Feasibility Study on Green Hydrogen Potential in Maldives

Baseline Assessment Report

November 2025

Prepared for

UN environment programme | CTCN UN Climate Technology Centre & Network | Funded by the European Union

Submitted by

pMANIFOLD Advancing Net Zero Markets

pManifold Business Solutions Pvt. Ltd.

CONTENTS

EXECUTIVE SUMMARY

Maldives, an archipelago of dispersed, diesel-dependent island microgrids, faces acute climate vulnerability, rising energy costs, and growing pressure to decarbonize critical sectors including power, water, transport, waste, and tourism. Despite contributing minimally to global emissions, the nation has committed to an ambitious Net Zero by 2030 target, positioning Green Hydrogen (GH2) as a potential long-term enabler for energy security, resilience, and deep decarbonization. This baseline assessment establishes the technical, institutional, and sectoral foundations required to evaluate GH2 adoption pathways across the Maldives.

In Maldives, a fifth of total annual imports comprises of petroleum products namely, diesel, aviation gas and petrol. The energy systems also remain entirely reliant on imported diesel (>90%), with electricity generation, desalination, and transport forming the largest and most energy-intensive uses. Renewable penetration has grown (6% RE share in total energy mix) but remains limited, constrained by land scarcity, fragmented island grids, and diesel's entrenched cost structure. At the same time, the Maldives possesses abundant solar resources and projects like POISED and ASPIRE are established to transform the existing diesel-based energy systems across islands into hybrid solar PV-diesel systems. Additionally, emerging hybrid RE-desalination models, and expanding resort-led renewable initiatives are collectively creating a favorable condition for future RE based GH2 production and use. However, the cost of producing RE-based GH2 will be a critical challenge to resolve and deep dive to understand adoption and export potential.

Apart from the economics of production, GH2 adoption in the country will also be dependent on the growth trajectory of other related sectors such as electricity, transport, waste and tourism. This report evaluates these sectors and informs about their potential interfaces with GH2. Some of these sectors can act as supply-side enablers for GH2 production while some sectors may serve as demand centers for GH2 use, requiring need further detailed feasibility assessment.

- Electricity & Microgrids: Surplus solar and future floating PV can provide low-cost input for electrolysis. Also, GH2 offers long-duration storage and diesel displacement for isolated grids
- Waste: Organic and mixed waste streams offer long-term potential for waste-to-hydrogen pathways, supporting circular resource utilization
- Transport: Marine transport, one of the largest national fuel consumers presents a strong early demand center for GH2, alongside emerging opportunities in land transport
- Tourism & Resorts: High-energy, self-contained resort microgrids are well-positioned for early GH2 pilots combining solar, storage, desalination, and clean marine mobility

To guide GH2 development in the country, the report benchmarks global island systems with similar demography of Maldives like Mallorca, Canary Islands, Cabo Verde, Sri Lanka and Mauritius, highlighting key approaches being adopted by the countries to drive GH2 adoption. These insights suggest a five-pillar approach Hy-SPARC that needs to be espoused for Maldives. This approach emphasizes on a bottom-up approach of Strategy development with a focus on GH2, Pilot demonstrations in priority sectors, Aligned policies and safety standards, Resource and finance mobilization, Capacity and ecosystem development.

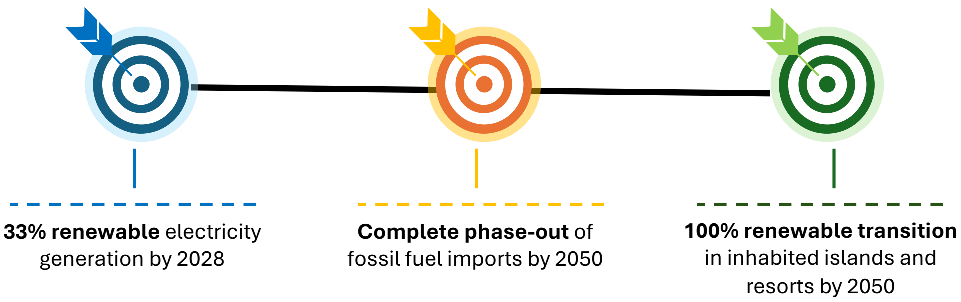
The stakeholder consultations with utilities, transport operators, and resort stakeholders confirms strong interest in exploring clean alternatives, while informing constraints such as diesel subsidies, limited technical standards, infrastructure gaps, and high upfront investment barriers for GH2 adoption. The existing government subsidies for electricity, fuel, and public transport, as well as duty exemptions for renewable energy equipment, form important levers that can be realigned to support GH2 techno-economics in the early transition phase.

