ₂	carbon dioxide
GDP	gross domestic product
GESI	gender equality and social inclusion
GHG	greenhouse gas
IPP	independent power producer
IWMC	Island Waste Management Center
LPG	liquefied petroleum gas
MEE	Ministry of Environment and Energy
MCCEE	Ministry of Climate Change, Environment and Energy
MOH	Ministry of Health
MVR	Maldivian rufiyaa
NDC	Nationally Determined Contribution
OTEC	ocean thermal energy conversion
POISED	Preparing Outer Islands for Sustainable Energy Development
PPA	power purchase agreement
PV	photovoltaic
SAP	Strategic Action Plan
SDG	Sustainable Development Goal
SMEs	small and medium-sized enterprises
STELCO	State Electric Company Ltd.
SWAC	seawater air-conditioning
URA	Utility Regulatory Authority
V2G	vehicle-to-grid
WDC	Women Development Committee
WEC	wave energy converter
WTE	waste to energy



WEIGHTS AND MEASURES

kW	kilowatt
kWh	kilowatt-hour
kWp	kilowatt-peak
m ³	cubic meter
m/s	meter per second
MMPA	million air-conditioning tons per annum
MTPA	metric ton per annum
MW	megawatt
MWh	megawatt-hour
MWp	megawatt-peak



EXECUTIVE SUMMARY

The Republic of Maldives, a nation of 1,192 islands in the Indian Ocean that includes 187 inhabited islands, 168 resort islands, with population of 515,132 as of 2022, has seen considerable economic growth over the past four decades in sectors such as tourism, fisheries, sea transport, and construction. Tourism contributes 25% to GDP, while construction and fisheries account for 7% and 5%, respectively. However, socio-economic inequality persists, particularly between Male' and the outer atolls. The country's heavy reliance on imported fossil fuels poses fiscal challenges and makes the economy vulnerable to price fluctuations. Fossil fuels remain the primary energy source, with imports accounting for about 13.5% of GDP in 2023. The logistics of fuel distribution across islands are complex and costly.

Maldives faces significant geographic and climate challenges. The COVID-19 pandemics exposed weaknesses in its economic model, underscoring the need for diversification, job creation, and reduced fossil fuel dependence. Strengthening sectors like fishing and agriculture, and investing in renewable energy, are crucial for economic transformation and reducing fiscal burdens. The Maldives Ministry of Climate Change, Environment, and Energy (MCCEE) aims to transition to a renewable energy-based sector, promoting equity, climate justice, and social inclusion. The updated Energy Road Map aligns with the Government's commitment to source 33% of its electricity from renewables by 2028, and with its broader policy objectives, such as economic growth, poverty reduction, job creation, and climate resilience.

Maldives has abundant renewable energy resources, including solar, wind, and ocean energy. Solar PV projects are highly viable, with ongoing integrations with diesel power plants. Wind and ocean energy hold promise but require further assessment and technological development. As of July 2024, Maldives has an installed electricity capacity of 600 MW, with 68.5 MW from solar PV, producing about 6% of all electric power consumed by the country. The main challenge for the energy transition is island dispersion. Central power generation is limited to Greater Male'. Greater Malé has an electricity generation capacity of 140 MW from diesel generators and 10 MW from solar PV. Demand growth is expected at 9.6% in 2024. The rest of inhabited islands have a capacity of 208 MW of which 27 MW were solar PV, with ongoing projects aiming to create hybrid solar PV-diesel systems. Gender inclusion and women's empowerment are promoted through renewable energy education. Resort islands have an installed capacity of 242 MW, mainly from diesel generators, with 31 MW from solar PV. These islands have high operational costs and limited reporting on their energy usage, complicating efforts to assess and improve efficiency.

Electricity consumption in Maldives is increasing at about 5% per year, projected to reach 2,400 GWh by 2028. The Government's target of 33% renewable energy in electricity consumption means that 800 GWh must come from renewable sources. Currently, Maldives has 68.5 MW of solar PV installed, with an additional 90 MW under development, totaling about 160 MW by 2028. Achieving the Government's targets will require an estimated 330 MW of additional renewable energy capacity. Moreover, significant investments are necessary to upgrade the islands' power systems to support a high proportion of renewable energy.



Altogether, integrating this 330 MW of renewable energy is projected to require approximately \$1.3 billion in financing over the next four years. Investment mechanisms include Power Purchase Agreements for large projects and net-metering for smaller installations. Beyond 2028, exploring wind, ocean and other marine renewable energy technologies will be essential. These initiatives are expected to enhance energy security, create jobs, stimulate economic growth, and mitigate climate change, demonstrating the government's commitment to sustainable development and carbon neutrality.

Maldives' isolation and dispersed population also make transport fuel-intensive and expensive, despite a basic nationwide ferry and jetty network serving all inhabited islands. Diesel and petrol consumption for transport has nearly doubled over the past decade, with registered vessels increasing by 50% and vehicles more than doubling from 2010 to 2020, though data on their manufacturing year, efficiency, and CO₂ emissions are lacking. Additionally, most imported liquefied petroleum gas (LPG) is used for cooking, with imports rising from 14,500 tons in 2017 to nearly 17,500 tons in 2022, distributed to consumers in standard LPG bottles.

The Maldives Energy Road Map outlines 15 flagship interventions fulfilling the 25 strategies defined by the Energy Policy and Strategy 2024-2029 and the guidelines of the Electricity Act 2021. These flagship interventions include:

1. Accelerating the uptake of rooftop renewable energy.
2. Evaluating maximum potential for renewable energy integration into the grid.
3. Decarbonizing transport.
4. Leapfrogging solarization of islands.
5. Mainstreaming efficient consumption.
6. Setting up a fair and cost reflective electricity tariff and replacing indirect subsidy mechanism by targeted subsidy.
7. Transitioning to cleaner fuels in Greater Male'.
8. Erecting and integrating waste-to-energy plants.
9. Preparing smart, flexible and reliable grids.
10. Exploring interconnection possibilities of island clusters and extending access to electricity service.
11. Interconnecting power systems of Greater Male'.
12. Strengthening regulatory framework.
13. Accessing and collecting reliable energy data.
14. Developing institutional capacity.
15. Unleashing the potential of marine renewable energy and exploring Green Hydrogen options.

Transitioning to renewable energy in Maldives is a capital-intensive process, particularly for the islands, and requires private sector involvement, which has been difficult to secure. Engaging local SMEs in renewable energy infrastructure can create jobs and diversify the economy. An enabling environment to facilitate a just energy transition is needed for the successful implementation of the Energy Road Map. Such enabling environment should be founded in 7 elements:

- an integrated and comprehensive framework,



- the increase of cross-sectoral efforts,
- preparation of the future workforce for change,
- continuation of already successful community engagement efforts for gender equality and social inclusiveness,
- monitoring road map results,
- aligning with sustainable development goals, and
- ensuring financing schemes.

An integrated framework is essential for a smooth and inclusive energy transition. This framework should cover multi-sectoral policies, financing, social protection, resilience, and institutional strengthening. The Road Map identifies eight critical domains for guiding the just energy transition, including coherent policies, access to key utilities, economic development, green jobs, social protection, community-centered governance, technological innovation, and financing.

The POISED project highlights the importance of cross-sectoral efforts, with initiatives like solar PV-based ice-making plants for fisheries and renewable energy-based ferries that enhance livelihoods and women's income opportunities, demonstrating resilience during crises like the COVID-19 pandemic.

It is essential to prepare the next generation for the challenges and opportunities within the energy sector. Initiatives aimed at educating and training students from an early age are crucial. Programs focusing on renewable energy, efficiency, and conservation practices should be integrated into school curriculums, particularly for students in grades 8–12. These initiatives can include hands-on training, internships, and field trips to renewable energy sites, offering students practical experience and insights into potential career paths. Looking at the future, the country needs more vocational and higher education programs on science, technology, engineering and mathematics careers.

In relation to efforts to achieve gender equality in the sector, Maldives has already set exemplary action for initiating change and close the gender gap. The POISED project has prioritized empowering women by engaging communities vigorously through sustained campaigns on gender inclusivity, renewable energy, and the green economy across its targeted 160 islands. The MCCEE aims to reinforce and mainstream these training and educational activities in all its programs.

Finally, ensuring robust financing schemes, leveraging international support and improving financial performance through lower renewable energy generation costs are all crucial for the successful implementation of the Energy Road Map.

The Government is committed to provide such enabling environment to confer authority, build consensus, attract attention to, and provide needed resources for the Road Map implementation.



1 » BACKGROUND

1.1 Maldives Development Path

Maldives, with its 1,192 islands in the central Indian Ocean, is one of the world's most geographically dispersed countries.¹ The population of Maldives in 2022 was 515,132², with most people living in Male'³ (211,908 people) and Addu City (25,062 people).⁴ The rest of inhabited islands are small, with dispersed population; and 27% of the inhabited islands have a population of less than 500 (footnote 4). In defiance of this complexity, Maldives achieved universal access to electricity in 2008.

The extraordinary economic growth in tourism, fishery industry, sea transport, and construction over the past 4 decades has led to an exponential growth of the country's connectivity and universal access to basic healthcare and education for the population. The tourism sector contributes to about 25% of the national gross domestic product (GDP), followed by the construction industry with about 7% and fishing industry with up to 5%. The continuous improvement of economic opportunities in the atolls is at the top of priorities of the Government. This requires a reliable, sufficient, sustainable and affordable energy supply.

Each island operates independent power generation and distribution facilities because of their geographic isolation. These systems rely on centrally stored fuel that is transported when required. Maldives is highly dependent on foreign imports for almost all goods, including staple food items, electronics and appliances, and other necessities. Imported goods are transported to all islands by boats that run on fossil fuel. Thus, the prices of imported fuels and the volatility of those prices have a direct and strong impact on the country's economy and social stability. Maldives' dependence on fossil fuels imposes a significant fiscal burden on the government budget and makes it vulnerable to fuel price fluctuations. Transitioning to cost-effective renewable energy (RE) sources is the best option Maldives has to stop this dependency.

The interventions implemented in the country already show great success scaling up RE.⁵ As of July 2024, Maldives has installed approximately 68.5 megawatts (MW) of solar photovoltaic (PV) electricity generation systems and at least 8 megawatt-hours (MWh) of battery energy storage systems (BESS) across the nation. The demand for electricity in inhabited islands has more than doubled in the past 15 years due to economic growth; thus, the need for new RE investments is continuous to maintain and keep increasing the RE share in the energy mix. This Road Map will contribute to reducing dependency on fossil fuels and improve national accounts. The Road Map establishes actions and targets independently for the electric power

¹ Out of its 1,192 islands, 187 are inhabited, 106 are leased for long-term development (mostly for agricultural and industrial purposes), and 293 are allocated for tourism development (168 operate as self-contained tourist resorts and marinas).

² 74% resident Maldivians and 26% resident foreigners.

³ Population of Male' City includes inhabitants of Villingili and Hulhumale'.

⁴ Government of Maldives, Ministry of National Planning & Infrastructure, National Bureau of Statistics. 2023. [Maldives Population and Housing Census 2022 – Population Dynamics in the Maldives](#). Male'.

⁵ Particularly important in this journey are the Asian Development Bank funded projects *Preparing Outer Islands for Sustainable Energy Development* (POISED) and *Accelerating Sustainable System Development Using Renewable Energy* (ASSURE), and the World Bank funded project *Accelerating Sustainable Private Investments in Renewable Energy* (ASPIRE).



use and other energy uses. Table 1 specifies the general assumptions for the electric power use and other energy uses. By implementing this Road Map, the country will have the opportunity to capitalize on a low-carbon economy, create new jobs and skills, and cut energy bills. A low-carbon energy sector will, therefore, contribute to the economic growth of Maldives and the well-being of its population.