The baseline assessment concludes that green hydrogen may not be an immediate substitute for diesel at scale, but a strategic complement to renewable energy expansion and a viable decarbonization pathway for selected high-value applications, especially marine transport (retrofitting ferries and jetties), resilient microgrids, resort islands, and integrated RE-water systems. The next phase of the study will build on this baseline to quantify techno-economic feasibility, identify pilot-ready sites, and propose a national GH2 roadmap aligned with the Maldives' Net Zero vision.

1. INTRODUCTION

The Maldives, a nation of more than 1,192 coral islands, grouped into 26 atolls, with an average elevation of just 1.5 metres above sea level, is among the most climate-vulnerable countries in the world. Rising seas are already eroding coastlines, in some islands more than 200 feet of beach have been lost and threaten to submerge much of the country by the end of this century. Freshwater scarcity is also an escalating crisis: rainwater and shallow aquifers, once the primary sources, are increasingly contaminated by saline intrusion and irregular rainfall, forcing reliance on energy-intensive desalination.

Although the Maldives' contribution to global greenhouse gas (GHG) emissions is negligible, it will be among the first countries to feel the devastating impacts of climate change through sea-level rise and water stress. Recognising this, the Maldives has committed to achieving net-zero emissions by 2030, as outlined in its Third Nationally Determined Contribution (NDC, 2024) and Energy Roadmap 2024–2033, conditional on international financial and technical support. Key targets under this strategy include:



In Maldives, imported fossil fuels are the most important source of energy and accounts for about 13.5% of GDP. More than 50% of the fuel imports is used for Electricity generation and supplied over 94% of total electricity. Diesel is mostly used in electricity generation, industrial processes, and sea transport while petrol is mostly for road transport, LPG for cooking, and aviation fuel for airplanes. In 2024, installed renewable capacity stands at only 68.5 MW of solar PV (6% generation share), while demand continues to grow by roughly 5% annually. The transport sector contributes approximately 21% to national CO2 emissions, with 131,000 registered vehicles (of which only 4% are electric) and around 18,000 maritime vessels reliant on diesel.

Green Hydrogen's importance to Maldives lies in how it connects key sectors rather than in its standalone use. Each of the following sectors interacts with green hydrogen either as a potential producer, user, or enabler of a low-carbon energy system.

01 Electricity — The electricity sector underpins hydrogen production, as renewable power is required for electrolysis. With growing solar capacity and fragmented island grids, hydrogen can help store excess electricity and support stable, round-the-clock supply

02 Waste — The waste sector offers a feedstock source for hydrogen through waste-to-energy and gasification technologies. It also addresses a national challenge by reducing landfill dependence and turning waste into a domestic energy resource

03 Transport — Transport, especially marine and inter-island movement, is one of the largest fuel consumers. Hydrogen and its derivatives can provide clean alternatives to diesel, helping cut emissions and fuel imports

04 Water — Desalination is energy-intensive but essential for freshwater production. It also provides purified water required for electrolysis. Hydrogen can in turn power RO plants, creating mutual efficiency between water and energy systems.

This baseline assessment report focuses on these interconnected sectors, identifying potential interfaces with hydrogen within the Maldives' existing infrastructure and resource systems.

1.1. Objective

The baseline assessment establishes the foundation for the assessing Feasibility of Green Hydrogen Potential in Maldives. Its objectives are to:

- Provide a comprehensive overview of the Maldives' demographic, climate policies, energy and transport context that frames the relevance of hydrogen
- Map the sectors where hydrogen could play a role in decarbonisation, energy security, and resilience
- Benchmark Maldives against other island nations that are advancing hydrogen strategies and understand best practices
- Identify opportunities and constraints that will inform the policy framework development

1.2. Methodology

The assessment draws on three main sources of input as mentioned below:

1 Desk research
Review of National Energy Roadmap, climate commitments (NDC 3.0), sectoral strategies, and relevant international studies (IRENA, ADB, World Bank, etc.)

2 Primary research
Consultations with representative stakeholders to validate the baseline landscape of the country

3 Comparative benchmarking
Analysis of hydrogen initiatives in other island contexts, such as the Canary Islands, Sri Lanka, Cabo Verde, and Mauritius

2. MALDIVES: COUNTRY PROFILE

2.1. Demography

The Maldives is an archipelago of 1,192 coral islands grouped into 26 atolls, stretching over 800 km in the Indian Ocean. Only around 200 islands are inhabited, with an additional 168 developed as resort islands. The country had a population of roughly 515,132[1] (2022), concentrated in the capital Malé and a few larger islands, while most islands host small communities of a few hundred to a few thousand people.

This dispersed geography creates unique energy and infrastructure challenges. Each inhabited island typically operates as an independent microgrid, often powered by diesel generators. The lack of interconnection means every island must manage its own electricity and water systems, raising costs and complicating renewable integration. Tourism is the backbone of the economy, contributing about 25-30% of GDP, and resort islands are among the highest energy consumers per capita.

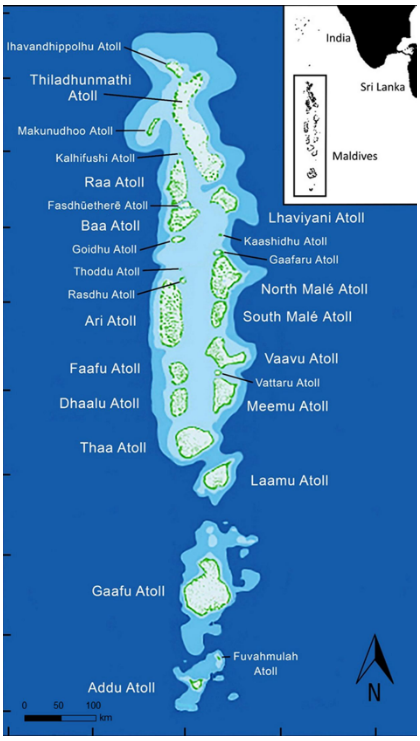


Figure 1. Maldivian Atolls

[1] Census 2022

2.2. Climate & Environment

The Maldives is one of the most climate-vulnerable nations globally. With an average elevation of just 1.5 metres, it faces existential risks from sea-level rise, coastal erosion, and saline intrusion. Several inhabited islands have already reported significant shoreline retreat, while flooding from tidal surges and monsoon rains frequently disrupts communities.

Freshwater scarcity is a mounting challenge. Historically reliant on rainwater and aquifers, many islands now face saltwater intrusion and irregular rainfall, forcing reliance on desalination. This adds pressure to the already fuel-dependent power system.

Greenhouse gas (GHG) emissions remain negligible in global terms, in 2022 around 2.38 million tonnes CO2e (~4.5 tCO2e per capita)[2] were recorded in Maldives, mostly from fuel combustion activities. This represents only 0.003% of global emissions, underscoring the paradox of the Maldives: a negligible emitter but among the first to feel the consequences of climate change.

Maldives emission profile is dominated by the energy and waste sectors[3], as shown in Figure 2. This is due to the exponentially growing energy demand in Maldives due to extraordinary economic growth in tourism, fishery industry, sea transport, and construction and widely practiced open burning of waste across islands. The energy sector accounts for 96.33% of the total emissions, while the waste sector contributes 3.67%. The Other Sectors category is the largest contributor to national emissions, totalling 822.38 kt of CO2 eq, representing 33.4% of the national emissions. Energy combustion in other sectors includes various sub-categories. The second largest contributor are the energy industries which account for 32.6% of the total emissions. Transportation is the third contributor at 29.8% while accounts for 3.7%. Manufacturing industries contribute to 0.6%.