Table 1: General Assumptions Used in the Road Map

Electric Power	Other Uses
<ul style="list-style-type: none"> • Fuel used: All thermal power plants of Maldives use diesel fuel • Three differentiated geographic scopes: Greater Male' Region, other inhabited islands, resorts/industrial/agricultural islands. • Technologies proposed: Energy efficiency, switch to LNG in Greater Male' diesel power plants, Hybrid RE-diesel plants, PV (rooftops, ground-mounted and floating solar), small wind turbines, waste to energy and ocean energy. • Storage: Battery energy storage in the short term. Introduction of Hydrogen storage. 	<ul style="list-style-type: none"> • Industry: Electrification through renewables of a sector mostly dependent on diesel. • Sea and road transport: Uses diesel and petrol. Replacement with efficient engines, solar boats, hybrid and electrical buses /vehicles / bikes. • Air transport excluded from this Road Map. • Cooking: Double use of fuels since LPG is transported bottled by ferry to islands. Replacement with induction stoves for islands with high penetration of renewable energy.

LPG = liquefied petroleum gas, PV = photovoltaic.
Source: Asian Development Bank.

1.2 Positive Policy Evolution

Achieving a dignified life for all the Maldivians is the greatest priority of the Government. Maldives has defined the vision for its energy sector as the “provision of sufficient, reliable, sustainable, secure and affordable energy for a prosperous Maldives.” Reversing the country’s dependence on imported fuel and realizing a better future powered by renewables is possible for Maldives. Since early 2008, Maldives has called upon a cut in global greenhouse gas (GHG) emissions. The Energy Action Plan 2009–2013 included a series of energy efficiency interventions and conservation awareness aiming to reduce the country’s CO2 emissions. The 2010 National Energy Policy has pledged to carbon neutrality by 2020, and to provide all citizens with access to an affordable and reliable supply of electricity. The 2012 Maldives Scaling-Up Renewable Energy Investment Plan has put forward a strategy to scale-up renewable energy in the country. The Energy Policy and Strategy 2016 established seven guiding principles, including 100% electricity access, reduction of fossil fuel dependency,



improved energy efficiency, adoption of low carbon technologies, exploitation of renewable energy, engaging the private sector, and ensuring energy equity through social protection. The Strategic Action Plan (SAP) 2019–2023 also outlined energy efficiency and renewable energy development targets and priorities of the government for clean energy, the use of waste as resource, water and sanitation, and transport. The COVID-19 pandemics and the subsequent economic crisis prevented many of these targets to be achieved in the planned timeline. The government is working to update the strategic action plan for the next period with updated targets for the energy sector.

The current Maldives' energy policy framework comprises the updated Nationally Determined Contributions (NDC)⁶ submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2020, the Maldives Energy Act from 2021⁷, and the recently drafted Energy Policy and Strategy 2024-2029.⁸ The updated NDC establishes a 2030 conditional GHG emissions reduction target of 26%, and states the government's goal to reach net-zero by 2030 on the condition that Maldives gets the extensive support and assistance from the international community. The updated NDC defines the energy and waste sectors as key sectors for GHG emissions reduction. At the 28th Conference of the Parties (COP28)⁹, President Dr. Mohamed Muizzu announced an even more ambitious goal to generate 33% of the country's electricity demand from renewable sources by 2028.

The Maldives Energy Act of 2021 establishes the framework to make energy services available to consumers at a reasonable price, promoting renewable energy sources, and ensuring that the energy sector promotes sustainable development that is environmentally friendly and adaptable to climate change. The Energy Policy and Strategy 2024-2029 establishes 5 policy objectives:

1. Diversifying the energy mix by promoting the development and utilization of RE sources.
2. Improving energy efficiency by implementing measures across all sectors to reduce energy consumption and lower GHG emissions.
3. Enhancing access to energy services by ensuring universal access to affordable, reliable, and modern energy services for all citizens.
4. Strengthening energy governance by enhancing institutional capacity, regulatory frameworks, and governance structures.
5. Promoting public awareness and engagement by promoting community participation in energy conservation and renewable energy initiatives.

The Energy Policy and Strategy 2024-2029 translates these policy objectives into 25 strategies (Table 2). Realizing these policy objectives and strategies requires a realistic and consensus-

⁶ Government of Maldives, Ministry of Environment, Climate Change and Technology. 2020. *Update of Nationally Determined Contribution of Maldives*. Male'.

⁷ Government of Maldives, Ministry of Environment, Climate Change and Technology. 2021. *Maldives Energy Act 18/2021*. Male'.

⁸ Government of Maldives, Ministry of Climate Change, Environment and Energy. 2024. *Energy Policy and Strategy 2024-2029*. Male'.

⁹ The 28th Conference of the Parties (COP28) to the United Nations Framework Convention on Climate Change (UNFCCC) was held in Dubai, United Arab Emirates, from 30 November to 12 December 2023.



based road map that addresses multiple barriers—regulatory, infrastructural, technical, financial, and human resource barriers. The Ministry of Climate Change, Environment and Energy (MCCEE) is in charge of formulating the national energy policy, and planning and developing the energy sector. After a thorough consultative process with all relevant stakeholders in the country, international and national experts, and other government agencies, the MCCEE has developed this Road Map to open new development and business opportunities for the country and facilitate the alignment of external assistance with the national policy. The updated Road Map aims to provide direction to policy makers, financing institutions, and other stakeholders, and help them effectively coordinate their efforts in creating an enabling environment for the needed investments.

Table 2: Overview of Maldives Policy and Strategies for 2024-2029

Policy	Strategies
1. Increase RE integration and sustainable transportation	1.1. Encourage renewable energy utilization amongst public
	1.2. Encourage private sector renewable energy development and deployment
	1.3. Establish innovative financing mechanisms to facilitate RE investments
	1.4. Increase awareness on RE opportunities
	1.5. Introduce and promote sustainable transportation
2. Promote energy efficiency and conservation	2.1. Increase public awareness on energy efficiency and energy conservation
	2.2. Expand energy efficiency standards and labelling program
	2.3. Introduce energy efficiency practices in buildings
	2.4. Improve supply side energy efficiency and infrastructure
	2.5. Introduce low emission fuels
	2.6. Develop a standard and monitoring plan for the quality of fossil fuel sold in the country
3. Improve energy security and affordability	3.1. Introduce targeted subsidies for electricity sector
	3.2. Review tariff structure for electricity sector
	3.3. Increase and enhance fuel storage capacity
	3.4. Diversify energy mix
	3.5. Increase use of locally available renewable energy sources
	3.6. Improve operational performance of service providers to maintain electric power infrastructure
4. Strengthen institutional capacity	4.1. Strengthen regulatory framework for energy sector
	4.2. Develop a mechanism for reliable energy data collection and access



and regulatory framework of the energy sector	4.3. Develop institutional and human resource capacity for a sustainable energy future
	4.4. Strengthen national, regional and international cooperation in energy sector development
5. Promote energy research and development	5.1. Increase investments in energy R&D
	5.2. Collaborate with national and international parties on R&D
	5.3. Encourage energy sector innovations
	5.4. Provide incentives through financing mechanisms for R&D

RE = renewable energy and R&D = research and development.

Source: Ministry of Climate Change, Environment and Energy. 2024. *Energy Policy and Strategy 2024-2029*.



2 » AMBITION AND CHALLENGES

2.1 Government Target and Expected Result

The Government of Maldives has pledged in December 2023 at the COP28 its commitment to develop renewable energy systems to provide 33% of the nation's electricity needs within the next five years, that is by end of 2028. The updated Road Map forecasts a continuous and sustained moderate transformation of the national energy matrix and builds up on this commitment, on the guidelines established by the Maldives Energy Act 2021, and the Government's Energy Policy and Strategy 2024-2029.

Diesel fuel used for electricity generation has doubled in 10 years reaching an estimate of 390,000 tons in 2023 due to Maldives extraordinary economic growth. It is expected that by achieving the Government's target for 2028, the annual consumption of diesel for electricity generation would reduce to 330,000 tons, without affecting the promising economic growth in the years to come.

2.2 A Turn Towards a Just Energy Transition

Maldives' geographical dispersion and its dependence on fossil fuels are major obstacles to improving shared prosperity. The geographical peculiarity of the country makes it exceptionally vulnerable to climate change, weather severity, and external economic shocks. The large dependence on fossil fuels reduces the country's capacity to invest in creating jobs, improve health care and education, and introduce new farming practices to keep yields up in times of food insecurity. The development challenges of Maldives stem from these vulnerabilities. The massive and unexpected economic shock caused by the coronavirus disease (COVID-19) pandemic exposed the weaknesses of the economic model implemented in Maldives over the recent decades. While tourist arrivals recovered to a large extent a year after Maldives relaxed its travel restrictions in July 2020, they are not be able to offset rising trade deficit, severely impacted by the import of fossil fuels.

Looking at the future, the resilience of Maldives' economy largely depends on its capacity to diversify income sources, create jobs, and reduce its dependence on fossil fuel imports. A rapid economic transformation will require the incorporation of modern climate-smart practices and technical precision. Strengthening and modernizing the fishing industry and other primary sectors such as agriculture will contribute to reduce inequality and the expense on food imports, improving also the country's food security. The economic transformation should be based on the economic empowerment of small and medium-sized enterprises (SMEs) through entrepreneurship, innovation and jobs creation. Investments in renewable energy are an opportunity to lower production costs. Moreover, investments in renewable energy will also result in the reduction of fossil fuel imports, consequently reducing the burden on government finances. Thus, a reliable, sustainable, and affordable energy supply for citizens and businesses across the country is key to achieving the aimed transformation.

This Road Map establishes the guidelines for transitioning from a fossil-fuel-based energy sector to a cost-effective, business-competitive, affordable, and sustainable renewable energy. Through a cross-sectoral approach, the Road Map has been formulated to serve Maldives'



vision for the energy sector, and it is built upon the country's broader policy objectives: economic growth, end of poverty, creation of employment, reduction of regional disparities in living standards, and resilience to weather severity and effects of climate change. The update of the Energy Road Map is fruit of a consensus process to accelerate the energy transition of Maldives, prioritizing equity, climate justice and social inclusion. Maldives is committed to take the opportunities presented in this Road Map to leap-frog technology, economic and social development gaps, and inequities based on the growth of its tourism, fishing and agriculture industries, leading to sustainable economic and social development.

2.3 Challenges

Maldives faces many challenges to the transition towards a low carbon energy sector. These challenges must be addressed when implementing this Road Map since they can quickly affect the security and affordability of the energy supply. Thus, negatively impacting the country's economy and the country's efforts to end poverty and reduce regional disparities in living standards.

2.3.1 Resiliency to Severe Weather and the Impacts of Climate Change

Maldives is at the forefront of the most vulnerable countries to the impacts of climate change. Its high vulnerability stems from the geographical characteristics of the islands—their small size, low elevation, and scattered distribution in a large ocean area. These distinctive characteristics have led to the establishment of the country's critical infrastructure within 100 meters from the coastline. These include powerhouses, desalination plants, medical centers, waste collection and treatment plants, and households.¹⁰ Such proximity makes Maldives' islands very vulnerable to the many effects of climate change, including the erosion caused by sea level rise, tsunamis, extreme weather, and sea temperature rise.¹¹ The "El Niño" phenomenon is happening with more frequency in the past 2 decades and causes significant coral bleaching of the coral reefs of Maldives. Coral reefs are not only home to thousands of fish species, hundreds of mollusks and crustacean species, and species of amphibians, whales, and dolphins; they also protect the islands from the erosive effects of the sea. Rainwater shortages are also more frequent due to the effects of climate change.¹²

The country lacks sufficient capacities and resources to respond locally, on time, and effectively to weather-related disasters. Extreme weather events disrupt, and many times, fully stop the regular supply of food, fuel, and essential goods to the islands. The small size of the islands and their lack of resources have made emergency stockpiling very difficult.

Higher levels of community resilience to prevent and combat these risks and enhance local human capacity to respond to emergencies can be achieved through renewable energy

¹⁰ Government of Maldives, Ministry of Environment and Energy. 2016c. *Second National Communication of Maldives to the United Nations Framework Convention on Climate Change*. Male'.

¹¹ The 2007 IPCC report predicted that global warming would result in sea level rises of up to 59 centimeters by 2100, which would mean that most of the country may need to be abandoned.

¹² Maldives Meteorological Services predicts an overall decreasing trend for annual rainfall over Hanimaadhoo, Malé and Gan of 9.5, 0.02 and 2.21 mm respectively.



investments. Besides achieving energy independence, renewable energy offers the opportunity to strengthen water and food security and fuels-free transport through renewable energy powered solutions for water desalination and for agricultural irrigation, sea water cooling for fishing vessels, ice-making factories for food preservation, solar-powered vessels, etc. Pilots of these solutions are already being implemented and tested in the country.¹³ These pilots will provide relevant information for the scale up and replication of these solutions across the country.

2.3.2 Fuel Price Volatility and the Subsidy Issue

Imports of fossil fuels, including diesel, petrol, LPG, and aviation fuel, represent the most significant energy source for Maldives, accounting for 13.5% of its GDP in import expenses in 2023. In addition, several economic insecurity issues are associated with the import of fossil fuels. The limited volume of imports tendered hinders the potential for price competition in Maldives. Local importers are often unable to take advantage of the credit terms that their counterparts in larger countries might receive. The typical credit term offered to Maldivian importers by international suppliers is 45 days, with a few extending up to 90 days. Additionally, the capacity of tankers utilized by Maldivian firms is limited to a maximum of 24,000 metric tons, preventing them from accessing facilities in South Asia and securing more competitive freight rates. As a result, importers in Maldives frequently have to arrange shipments through more distant nations, leading to vessels transporting cargo one way and returning with ballast, thus incurring additional freight costs for these companies. Consequently, fuel price volatility has a huge impact on Maldives' economy.

To aggravate this challenge, subsidies to fuel used in electricity generation have increased 10 times in the past 7 years because of the multiplying effect of power demand growth and fuel price increase.¹⁴ This fuel subsidy amounted to roughly \$150 million in 2022 and \$130 million in 2023. For comparison, the annual fuel subsidy for electricity generation in pre-COVID years was close to \$14 million in 2017 and close to \$40 million in 2019. The fuel subsidy accounts for the volatility in fuel prices above the threshold baseline rate paid by utilities to the State Trading Organization (STO). The difference between the market price and the baseline rate is paid by the Government to STO. Thus, this is a generalized subsidy benefitting everyone in Maldives, rather than benefitting only those in need. This situation has led to a financially unsustainable power sector with limited access to financing to invest in transmission and distribution infrastructure and renewable energy technologies.

Addressing the challenge of fuel price volatility and the subsidy issue requires:

- Accelerating the transition to renewable energy sources across the country. As the renewable energy transition for Greater Male' will be slower due to its limited options for cost-effective renewable energy solutions, the substitution of diesel fuel for a less

¹³ The POISED project includes the piloting of a solar ferry and community ice-making plants for fishery activities. The ASSURE project is financing a pilot solar desalination plant for agricultural irrigation activities.

¹⁴ Between 2017 and 2023, the amount of diesel used for electricity generation increased 56% due to the growing power demand, and the subsidy per liter of diesel increased in the same period 7 times, from 1.16 MVR/liter to 6.07 MVR/liter.



expensive and lower GHG emissions fuel such as liquefied natural gas (LNG) in Greater Male's plants should be strongly considered.

- Visualizing the dire situation of generalized subsidies to the population through clear communication of the actual costs of fuel and electricity.
- Implementing a sensible subsidy and tariff reform that benefits those really in need.

2.3.3 Grid Integration of Renewable Energy Technologies

Prior to 2014, Utility companies owning and operating electricity production assets in Maldives have mainly implemented conventional energy projects since the beginning of the country's industrialization. They have been operating and maintaining diesel-based power plants and grids with poor flexibility services for many years. When it comes to renewable energy technologies, including their integration to grids, however, they are still walking the learning curve of their installation, operation and maintenance. While they progress fast in this learning, the risk of wrong technology choices, deficient design of solutions (including capacity sizing, storage, control system installation, and service implementation), and non-optimal or poor configuration of power systems is still relevant.

As consequence, power grids in small islands are not sufficiently prepared for the increasing capacity of rooftop PV solar installations. Electricity demand in most islands is in the same range as the cumulative capacity of solar PV installed. Small variations in power generation from solar PV can create relatively large disturbances in the island grids when equipment to monitor and control the grids, and batteries to compensate manage surpluses or deficits are not installed. A large number of solar PV systems multiplies the risk of disturbances, impacting the reliability and stability of grids. Fenaka has to frequently curtail the electricity production of its own solar PV systems to allow the injection of electricity produced by customers' rooftop solar PV installations to be absorbed. In relation to the Male'-Hulhulmale' interconnected grid, the risk of large voltage fluctuations would be significant when larger penetration of renewable energy is achieved. At present, solar PV installations currently provide no more than 7% of the maximum demand of the power system. However, sometimes power quality is affected in parts of the grid due to harmonics caused by inverters operating with solar PV systems. These voltage fluctuations affect the lifetime of electrical motors and all types of electronic equipment. Furthermore, the grid stability would be better controlled if the generation dispatch of STELCO's diesel gensets would be automatically controlled (currently generation dispatch is done with old fashioned manual controls) and the distribution grid would be adequately monitored and controlled with modern equipment.

New emerging technologies such as ocean energy and small wind technologies will be explored and piloted.¹⁵ The implementation of such pilot projects is also relevant to study their interactions with evolving policies, regulations, tariff methodologies, and business models.

¹⁵ The ASSURE project will test a pilot wind power system on Noonu Manadhoo Island and a pilot ocean power system off an island yet to be determined.



2.3.4 Independence and Capacity of the Regulator

The Utility Regulatory Authority (URA) was established under new legislation, Law No. 26/2020. However, URA needs to be strengthened in terms of human resources with required skills and knowledge and required facilities.

2.3.5 Protection of the Environment and Biodiversity

Maldives is globally known for its unique beauty formed by coral reefs, seagrass, mangroves, beaches, forests, and brackish lakes and ponds. These natural habitats and their rich biodiversity have contributed in the past years to 89% of the national GDP and 71% of employment.¹⁶

Numerous challenges faced in waste management, including the lack of adequate and effective procedures to dispose used chemicals and untreated sewerage, has increased the levels of pollution across the country—harming biodiversity and aquifers. In the absence or insufficiency of natural water supplies, the population is forced to produce larger amounts of desalinated water and import more prepared food and bottled water. This has led to larger use of fossil fuels which could significantly harm the environment and biodiversity.

Besides power generation, renewable energy offers solutions to other energy uses. Such solutions give the opportunity to reduce the possibility of fossil fuel spills and pollution by contributing to sustainable agriculture and fishing practices, water desalination and renewable energy based transport.

¹⁶ Government of Maldives, Ministry of Environment and Energy. 2015b. *National Biodiversity Strategy and Action Plan of Maldives 2016-2025*. Male'.



3 » SOURCES OF ENERGY

3.1 Renewable Energy Resources

Maldives does not have any proven fossil fuels reserves. However, it has abundant renewable energy resources, including solar, wind, ocean and waste to energy.

3.1.1 Solar Energy

Solar PV energy is an indigenous resource with the most immediate exploitation possibilities in Maldives. The annual solar irradiation per square meter (m²) is in the order of 1,200 kilowatt-hour (kWh)¹⁷, which is considered good for any solar PV project. The solar PV project is being successfully implemented in hybrid systems in many islands of the country. Energy management systems (EMS) are used to enhance the control of the hybrid systems. This hybrid configuration can offer short pay back times when compared to current prices of electricity produced by diesel generation sets.



Solar photovoltaic panels on the roofs of schools and public buildings are connected to diesel power plants—forming hybrid systems (photo of POISED project installation by the Ministry of Climate Change, Environment and Energy).

¹⁷ ADB. 2014. *Toward a Carbon-Neutral Energy Sector: Maldives Energy Roadmap, 2014–2020*. Manila.



3.1.2 Wind Energy

Wind resources are not equally distributed across the country. The wind energy resource maps indicate that the northern half of the country is relatively richer in wind resource than its southern part.¹⁸ Wind speed recorded at 40 meter height in 2016 showed an annual average of 5.69 m/s in Naifaru and 5.73 m/s in Gulhifalhu. Such wind speed is not as high as those for large wind farm projects in the world, but they can sufficiently compete against diesel-generated electricity. However, the economic viability of such projects needs to be further explored. Power grid capacity of each island, land availability, and logistics constraints have led to a scenario that only industrial islands in the Greater Male´ region have the potential for large-scale onshore wind projects using 2 MW turbines (estimated potential is 80 MW). For other islands, the deployment of midsize wind turbines of between around 100 kilowatts (kW) and 300 kW rated capacity could be explored. Wind turbine noise impacts must be carefully examined for each case.



Wind - Solar photovoltaic and Battery Energy Storage system installed at K. Kaashidhoo Island.

¹⁸ National Renewable Energy Laboratory. 2003. *Wind Energy Resource Atlas of Sri Lanka and Maldives*. <https://www.nrel.gov/docs/fy03osti/34518.pdf>; M. Purcell and T. Gilbert 2015. *Wind Resource Mapping in Maldives: Mesoscale Wind Modeling Report*. Washington, DC: World Bank Group. <http://documents.worldbank.org/curated/en/836871467997849102/Wind-resource-mapping-in-the-Maldives-mesoscale-wind-modeling-report>



3.1.3 Ocean Energy

Ocean energy (from marine currents, wave, and thermal sources) is considered one of the most promising renewable energy resources for Maldives. Progressive development of ocean energy technologies and projects are key to the successful adoption of ocean energy for Maldives. Marine current, wave, and ocean thermal energy for electricity production and various co-applications such as cooling, desalination or water production, and initiatives toward a green maritime ecosystem (i.e., green ports, electrification of vessels, smart bays and buoys) are particularly interesting. It is a major advantage over solar and wind energy that ocean energy could provide a continuous stream of energy. This advantage reduces the need for any form of energy storage, which is usually expensive. This characteristic is particularly relevant for the resort islands where some of their services, such as laundry, air-conditioner, or desalination water plants, run day and night. However, their quantification is at the very early stages and most technologies are not fully commercial yet. A preliminary resource assessment of tidal and in-stream energy has quantified the potential in a range from 28 MW to 106 MW in selected channels and currents reaching up to 1.5 m/s to 2.6 m/s.¹⁹ Current or in-stream energy is harvested by extraction technologies, such as marine current or tidal turbines, placed in the water where fast-flowing currents turn the turbine blades (similar to what wind does with wind turbines). Wave energy is also potentially an important source of renewable energy for Maldives. A constant stream of waves propagated from the South Pole and across the Indian Ocean reaches Maldives. Wave energy installations face a low risk of damage from extreme weather conditions as Maldives is not prone to hurricanes or typhoons. A recent study indicates good potential of 8.46 kW per meter (kW/m) to 12.75 kW/m.²⁰ Ocean thermal energy conversion (OTEC) may also become promising in the future once OTEC technologies reach commercial stages of development.

As the potential of these types of energy is affected by atoll configurations, more precise assessments are needed to initially find areas where resource and consumption exist in an aligned manner (i.e., not too far from each other that it becomes economically impractical).

3.1.4 Biomass Energy

Biomass resources are constrained because they are distributed in much dispersed small quantities across the country. Those amounts are too small for local solutions, and their collection would be complex and carbon-intensive to bring them to a place with large energy demand. Marine biomass may become an interesting resource in the long term when technologies for converting them into energy are cost-effective. No assessment on the potential of marine biomass exists at the moment.

¹⁹ Centre for Understanding Sustainable Practice, Robert Gordon University. 2011. *Marine Energy in Maldives: Pre-Feasibility Report on Scottish Support for Maldives Marine Energy Implementation*. Aberdeen

²⁰ P. Contestabile et al. 2017. Offshore Wind and Wave Energy Assessment around Male' and Magoodhoo Island, Maldives. *Sustainability*. 9 (4). p. 613. DOI: 10.3390/su9040613. Basel.