In the Other Sectors, the commercial/ institutional sub-category accounts for the majority, contributing 86.2% of the emissions within other sectors. This includes emissions from commercial electricity generation (by MACL, resorts, MWSC) and commercial LPG usage (Maldive Gas and Villa Hakatha). The second-largest contributor is off-road vehicles and machinery, which contribute 4.2% of other sectors emissions for construction, port, and airport operations by MACL, MPL, STO, and MTCC. The Residential sub-category contributes 3.7%, which is solely from LPG usage by households, as residential electricity generation is accounted for under public electricity generation. Fishing and mobile combustion emissions arise from the operation of fishing vessels, while emissions from Fishing stationary sources are due to electricity generation at fish processing plants.

Table 1. Sectoral GHG Emissions

Sector	GHG Emissions CO2 eq. (2022) in kt
Energy	**2,273.07**
Other Sectors	822.38
Energy Industries	769.80
Transport	667.89
Manufacturing Industries & Construction	13.01
Waste	**86.64**

[2] Climate Watch
[3] Maldive BTR to UNFCCC 2024

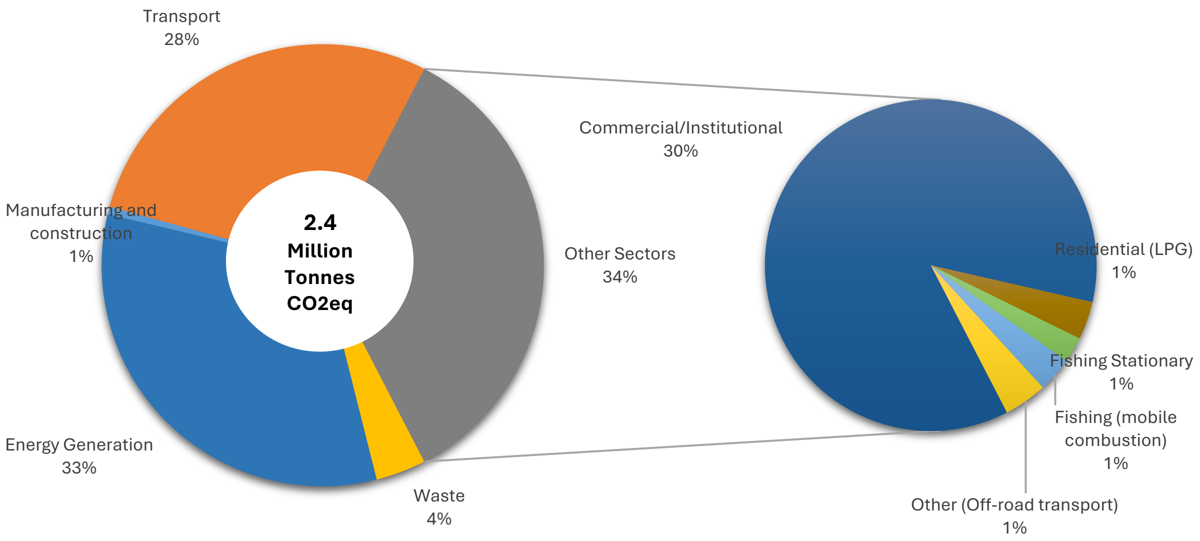


Figure 2: Maldives Sectoral Emissions in 2022 in million tons CO2e

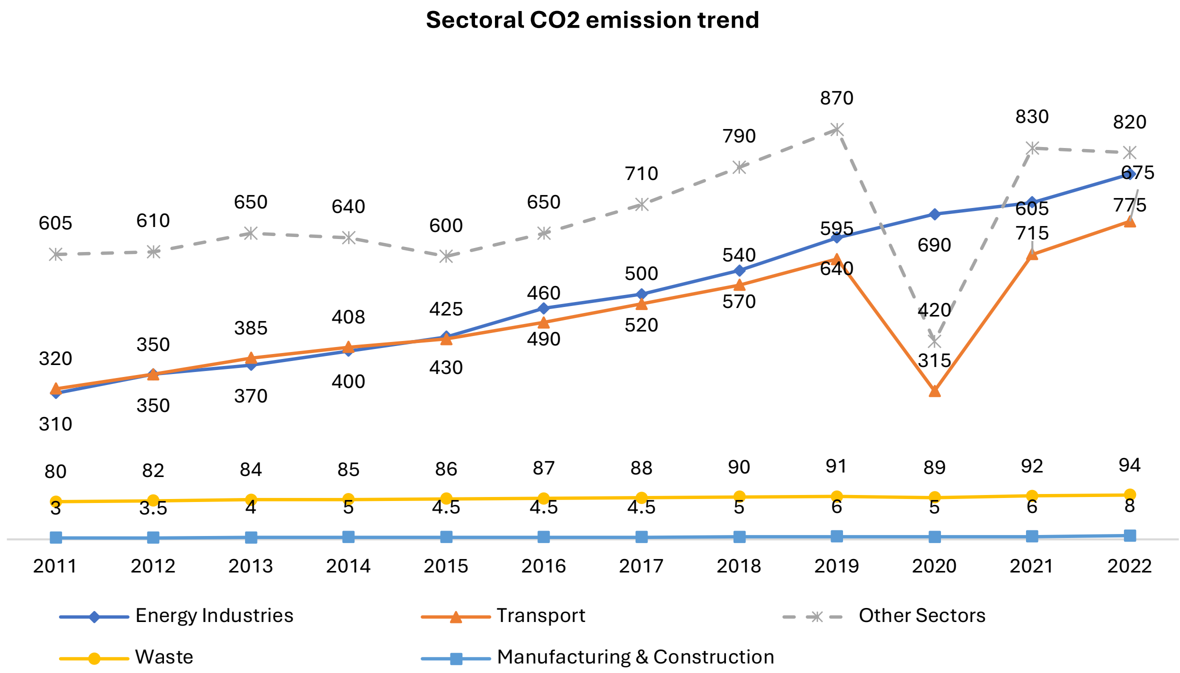


Figure 3: Maldives Total CO2e Emissions Trend Over the Years[3]

2.3. Policy Landscape

The Maldives' policy landscape provides an increasingly supportive foundation for the future development of green hydrogen across the energy, transport, water, waste, and climate sectors. While Green Hydrogen is still in its early stages of consideration, several national strategies particularly the Energy Roadmap 2024-2033 and NDC 3.0 recognises its potential as a low-carbon fuel for remote islands and marine transport. Complementary policies in renewable energy expansion, solar-hybrid desalination, circular waste management, and sustainable tourism further create the enabling conditions for green hydrogen pilots by ensuring access to renewable electricity, desalinated water, supportive regulatory frameworks, and sectoral demand opportunities.