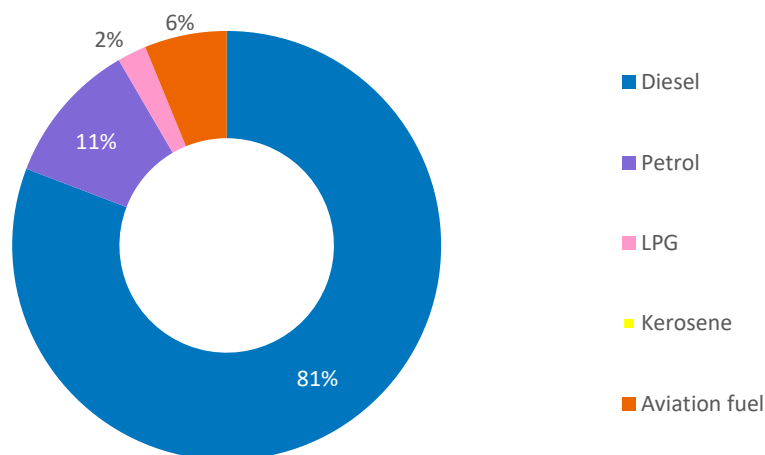


3.2 Fuel Imports

Fossil fuel imports are the most important source of energy for Maldives with an import bill of about 13.5% of GDP in 2023. Approximately half of the fuel imports is for electricity generation. In 2022, with tourism activities fully recovered after the COVID-19 pandemics, Maldives imported more than 850,000 tons of refined petroleum products²¹ (Figure 1), 50% more than what the country imported in 2017. Fossil fuels are used for the following purposes.

- Diesel is used for electricity generation, industrial uses (fisheries and water desalination) and sea transport.
- Petrol is used in road and sea transport
- LPG is used for cooking.
- Aviation fuel is used by the aviation sector.

Figure 1: Fuel Imports by Maldives in 2022
(tons)



Source: Government of Maldives, Maldives Customs Service. 2023.

²¹ Government of Maldives, Maldives Customs Service. 2020. *Total imports 2019*. https://www.customs.gov.mv/Media/Documents/downloads_Male/



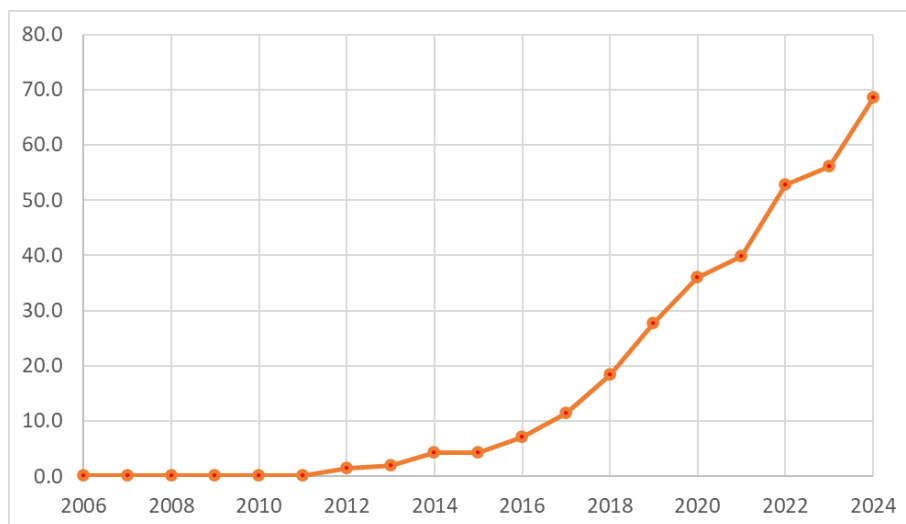
4 » SECTOR ASSESSMENT

4.1 Electric Power

Universal access to electricity was achieved in all of Maldives in 2008. As of June 2024, Maldives had a total power generation capacity of about 600 MW, of which 68.5 MW are solar PV, producing about 6% of all electric power consumed by the country. The growth of solar PV capacity in Maldives is shown in Figure 2. The rest of installed capacity corresponds to diesel generators. The dispersion and small size of most islands have prevented the possibility of central power generation.

Cooperatives that traditionally provided electricity at each island have been consolidated into two public utility companies: State Electric Company Limited (STELCO) and Fenaka Corporation Limited (Fenaka). STELCO operates power plants in 30 inhabited islands including the Greater Malé. Fenaka operates power plants in 157 inhabited islands. In addition, the power system of one island, ADh. Maamigili, is operated by a private party and island, R. Dhuvaafaru, is operated by the Malé Water and Sewage Company. While current private investments in the power sector are mostly limited to provide electricity service to self-contained resorts, Maldives and its development partners are working together to increase private sector investments in renewable energy.

Figure 2: Evolution of Renewable Energy Installations in Maldives (megawatt)



Source: Asian Development Bank with information from the Ministry of Climate Change, Environment and Energy.

The URA establishes tariffs, guidelines, and regulations to ensure the reliability and security of the grids, and to safeguard the rights and obligations of consumers and service providers. The cost of electricity production on many islands is among the highest in South Asia because of genset inefficiency and expensive diesel fuel logistics. The imported diesel fuel is shipped in small quantities by boat to each island across the country, which can make fuel notably more



expensive. The most efficient diesel generators in Maldives produce electricity at a cost ranging between \$0.23/kWh and \$0.33/kWh. In order to provide electricity at current tariff rates government has to provide subsidy to the electricity sector (fuel subsidy and utility operational subsidy) amounted roughly to MVR3 billion (\$200 million) in 2023,²² which accounted for more than 70% of all indirect subsidies given by Maldives. Subsidies is one of four areas identified by the government for stricter expenditure management. Both STELCO and Fenaka rely heavily on government subsidies. Fuel subsidy accounted for the volatility in fuel prices and made up about 41% of the direct subsidy budget in 2023. It is applied if the fuel cost per liter is above a threshold baseline rate. The difference between the market price and baseline rate is then paid off directly to the State Trading Organization (STO) as a subsidy to allow the utilities to purchase fuel from STO at a lower price. Usage subsidy accounts for about 30% of latest direct subsidy budget, to be paid to the utilities to compensate an adjustment for harmonizing domestic and business category tariffs across all islands. As a consequence, despite 100% accessibility, energy supply becomes expensive and the country cannot guarantee the financial sustainability of the sector.

4.1.1 Greater Male'

As of June 2024, the power generation installed capacity of diesel generators in Greater Male' is about 140 MW and 10 MW solar PV. Solar PV installations include small rooftop PV installations in Male' and Hulhumale', and two larger installations of 1,500 kW in Hulhumale' and 5,600 kW installed on the link of the road connecting Hulhumale' and the Velana international airport under power purchase agreements (PPAs).²³



A 100 kilowatt peak solar PV system installed at Maldives Center for Social Education in Male' (photo by Ministry of Environment)

²² The fuel subsidy for electricity generation accounted approximately for MVR2 billion and the operational subsidy to electricity utilities accounted for MVR1 billion in 2023.

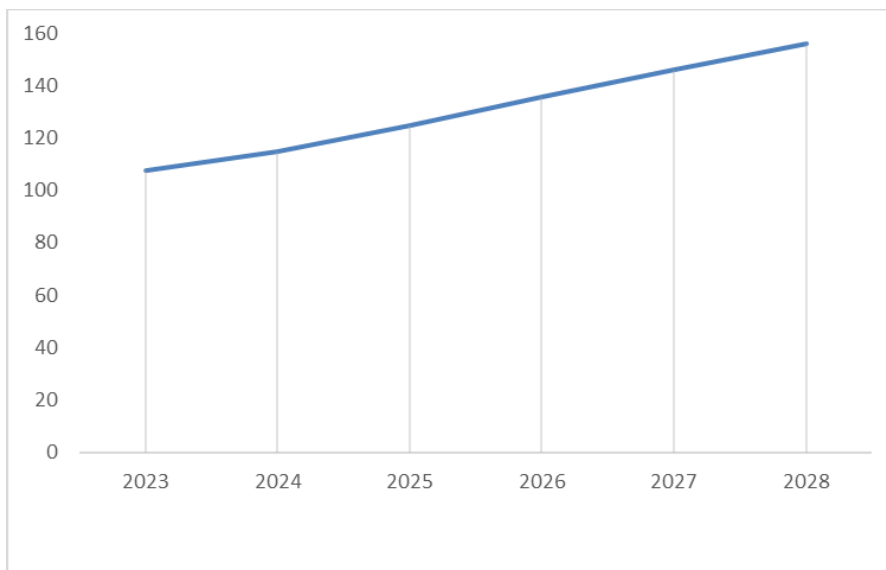
²³ The 2 solar PV installations operating with power purchase agreements were supported by the World Bank's funded project ASPIRE.



Expected Demand Growth

The peak demand of the Male' – Hulhulmale' system was 108 MW in 2023. For 2024, a growth rate of 9.6% with respect to 2023 is expected by STELCO's draft Master Plan. This Master Plan has considered several approaches to develop the demand forecast of Greater Male' until year 2040. Those approaches related to the expected timeline of major developments. Figure 3 shows the forecast until year 2028, considering a realistic, still cautious, demand growth rate of 7.9%

Figure 3: Forecast of the Peak Day Demand in the Greater Male' Region (megawatt)



Source: Estimated from STELCO's draft Master Plan

4.1.2 Other Inhabited Islands

The power generation capacity installed in other inhabited islands was about 208 MW at the end of 2023, of which 27 MW were solar PV and 181 MW were diesel gensets including 20 MW installed on industrial islands. Only 12 of these islands have generation capacities above 1 MW, while capacity in the rest of the islands ranges from 100 kW to 800 kW. These small power systems are often oversized due to always increasing demand growth. This causes that many power systems of the islands run at very low loads during off-peak hours. Operations at low loads mean poor fuel efficiency and increased maintenance. Their average specific fuel consumption is particularly high, with often two or more generations sets running all the time at low load. The average specific consumption in these islands is 0.42 liter/kWh. These values are much larger than acceptable average rates for isolated systems operating with no flexibility options such as energy storage, usually marked at 0.35 liter/kWh.

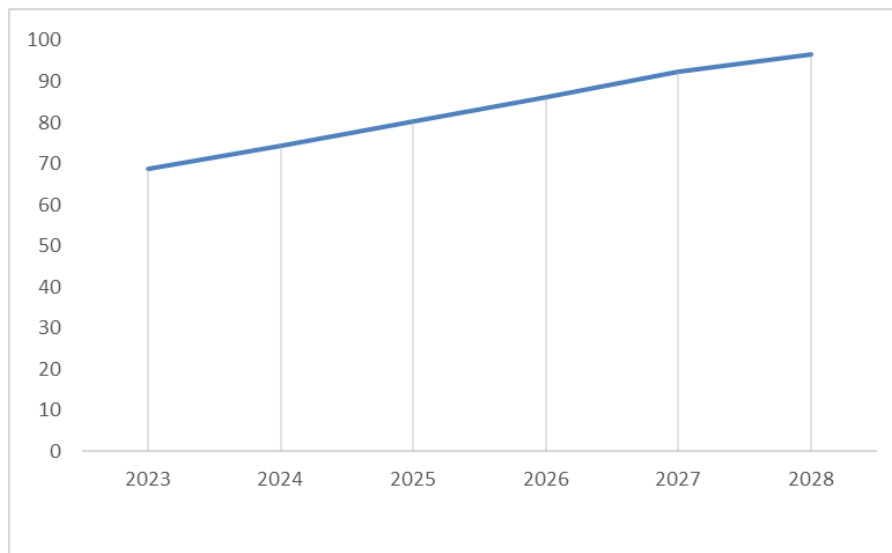


Left: 1,600 kilowatts-peak (kWp) Solar photovoltaic system in Addu City, S. Hithadhoo at phase 1. Right: 200 kWp in Kelaa, Haa Ali at phase 2 (photos of POISED project installations by Ministry of Climate Change, Environment and Energy).

Expected Demand Growth

The expected aggregated peak day demand of other inhabited islands to year 2028 is shown in Figure 4. Large growth rates of 9% for the next four years are expected. The opening of guest houses and tourism services on these islands have catalyzed the modernization of residential and public buildings and the improvement of their comfort conditions, which were traditionally lagging behind

Figure 4: Forecast of the Aggregated Peak Day Demand in Outer Inhabited Islands (megawatt)



Source: Asian Development Bank.