Across the Maldives, several essential services, including fuel, power and public transport are supported by government subsidies to ensure affordability and reliability across dispersed islands. Diesel-based electricity generation is often subsidized, reducing the effective cost of power for utilities and end users. Public transport operations, particularly under MTCC, receive subsidies for fuel and maintenance, helping to sustain nationwide coverage. In the tourism sector, tax and import duty exemptions for renewable energy equipment have enabled private investment in solar PV and battery systems.

The below policies form the initial but critical building blocks for a future green hydrogen ecosystem in the Maldives.:

Table 2. Existing GH2-related Policy Landscape

Sector	Policy	Key Points / Objectives
Energy	Energy Act, 2021	• Establishes a legal framework for sustainable energy development • Mandates energy diversification and integration of renewable sources
	Energy Policy & Strategy 2024-2029	• Establishes a unified legal framework for sustainable energy development • Mandates energy diversification and integration of renewable sources
	Energy Roadmap 2024-2033	• Strategic roadmap to achieve Net Zero Energy Sector by 2030 • Plans deployment of 500 MW solar PV and 200 MWh battery storage across islands • Integrates hybrid diesel-solar systems for islands under ≥5 MW grids • **Encourages use of surplus RE for H2 production & retrofitment of Ferries**
	National Energy Policy & Strategy 2016	• Prioritizes energy security through RE diversification • Promotes private sector-led RE development through open tenders and IPP models