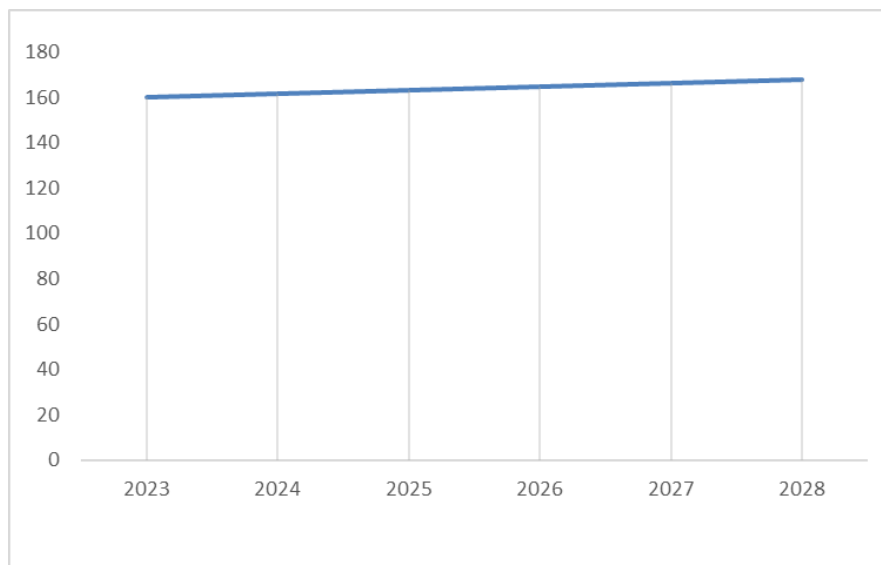
4.1.3 Resort islands

As of June 2024, the total installed capacity in resort islands is estimated at 242 MW, of which 211 MW are diesel gensets²⁴ and 31 MW are solar PV. The typical diesel power generation installed capacity on a resort island ranges between 1 MW and 2 MW.

Expected Demand Growth

The expected aggregated peak day demand of outer inhabited islands to year 2028 is shown in Figure 5. Different than inhabited islands, resort islands are already well equipped with all services their guests need. As most of these islands have fixed maximum capacity of guests, power demand growth is basically due to new resort island developments or enlargement of their capacities. An average 2% growth rate of power demand has been forecasted for resort islands.

Figure 5: Forecast for the Aggregated Peak Day Demand in Resort Islands (megawatt)



Source: Asian Development Bank.

4.2 Other Energy Uses

4.2.1 Transport

The country's geographic nature and highly scattered population makes transport of people, goods, and services fuel-intensive and very expensive. While all inhabited islands are served by a basic nationwide transportation network of ferries and jetties, connectivity across the islands still needs to be improved to sustain the development efforts of Maldives.

²⁴ Government of Maldives, Ministry of Environment and Energy. 2019. *Electricity Data Book 2019*. Male'.



The estimated consumption of diesel and petrol fuel used in transport has practically doubled over the past decade. During the period 2010–2020, the number of registered vessels has increased 50%, and the number of registered vehicles has more than doubled.

4.2.2 Liquefied Petroleum Gas

The liquefied petroleum gas (LPG) imported by the country is used for cooking. LPG imports have grown from almost 14,500 tons in 2017 to almost 17,500 tons in 2022. LPG is distributed in standard LPG bottles to the final consumer.



5 » WAY FORWARD

The Energy Road Map 2024-2033 foresees fifteen flagship interventions fulfilling the 25 strategies defined by the Energy Policy and Strategy 2024-2029 and the guidelines of the Electricity Act 2021 for the remaining period until 2033. The flagship interventions are listed in Table 3 and presented in detail in the following sections.

Table 3: Flagship Interventions Proposed by the Energy Road Map and Their Contribution to the Energy Policy and Strategy 2024-2029

Nº	Energy Road Map Flagship Intervention	Strategies ^(a) Supported
1	Accelerating the uptake of rooftop RE	1.1, 3.4, 3.5
2	Leapfrogging solarization of islands	1.2, 1.3, 3.4, 3.5
3	Evaluating maximum potential for RE integration into the grid	1.2, 1.4
4	Decarbonizing transport	1.5
5	Mainstreaming efficient consumption	2.1, 2.2, 2.3
6	Transitioning to cleaner fuels in Greater Male'	2.4, 2.5, 2.6, 3.3, 3.4
7	Setting up a fair and cost reflective electricity tariff and replacing indirect subsidy mechanism by targeted subsidy	3.1, 3.2
8	Erecting and integrating WTE plants	3.4, 3.5
9	Preparing smart, flexible and reliable grids	3.6
10	Exploring interconnection possibilities of island clusters and extending access to electricity service	3.6
11	Interconnecting power systems of Greater Male'	3.6
12	Strengthening regulatory framework	4.1
13	Accessing and collecting reliable energy data	4.2
14	Developing institutional capacity and strengthen international cooperation	4.3, 4.4
15	Unleashing the potential of marine RE and exploring Green Hydrogen options	5.1, 5.2, 5.3, 5.4

(a) The list of Strategies defined by the Energy Policy and Strategy 2024-2029 is presented in Table 2.

RE = renewable energy, WTE = waste to energy

Source: Asian Development Bank



5.1 Flagship Interventions

5.1.1 Accelerating the Uptake of Rooftop Renewable Energy

The installation of rooftop PV panels in Greater Male' has been increasing in the past 3 years, thanks to the net-metering tariffing system and STELCO's roof renting program. It is estimated that 9 MW of rooftop PV systems can be installed in Greater Male's households until 2028 under net-metering. To help this process, the *Accelerating Sustainable System Development Using Renewable Energy (ASSURE)* project, supported by ADB, will finance the installation of 6 MW of rooftop PV systems through net metering for at least 1,000 domestic and commercial consumers through the Government's Magey Solar Program. Rooftop PV under net metering has also already been successful in Addu city and in many other islands. The updated Road Map proposes to promote the installation additional 8 MW rooftop PV under the net metering scheme in Addu and other islands by 2028. Furthermore, 25 MW of rooftop PV systems are also foreseen over the roofs of the future commercial/industrial developments in Gulhifalhu and Thilafushi under a PPA arrangement by the end of 2028



Solar photovoltaic systems installed on a rooftop.

To ensure the success of this intervention, the utilities and the MCCEE should organize awareness campaigns to sensitize the public on the economic benefits, such as the reduction of their energy bill, rooftop solar PV offer through the net-metering mechanism. As the uptake of rooftop PV installations progresses, the net-metering regulation should be reviewed to adapt it to the challenges of integrating larger amounts of intermittent decentralized renewable energy into the grids.



5.1.2 Leapfrogging Solarization of Islands

The successful *Preparing Outer Islands for Sustainable Energy Development* (POISED) project, supported by ADB, has been a game-changer during the last decade in the country’s journey towards renewable energy. The POISED project installs smart hybrid RE mini-grid systems in islands combining solar PV panels, BESS, EMS, efficient gensets and upgraded grid networks.²⁵ The ASSURE project builds on the experience of POISED and will help 20 outer islands attain higher levels of renewable energy penetration through capital-intensive investments in energy storage to ensure island grids are ready for private investments for higher renewable energy penetration. By the end of 2028, ASSURE will provide utilities with 40 MWh BESS and improved EMS to enable the integration of at least 20 MW of solar PV through independent power producers (IPPs). The new power generation capacity will be additional to those already installed in the selected islands. ASSURE will also provide dedicated financial mechanisms, performance-based incentive schemes, and it will establish payment insurance coverage to safeguard risks of private investors. The World Bank funded *Accelerating Sustainable Private Investments in Renewable Energy* (ASPIRE) and the *Accelerating Renewable Energy Integration and Sustainable Energy* (ARISE) projects will also provide 36 MW of solar PV installations, including BESS by 2026. In addition, the updated Road Map proposes that additional 70 MW solar PV systems, with corresponding BESS and EMS, are installed on inhabited islands. BESS, at utility level in the distribution network, compensate the grid stability problems caused by insufficient spinning reserve or inertia in the system at instants of large intermittency of renewable energy production. Poor inertia is especially a challenge in systems like Male’ - Hulhulmale’, run by diesel gensets. The technical interventions listed in Table 4 are recommended to ensure the success of these investments.

Table 4: Recommended Technical Interventions to Ensure Solarization Investments

Recommendation	Details
Test and Program Inverters	Inverters should absorb or deliver reactive power, certified for harmonics compatibility, and programmed for voltage rise/drop issues.
Grid-Forming Inverters	Strongly consider for new solar installations.
Upgrade Grids	Invest in control and monitoring equipment, including cabling, smart metering, and advanced energy management systems.
Modern Dispatch Center for STELCO	Equip STELCO with automated dispatching technology and modern generator management system.
Install Weather Station	Support Male’ – Hulhulmale’ system with weather forecasting models, cameras for cloud monitoring for a timely increase of spinning capacity.

²⁵ By the end of 2025, POISED will have installed about 28 MW of solar PV power and about 22 MWh of energy storage in 126 outer islands.



Weather forecasting model	Use of weather forecasting models for day-ahead forecasting will help operational planning of power systems.
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Source: Asian Development Bank.

The updated Road Map also proposes that the *Solar Street Light and Solar PV Installation Program* is expanded to all Island Councils and that the Government establishes a revolving fund promoting the adoption of RE solutions across all economic sectors to contribute to sustainable economic growth.

As for the resort islands, the successful experience Maldives has had by converting power systems of inhabited islands into smart RE hybrid mini-grids has set an example to follow. At present, half of the RE capacity installed in Maldives is installed in resort islands, which illustrates that resorts are catching up at fast pace. Some resorts already have small floating solar systems installed. Transitioning to RE is a pure economic decision for resorts. The updated Road Map foresees that additional 125 MW are installed in resorts and industrial islands by the end of 2028.

5.1.3 Evaluating Maximum Potential for Renewable Energy Integration into the Grid

Utilities should carry out analytical studies that include adequate modelling to determine the maximum levels for renewable energy integration into the grid. Those studies should identify the technical measures and solutions to increase those maximum levels in a phased manner suitable to the investments proposed in the updated Energy Road Map. This is in particular important for STELCO in determining the upgrades and flexibility services needed in the Male’ - Hulhumale’ grid to allow higher levels of renewable energy penetration.

5.1.4 Decarbonizing Transport

Maldives population is scattered across hundreds of small islands. This unique characteristic requires efficient and affordable transportation systems. Thus, the provision of inter-island transport is crucial for Maldives. In relation to road intra-island road transportation, private vehicles are mainly used, causing high levels of road congestion. Interventions in energy efficiency, demand curtail, fuel substitution, and integration of new technologies are foreseen. Flag interventions for these energy uses are listed in Table 5.

Table 5: Proposed Interventions for Sea and Road Transport

Transport Type	Measure	Details	Goal
Sea	Replacement of inefficient fleet	The initiative aims to replace a portion of the existing sea vessels with more efficient units, including electric models, while improving fuel efficiency and reducing operational costs. This will be achieved by conducting a comprehensive fleet	Replace 10% of the existing sea vessels within the next 5 years with more efficient units including electric models to improve



		audit to identify inefficiencies and establishing a government tax incentive program: to support vessel replacement, setting technical standards for new vessels, installing charging infrastructure for electric vessels, and regularly monitoring fuel efficiency and operational costs.	overall fuel efficiency.
Sea	Hybrid solar boats	Introduce hybrid solar boats as pilot project for short-distance travel, particularly for tourism purposes. Electric motors run on batteries charged with power supplied by solar panels mounted on the boat.	No sound and vibrations and are fuel odor free when propelled by the electric motor.
Road	Reduction of vehicles registration	Move from the use of personal vehicles to efficient and sustainable public transportation by placing restrictions on the issuance of new registrations and on the age of vehicles allowed on the roads.	Efficient and sustainable public transportation.
Road	Replacement of inefficient fleet	To replace an inefficient fleet with more efficient vehicles, including electric and hybrid models, and improve average specific consumption, the following steps will be taken: conduct a fleet audit to identify inefficiencies; establish a government tax incentive program to support the replacement of old vehicles with electric and hybrid models; install EV charging infrastructure; and regularly monitor fuel efficiency and operational costs.	Replace 10% of the existing inefficient and old vehicles with more efficient electric and hybrid models over the next 5 years to enhance overall fuel efficiency
Road	Electric buses, vehicles and motorbikes	Introduction of full electric buses, vehicles and motorbikes nationwide. Requires proper charging infrastructure.	Achieve a 1% share of hybrid or electric units by 2028.

Source: Asian Development Bank.



5.1.5 Mainstreaming Efficient Consumption

The updated Road Map focuses its energy efficiency and conservation interventions in the built environment, efficient electrical appliances, and public awareness and responsible energy consumption behavior.

Built environment. Energy consumption in buildings and houses accounts for a large share of the total end use of energy in Maldives. However, there is no data available on their energy consumption and their levels of energy efficiency. Most buildings in Maldives suffer from large energy losses. The majority of residential buildings have been designed for the use of fans as the source of comfort air. These buildings later adopted air-conditioners. Unfortunately, not many dwellings are designed to keep comfortable room temperatures.

Interventions related to the energy efficiency in the built environment are shown in Table 6. The promotion of energy service companies (ESCOs) and the use of energy savings performance contracts (ESPCs) may facilitate the implementation of these measures.

Table 6: Mainstreaming Energy Efficient Interventions in the Built Environment

Intervention	Description
Revise and enforce building codes	Require energy efficiency and conservation measures for public buildings and new housing developments. Promote installation of rooftop solar PV panels for electricity production and solar thermal for water heating.
Implement a certification mechanism	For energy-efficient buildings and carry out energy efficiency audits. Audits should identify most viable options for dwelling refurbishments and should be obligatory for all public buildings and new housing developments.
Promote efficient lighting	The “FahiAli” program, managed by the MCCEE, illustrates well the success story of the promotion of efficient lighting. Phase 3 of this program has handed a total of 262,500 LED lights to Fenaka for distribution to each beneficiary household. Previously, phase 2 of this program distributed 75,000 LED lights to different institutions and individuals, and 534 harbor lights were provided to seven islands. Phase 1 of the program distributed a total of 265,000 LED lights to 164 islands and 511 institutions. It is recommended to maintain similar programs for low-income households.

Source: Asian Development Bank.

Efficient appliances. Imports of air conditioners, refrigerators, freezers and washing machines have grown rapidly over the past decade. However, efficient, automated, centralized air conditioning systems are not the norm in buildings. Most buildings and houses use manually controlled air conditioning units installed in each room and space to be climatized. Import and purchasing of air conditioning units do not follow any energy performance criteria. The necessary information for monitoring the energy performance of appliances arriving to



Maldives is lacking; for instance, technical records of imported equipment are nonexistent. The data regularly recorded by the Maldives Custom Services do not capture information related to the capacity and technology of products imported, the energy rating, and the models and make, among others. Without this information, it is difficult to plan and implement adequately tax incentives to best performing appliances and equipment, or to inform the population on the benefits of using energy-efficient equipment, or to monitor the results of any related campaign. It is recommended to continue and expand the energy efficiency labeling for electrical appliances, making sure that it covers all types of air-conditioners, refrigerators, freezers, other type of cooling appliances, washing machines and microwaves for household, commercial and industrial use. It is also recommended to review procurement policies and the Public Finance Act to promote procurement of energy-efficient appliances

Public awareness and behavior. The following interventions are recommended to improve public awareness and promote responsible behaviors in energy consumption and conservation.

- The MCCEE and the power utilities to regularly conduct public awareness campaigns on energy efficiency and conservation.
- The MCCEE, in collaboration with the Ministry of Education, to develop energy efficiency guidelines for schools.
- The MCCEE, in collaboration with the Ministry of Tourism, to promote eco-tourism across the country.

5.1.6 Transitioning to Cleaner Fuels in Greater Male'

Power demand in Greater Male' is expected to increase to about 400 MW by 2040. Transitioning to RE and achieving the 33% RE target in Greater Male' presents two important challenges affecting the promptness of needed large RE projects:

- the size and technology readiness of RE installations (large floating solar PV, ocean and other marine energy power plants), and
- the flexibility of the grid to integrate such large projects.

Substituting old and inefficient diesel gensets by modern, more efficient and less polluting gas fueled units with larger power output is an effective measure for the energy transition of Greater Male'. For example, natural gas burns cleaner than diesel fuel, releasing about 25% less CO₂ emissions. Natural gas as a fuel for the power sector has advantages beyond its cleaner burning properties. Natural gas fired combined cycle power plants can provide required flexibility for the integration of important amounts of intermittent RE, are more efficient than diesel gensets, and incur less maintenance and operating costs. Also, the construction of LNG facilities increases and enhances fuel storage capacity. Thus, natural gas fueled power plants neither compete nor delay the implementation of large RE projects but can complement future large RE projects and help their integration into the grid. However, the replacement of diesel gensets may require moving the powerhouses to more adequate locations. In addition, lacking domestic reserves means Maldives must import liquefied natural gas (LNG), which must be turned back into gas form and delivered via pipelines to power stations.



At present, Maldives lacks the infrastructures needed to import, store, transport and use LNG. A recent report conducted for the MCCEE under technical assistance funded by the Asian Development Bank (ADB), analyzed the competitiveness of generation of power through gas and diesel through an estimation of levelized cost of electricity (LCOE).²⁶ At a plant load factor of 60% for a power plant located in Gulhifalhu, with an initial size of 140 MW (and growing over time up to 400 MW), the cost of generation of power through diesel is estimated to be 27.7 \$cents/kWh as compared to 14.0 \$cents/kWh for a gas fired power plant. Since, the most efficient diesel generators in Maldives produce electricity at a cost ranging between \$0.23/kWh and \$0.33/kWh, gas as a fuel for electric power production shall remain affordable as long as the delivered cost of gas at plant gate is below 25 \$/MMBtu, which is significantly higher than prevailing LNG prices.

It is recommended to undertake a detailed feasibility study assessing the techno-economic viability of LNG sourcing, including a floating storage unit, associated seaside mooring infrastructure, pipeline network and construction and operation of the resulting power plant(s).

5.1.7 Setting Up a Cost Reflective Tariff and Replacing the Indirect Subsidy Mechanism by a Targeted Mechanism

The URA should work with the MCCEE and the Government of Maldives to implement cost-reflective electricity tariffs and eliminate generalized indirect subsidies that may have a distorting effect on electricity pricing and financial viability of the utilities.

The current level of subsidies to the electricity sector is economically unsustainable and unfair to most economically vulnerable consumers. The mechanism of generalized indirect subsidies rewards the most to large consumers (Figure 6). A consumer of 1,500 kWh/month will benefit from a monthly subsidy of MVR 2,285, while a consumer of 50 kWh/month will benefit from a subsidy of MVR176.50. Instead, a target subsidy scheme for those consumers in need of economic assistance would be the best option for getting out of the dangerously spiral of boundless subsidy growth.

²⁶ Deepak Mahurkar. 2024. Maldives Energy Transition – Role of LNG – Prefeasibility Report.



Figure 6: Subsidy in Electricity Bill According to Household Consumption (in MVR/month)



Source: Asian Development Bank.

The updated Road Map recommends to transition from the current indirect subsidy mechanism benefitting everyone, to a targeted subsidy mechanism by implementing the following steps:

- Finalize the preparation of a cost reflective electricity tariff methodology.
- Establish transparency rules for the quantification and communication of operational costs of the Utilities to the URA.
- Elaborate and implement a 4-years tariffs reform road map that includes the transitioning from the current indirect subsidy mechanism to direct targeted subsidies to eligible consumers.

5.1.8 Erecting and Integrating Waste-to Energy Plants

The most pressing environmental issue at present in Maldives is waste management. Open burning of waste is still widely practiced in several islands. The fraction of organic waste is the largest stream, followed by the plastic and paper waste fractions. Most of the inhabited islands have Island Waste Management Centers (IWMCs), where waste is collected. Machinery and technical know-how are deficient in these facilities. Most of them lack the basic equipment required for effective waste management. In the case of the Greater Male' Region, the island of Thilafushi was developed to collect and treat the Region's household waste. In order to generate power from municipal solid waste, 3 different projects have been initiated and should be fully operational by the end of 2024:

- 12 MW capacity in K. Thilafushi,
- 1.5 MW capacity in Addu city, and
- 0.5 MW capacity in R. Vandhoo.

5.1.9 Preparing Smart, Flexible and Reliable Grids

A large part of distribution grids in the Greater Male' Region was not designed for the current and forecasted uses. Energy losses in these grids are a concern that must be promptly addressed. The current average grid losses is estimated at 8% for Greater Male' and at 12%



for outer islands. The upgrade of grids aims at reducing such losses country wide to 5% by 2028.

It is recommended to improve the efficiency of electricity power grids through upgrades and by establishing a benchmark for utilities to control grid losses.

Upgrading of distribution grids should include smart metering, automation of distribution systems and remote data acquisition. Smart metering allows to measure electricity consumption as close as possible to real-time. Smart metering enables utilities to offer differentiated hourly tariffs according to the time of day and the source of energy supplied (renewable or diesel).

Enhancing the energy storage capacity becomes very relevant when the share of renewable energy in a system surpasses the 25% ratio and becomes essential when it surpasses the 40% ratio. Flexibility services provided by energy storage provide stability to the grids and facilitate the integration of a larger amount of intermittent renewable energy. Feasibility studies will be needed to determine the specific amount of energy storage required by each island.

5.1.10 Exploring Interconnection Possibilities of Island Clusters and Extending Electricity Service

Interconnection possibilities for some close-by island systems should further be studied in detail. If a power interconnection is found to be feasible, it is also good to include the option of fiber optic so that the cable can be used for power and also for telecommunication. That will eliminate microwave radio used between islands for telecommunication and can cater for future capacity required in the country. Fenaka has identified at least seven cases where distance between islands is smaller than 2 km and interconnection seems possible. Resulting electrical systems would range between 2 MW to 10 MW. Interconnections will be done either with a submarine cable or aerial cable, depending on the depth of the sea and traffic of vessels. Feasibility studies are currently being carried out. Continuous assessments of those possibilities are recommended.

It is also recommended to extend the electricity service to newly developed, reclaimed, industrial and agricultural islands, and when possible, integrate them to interconnected island clusters.

5.1.11 Interconnecting Power Systems of Greater Male'

The interconnection of Greater Male' power grids, together with the implementation of energy storage and other flexibility services, are essential for enabling the integration of new renewable energy, and for increasing the reliability and efficiency of the power system.

A radial three-phase transmission grid interconnecting the six islands of Greater Male' at 132kV voltage will result in larger penetration of renewable energy sources and more efficient and redundant network that will optimize operation and reduce power losses in the interconnected system. Interconnection of power grids is, therefore, crucial for the success of this Road Map. The interconnection of Greater Male' involves two phases:

- **Phase 1: Hulhulmale'-Hulhule' -Male'**, operational since 2021 (Figure 7).



- **Phase 2: Male'- Villingili-GulhiFalhu-Thilafushi**, expected to complete by the end of 2026.

The interconnection is proposed level to optimize power transmission from Male'.

Figure 7: Phase 1 of the Interconnection of the Greater Male' Region



kV = kilovolt, SS =substation.

Source: Government of Maldives, State Electric Company Ltd. (STELCO). January 2020.

5.1.12 Strengthening Regulatory Framework

The regulatory framework should constantly be revised and adapted to technical developments and economic challenges. The technical regulatory measures proposed by the Energy Road Map are shown in Table 7.

Table 7: Technical Regulatory Measures Proposed by the Road Map

Regulatory Measure	Description
Revise the Energy Act	The Energy Act from 2021 requires an update to better enable private sector participation in the sector. It should also establish renewable energy targets and obligations to accelerate the energy transition.
Revise the net metering regulation	The net metering regulation should be periodically reviewed and updated when needed.
Develop and update codes and standards for products and services in the energy sector	Technical codes for the power industry. Develop technical operation codes and technical standards for equipment used in power generation and in the



operation of hybrid power plants. Define basic controller functions in technical codes, including automatic start-up, shut down, load sharing, and automatic recovery. Modernizing the grid code offers straightforward advantages for achieving a certain level of grid monitoring. A new grid code will establish technical requirements for all solar PV connections and the technical parameters for grid control and monitoring.

Technical standards for generation equipment. Develop and enforce technical specifications for electricity generation equipment, make compliance obligatory in all purchases with public finance.

Technical standard for fuels quality. The substitution of diesel and petrol for lower-emission fuels requires that a fuel quality standard and a monitoring plan are implemented to ensure that the quality of fossil fuel sold in the country is adequate.

Technical codes for grid connection of decentralized renewable energy. Establish clearer regulations and technical codes for the connection to the grids of prosumers' systems, ensure proper handling of intermittent energy and ensure grid security

Update the Energy Road Map periodically	The Energy Road Map should be updated periodically. These updates should be preceded by an assessment of its implementation.
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Source: Asian Development Bank.

5.1.13 Accessing and Collecting Reliable Energy Data

It is essential for the Government to empower URA and provide it with necessary resources to ensure that the electricity sector is regulated as per international best practices. Part of this empowerment is having enough capacities and enforcement power to collect annually audited cost-related and operational information from utilities and having full capabilities to assess and verify the adequacy of the collected information.

URA should also have enough capacity and enforcement power to collect information on power generation from resorts and privately managed islands. It is recommended that URA establishes a central data acquisition system to collect all relevant operational data, electricity generated, fuel consumed, batter performance, and RE generation and usage. All this data is necessary to monitor energy production and usage statistics in Maldives. Once collected and analyzed, this information should be made available to relevant stakeholders. Finally, it is recommended to set up an energy laboratory for regulatory monitoring purposes.



5.1.14 Developing Institutional Capacity and Strengthen International Cooperation

Enabling the transition requires strengthening institutional and staff capacities in the energy sector. Strengthening international cooperation with the different development partners and multilateral organizations supporting Maldives offers an excellent opportunity for accelerating best quality capacity building activities, based on knowledge transfer of best international practices. Staff from the sector (MCCEE, URA and utilities) should be permanently trained on electricity pricing mechanisms and power purchase agreements. In particular, training on innovative auctioning systems as potential future option for international private sector investment will be needed. MCCEE's staff should also be trained to improve knowledge on energy planning and the design of adequate regulation. Capacity building for the URA should cover the wide range of energy planning, tariffication, energy pricing, compensation mechanisms to large and decentralized power generators, and in general any other topics that facilitates their regulatory role. Furthermore, energy utilities should make all necessary efforts to train their staff to excel in operations and maintenance of their power plants. In particular, staff from remote inhabited islands should be benefitted with capacity-building programs offered by utilities.

Looking at the future, the country needs more vocational and higher education programs on science, technology, engineering and mathematics (STEM). It is recommended to collaborate with the Ministry of Education and the Ministry of Higher Education to further develop these programs.

5.1.15 Unleashing the Potential of Marine Renewable Energy and Exploring Green Hydrogen Options

The Government is actively working to promote private sector investments through IPPs in large scale floating solar and marine energy projects. For the longer term, the integration of the full potential of marine renewable energy would require a specific strategy and feasibility studies to identify the locations and technologies. The R&D required would benefit greatly from collaboration with international parties. A Marine Renewable Energy Road Map will be developed in the first half of 2025 through international technical assistance supported by the ASSURE project. The ASSURE project will also support the integration of evidence-based innovative technology solutions by financing one pilot project on marine renewable energy and one pilot on wind energy.

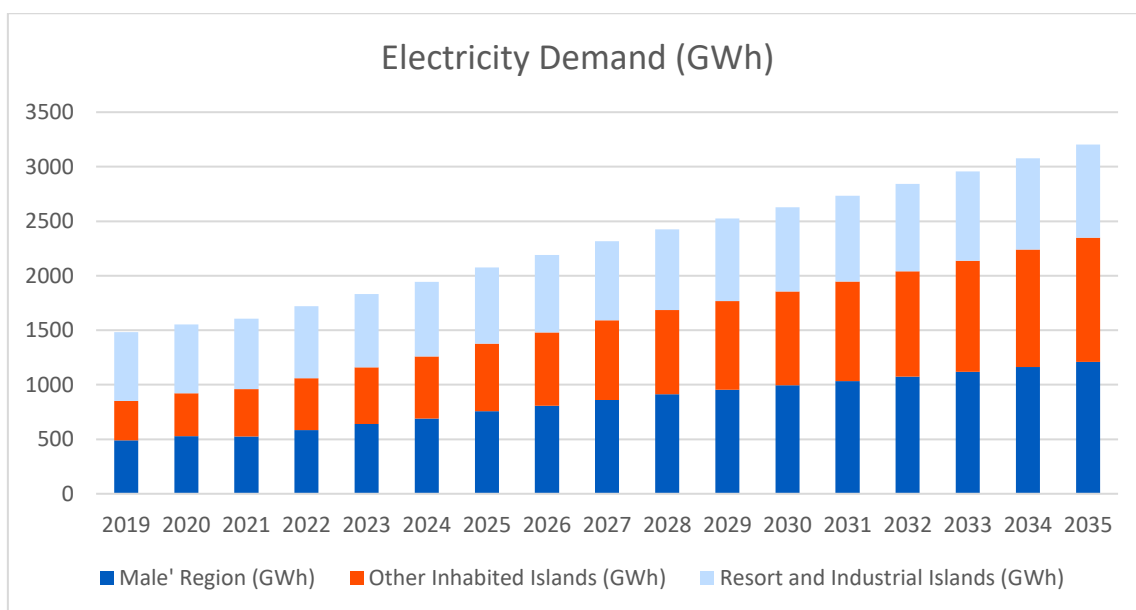
Hydrogen produced with RE (green hydrogen) is a future alternative to decarbonized generators, as well as over conventional lithium-ion BESS. The surplus of RE produced in the islands can be converted to hydrogen using electrolysis. Hydrogen can be stored, transported, and used as fuel in internal combustion engines. This is also an option for retrofitted ferries and jetties. At present, the most critical challenge facing the commercial production of green hydrogen is the cost of electrolysis. A pilot project is needed, preferably by 2030, to determine which options (technologies and sizes) are the most economically viable for Maldives. These innovative ideas require long-term R&D support. It is recommended that the Government provide incentives through financing mechanisms for national involvement in energy R&D.



5.2 Evolution of Renewable Energy Share

Electricity consumption in the country is steadily increasing at around 5% per year and expected to reach 2,400 gigawatts-hour (GWh) in 2028 (Figure 8). The Government target of 33% renewable energy in electricity consumption means that 800 GWh must come from renewable energy. Maldives currently has 68.5 MW of renewable energy from solar PV installed, and an additional 90 MW of renewable energy is already under development, making it a total of about 160 MW RE generation capacity installed by 2028. An additional 330 MW of solar PV infrastructure will be needed to achieve the 800 GWh target by 2028.

Figure 8. Forecasted Electricity Consumption in Maldives



Source: Asian Development Bank.

Table 8 outlines a list of planned and potential future initiatives that can be implemented by the end of 2028 and Figure 9 shows the proposed implementation plan for these initiatives. The investment mechanisms selected for these projects include Power Purchase Agreements (PPA) for larger infrastructure projects and net-metering tariffs for smaller rooftop installations. Achieving the Government's targets will require an estimated 330 MW of additional renewable energy capacity. Moreover, significant investments are necessary to upgrade the islands' power systems to support a high proportion of renewable energy. Altogether, integrating this 330 MW of renewable energy is projected to require approximately \$1.3 billion in financing over the next four years. This substantial investment will help drive the expansion of RE in Maldives and reduce reliance on imported fossil fuels.

Beyond 2028, the exploration and development of other RE technologies, such as wind and ocean energy, will be crucial. It is important to trial these technologies in the coming years to assess their feasibility and potential for broader implementation. By doing so, Maldives can continue to diversify its energy portfolio, work towards achieving its NDC targets, and progress towards carbon neutrality.



Furthermore, these initiatives not only contribute to environmental sustainability but also offer significant economic and social benefits. By investing in RE, Maldives can enhance energy security, create job opportunities, and stimulate economic growth. The transition to a greener energy system will also help mitigate the impacts of climate change, safeguarding the nation's natural beauty and resources for future generations. The Government's commitment to expanding renewable energy capacity and exploring new technologies demonstrates a proactive approach to sustainable development. Continued collaboration with international partners and stakeholders will be essential to mobilize the necessary resources and expertise to realize these ambitious goals.

Table 8. Planned and Possible Initiatives to achieve 33% Renewable Energy Share in the Electricity Sector

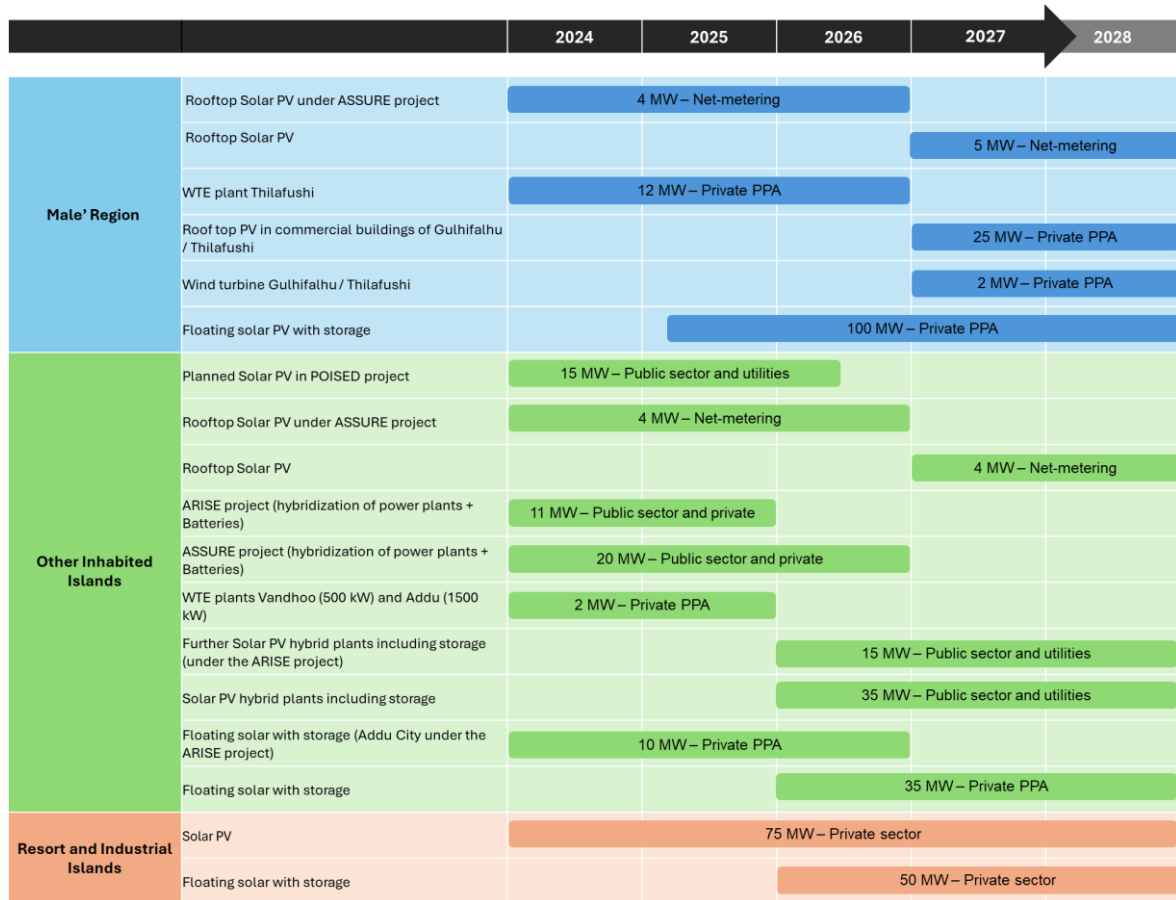
Project Investment	Planned (MW)	Potential Initiatives (MW)
Greater Male'		
Rooftop PV under ASSURE project	4	
Rooftop PV		5
WTE plant Thilafushi 2x4000 kW	12	
Roof top PV in commercial buildings of Gulhifalhu / Thilafushi		25
Wind turbine Gulhifalhu / Thilafushi		2
Floating solar with storage		100
Other Inhabited Islands		
Planned Solar PV in POISED project	15	
Rooftop PV under ASSURE project	4	
Rooftop PV		4
ARISE project (hybridization of power plants + Batteries)	11	
ASSURE project (hybridization of power plants + Batteries)	20	
WTE plants Vandhoo (500 kW) and Addu (1500 kW)	2	
Further Solar PV hybrid plants including storage (under the ARISE project)	15	
Solar PV hybrid plants including storage		35
Floating solar with storage (Addu City under the ARISE project)	10	
Floating solar with storage		35
Resort and Industrial Islands		
Solar PV		75
Floating solar with storage		50
Total	93	331



Source: Asian Development Bank.

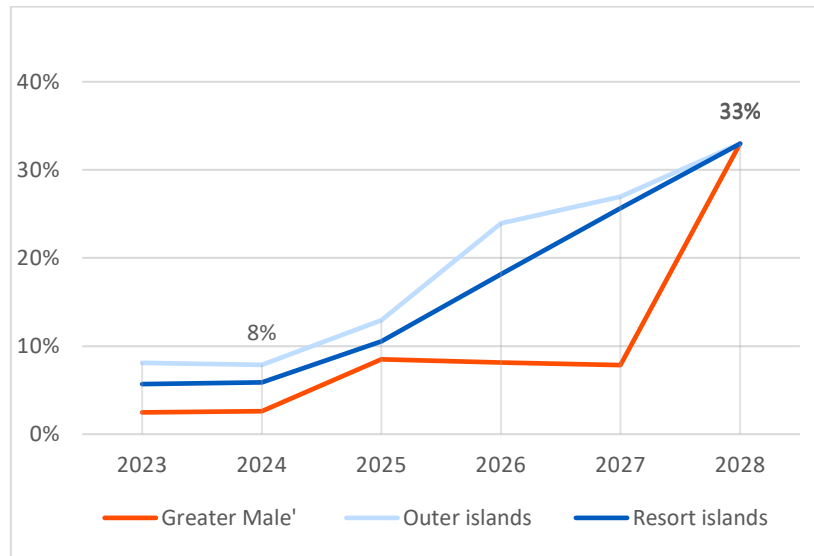
The proposed interventions will drive islands to meet the 33% renewable energy share announced by the Government of Maldives. The evolution of the Renewable Energy share over the years is shown in Figure 10.

Figure 9. Implementation Plan for the Potential Renewable Energy Initiatives



Source: Asian Development Bank.

Figure 10: Forecast of Renewable Energy Share in the Electricity Produced in Maldives (%)



Source: Asian Development Bank.



6 » ENABLING A JUST ENERGY TRANSITION

An enabling environment to facilitate a just energy transition is needed for the successful implementation of the updated Energy Road Map. The Government is committed to provide such enabling environment to confer authority, build consensus, attract attention to, and provide resources for the Road Map implementation.

6.1 Implement an Integrated and Comprehensive Framework

An integrated and comprehensive framework is essential for a smooth and inclusive energy transition cover multi-sectoral policies, financing for catalyzing just energy transition, social protection, resilience, and institutional strengthening in the energy sector, along with social and technical assessments of energy transition initiatives. Eight domains are identified to guide a just energy transition in Maldives (Table 9). These domains are interconnected and interrelated.

Table 9: Framework Domains Guiding the Just Energy Transition

Domains	Description
Policies	GESI policies should be in place to promote inclusive outcomes. Coherent policies are needed across the economic, environmental, social, education, training, and labor portfolios. Policies should also enable MSMEs, workers, investors and consumers to participate and drive the transition towards environmentally sustainable and inclusive economies and societies. Subsidy reforms are also needed, informed by GESI considerations.
Access to key utilities and quality energy services	Access by excluded and vulnerable groups in an integrated manner: income poor, women, older people, persons with disability, disadvantaged ethnic groups and castes, those in vulnerable geographic locations, slum and transient populations, and marginalized due to their sexual orientation, gender identity, and gender expression.
Economic development	The growth of green industries and the promotion of sustainable practices can lead to the creation of new job opportunities, MSMEs and contribute to economic development. Maximizing GESI in access to these opportunities means addressing the gender gap in STEM education, STEM industries and closing the gender pay gap in STEM industries.
Employment and green jobs	Workers in carbon-intensive industries may require new skills and training to transition into green jobs. Governments, employers, and educational institutions play an important role in providing the necessary training and support. Social dialogue between governments, employers, trade unions,



	and civil society is essential to develop inclusive and effective strategies for just energy transition and to address potential conflicts and challenges.
Social protection	The establishment of adequate social protection systems is essential to enable a just energy transition. Social protection systems need to provide income security and social services, based on international labor standards, to increase resilience and safeguard communities against the impacts of economic and environmental vulnerabilities and shocks.
Community-centered Local Governance	Vulnerable communities on the frontlines should be a part of the decision making and leadership of their transition. This also involves the utilization of traditional, indigenous and local knowledge; valuing of non-polluting care work as 'climate work'; application of integrated (community, district, subnational and national levels and across industries and sectors), inclusive and decentralized, community-based participatory approaches.
Technology innovation	Technology innovation presents promising opportunities for just energy transition, such as distributed generation and demand side participation in the power system and energy markets. The new challenges require socio-technical approaches for system design.
Financing	Funding mechanisms and arrangements to support GESI outcomes in the energy transition must be ensured. Countries that commit to a GESI-inclusive energy transition can use their commitments to leverage international funding.

GESI = specific gender equality and social inclusion; MSME = micro, small and medium enterprise; STEM = science, technology and mathematic.

Source: Source: R. Mohideen. 2024. *Managing gender-inclusive, just energy transitions in South Asia*. Oxford Open Energy, Volume 3, 2024. United Kingdom.

6.2 Increase Cross-sectoral Efforts

Soon after the POISED project started, the MCCEE realized that it needed to think cross sectoral. The production of renewable energy is not a sufficient outcome. It is a means to achieve a better quality of life for the population. Additional financing processed by ADB in 2020 supported cross sectoral pilot initiatives including solar PV based ice-making plants to support fisheries, and renewable energy-based passenger ferry to support marine transport. In partnership with island councils and the Women Development Committees (WDCs), POISED is installing ice-making plants on four islands to support the fishery industry and to expand women's income-earning opportunities and community-based enterprises. This initiative will not only boost livelihood in fisheries communities and become an income generation for



women, but also contribute significantly to develop alternatives to tourism industry activities, which is relevant in times of distress as it happened during the COVID-19 pandemics.

Regarding the synergies of energy and water, many of the islands need to install and operate desalination plants since aquifers have been contaminated with the intrusion of saltwater or uncontrolled disposal of waste. Reverse osmosis is the most suitable technology for those plants. Reverse osmosis is an energy-intensive process that could benefit from renewable energy production. It is recommended to further explore water–energy synergies in all other inhabited islands, as well as in resorts, industrial, and agricultural islands.

6.3 Prepare the Future Workforce for Change

As Maldives transitions towards a more sustainable energy future, it is essential to prepare the next generation for the challenges and opportunities within the energy sector. Initiatives aimed at educating and training students from an early age are crucial. Programs focusing on renewable energy, efficiency, and conservation practices should be integrated into school curriculums, particularly for students in grades 8–12. These initiatives can include hands-on training, internships, and field trips to renewable energy sites, offering students practical experience and insights into potential career paths. Moving forward, the nation requires an expansion of vocational and higher education initiatives in STEM careers.

6.4 Continue Community Engagement for Gender Equality and Social Inclusiveness

Achieving gender parity in the power sector remains a significant challenge, with women underrepresented across various roles. Current participation levels show that female staff constitute a small percentage of the workforce, particularly in technical and management positions. The female staff at STELCO reaches only 16%. Fenaka shows a slightly better situation with 18.4% female staff. Less than 15% of middle and top management positions are occupied by women, and female presence in technical positions is below 2%. Efforts are being made through leadership programs and initiatives aimed at enhancing skills in energy planning and management to increase female participation in these areas. Additionally, projects are promoting income-generating activities, especially for women, by supporting innovative practices and renewable energy solutions.²⁷

Maldives has already set exemplary action for initiating change and close the gender gap in the access to higher education and professional opportunities in the energy sector. The POISED project has prioritized empowering women by engaging communities vigorously through sustained campaigns on gender inclusivity, renewable energy, and the green economy across its targeted 160 islands. It also launched a gender-inclusive outreach program focusing on island women's committees to increase awareness about renewable energy and demand-side management at home. By the end of 2023, 113 gender-inclusive community programs were delivered to a populace of 12,908, with women making up more than half. These efforts should be mainstreamed in all programs. The MCCEE aims to reinforce, and mainstream in all programs, the continuation of training and educational activities carried out under the POISED

²⁷ Both initiatives funded by the ASSURE project.



project and planned under the ASSURE project. In particular, the Ministry should establish a long-term emphasis on training the female staff of the utilities in implementing the renewable energy mini-grid systems foreseen in this Road Map, and on increasing the number of female technicians and engineers. The current activities on career guidance sessions for school children for Grades 8–12 and on the promotion of women-run enterprises supplied with electricity from solar systems are crucial to achieve transformational change on gender equality.

6.5 Monitoring Road Map Results and Preparing Plans and Studies

Successful implementation of the Energy Road Map requires continuous monitoring and evaluation of results. Monitoring and evaluation provide the opportunity to test planning assumptions, compare effectiveness of different approaches, adjust and correct future actions, anticipate capacity-building needs, and prepare new regulations. It also informs the national government for better delegation of responsibilities to local authorities, provides the foundation for oversight, and facilitates accountability arrangements. A mechanism led by the MCCEE needs to be in place to monitor, assess, and communicate results, and coordinate actions with other ministries, government offices, energy utilities, city councils, industries, and resorts management. A well-functioning monitoring mechanism is also useful for facilitating access to international climate finance.

The MCCEE should also develop and keep updated the national energy balance, plans and feasibility studies, necessary for the effective monitoring of Road Map results. The energy balance should be updated annually with timely reporting inputs from energy companies, island councils, main industrial players and resorts.

6.6 Alignment with Sustainable Development Goals

The updated Energy Road Map is fully aligned with several United Nations' Sustainable Development Goals (SDGs) (Figure 11). The important level of foreseen investments in renewable energy infrastructure by this Road Map has its most direct impact on SDG 7 (affordable and clean energy), SDG 12 (responsible consumption and production), SDG 13 (climate action), and SDG 14 (life below water). This Road Map has an important positive effect on the conservation of oceans and life below water since it stops the uncontrolled growth of fossil fuel transportation by boats and possible spills this activity sometimes causes. Also, through the implementation of cross-sectoral interventions, the Energy Road Map also has clear socioeconomic impacts on SDG 1 (by contributing to reduce poverty), SDG 2 (by contributing to improve food security), SDG 5 (by contributing to gender equality in the sector), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure) and SDG 11 (sustainable cities and communities).



Figure 11: United Nations' Sustainable Development Goals



Source: <https://www.un.org/>

6.7 Financing Schemes

Maldives faces many difficulties in structuring the financing of its development projects, including climate change mitigation projects such as those listed in this Road Map. The main limiting factor is the reduced public sector financing capacity. This characteristic makes Maldives highly dependent on grants and soft loans from development cooperation to boost private sector investments. The foreseen actions for the transformation and paradigm shift scenarios are summarized in the design and monitoring framework found in the appendixes of this report.

The Road Map requires an important extra financial effort to achieve proposed targets. These additional efforts include:

- sustained support by multilateral development banks to specific actions and targets;
- bilateral cooperation with donor countries, which should include knowledge and technology transfer mechanisms;
- establishing alliances with foreign investors interested in the introduction of innovative renewable energy technologies; and,
- strengthening knowledge sharing with other island states.

Lower generation cost from renewable energies would improve financial performance of the public utilities and reduce the need for budget support to the electricity sector, thus improving the country's fiscal sustainability. Furthermore, renewable energy would positively impact the cost of electricity service as it can decrease the logistics difficulties in shipping and storing fuel across a large number of islands. Savings from lower generation costs should be transformed into a financing instrument leveraging additional funds for renewable energy infrastructure, particularly for the most economically vulnerable inhabited islands.



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