Sector	Policy	Key Points / Objectives
Waste	National Waste Management Policy 2023-2028	• Adopts "Magey Saafu Raajje" circular-economy approach • Enables waste-to-energy (WtE) as a power generation process • Sets guidelines for phasing out open burning and increasing waste segregation at source
	Waste Management Regulation 2022 (Regulation No. 2022/R-123)	• Defines extended producer responsibility (EPR) and waste valorisation
	Climate & Clean Air Coalition Program (2023)	• Supports GHG monitoring and methane reduction in waste sector
Transport	National Transport Master Plan 2021-2030	• **Promotes cleaner marine transport and inter-island connectivity** • Prioritises electrification of short-distance land transport and cleaner fuels for marine vessels
	Fisheries Fuel Subsidy Programme (2008-2013)	• ~USD 6.5 million disbursed (2013) to stabilise fishing operations
	Maritime Decarbonisation Study (MTCC Maldives 2023)	• **Assesses low-carbon marine fuels; recommends pilot hydrogen projects** • **Identifies priority routes (Malé–Ari, Addu–Fuvahmulah) for piloting low-carbon ferries, including hydrogen options**
Water	Integrated Water Resource Management Policy (2020)	• **Encourages renewable-powered desalination for remote islands**
	Water Security and Climate Resilience Program (World Bank)	• Supports solar-hybrid desalination pilots (potential H_2 feedwater link)
Climate	Nationally Determined Contribution 3.0 (2025)	• Emission reduction targets: 1.52 million tonnes of CO_2eq in 2035 • Expands solar PV and energy storage across inhabited islands • Green hydrogen recognized as long-term storage/fuel option for remote islands
	National Adaptation Plan 2024	• Integrates resilience and low-carbon pathways, with hydrogen noted as an emerging technology
	Maldives Climate Change Policy Framework (MCCPF), 2015	• Policy objective: "Low Carbon and Climate Resilient Development." • Promotes RE for emission reduction and resilience of island energy systems
Tourism	Fifth Tourism Master Plan (2023-2027)	• Provides policy priorities for sustainable tourism development, environmental integration in tourism planning, resilience, infrastructure development

2.4. Key Stakeholders

A strong, coordinated, and well-aligned stakeholder ecosystem is fundamental to developing a viable green hydrogen pathway in the Maldives. Since green hydrogen is a cross-sectoral opportunity, its success depends on the collective participation of government agencies, utilities, private sector developers, transport and tourism operators, research institutions, financial entities, and development partners.

Each stakeholder group can bring unique capabilities, from policy direction and resource allocation to technology deployment, infrastructure management, and end-use adoption. Given the early stage of hydrogen development in the country, strengthening collaboration, clarifying roles across the value chain, and building institutional and technical capacity will be essential to accelerate progress and ensure that green hydrogen is integrated in a coherent, sustainable, and economically viable manner.

The table below outlines key stakeholders across the hydrogen value chain and highlights their potential roles and importance:

Value Chain Stage	Key Stakeholders	Potential Role in GH2 Ecosystem
Renewable Generation	• Ministry of Tourism and Environment • Utilities (STELCO, FENAKA) • Independent Power Producers	• Central to resource planning, grid integration, and renewable project development • Provide the supply of clean energy required for GH2 production
Hydrogen Production	• Ministry of Tourism and Environment • Male Water and Sewerage Company (MWSC) • Private investors and Resort operators	• Lead development and implementation of electrolyzer projects • Enable initial pilots
Storage & Transformation	• Ministry of Tourism and Environment • Maldives Ports Limited • Maldives Airports Company • Logistics and fuel-handling firms	• Lead establishing safe storage, handling, and transport infrastructure • Support developing codes, standards, and operational protocols
Applications & End Use	• Male Transport & Contracts Company (MTCC) • Resort chains • Ferry and marine transport operators, sea planes and airlines • Utilities	• Represent anchor demand segments essential for project viability • Willingness to adopt GH2 will determine market scale and commercial sustainability
Export/Trade	• Ports Authority • Ministry of Trade • Shipping companies	• Potential future role in enabling hydrogen or derivative exports
Enablers	• Development banks (ADB, WB) • Bilateral donors • Academia • Vocational and training institutes	• Provide financing, technical expertise, R&D support, and capacity-building critical for de-risking early projects and strengthening local capabilities

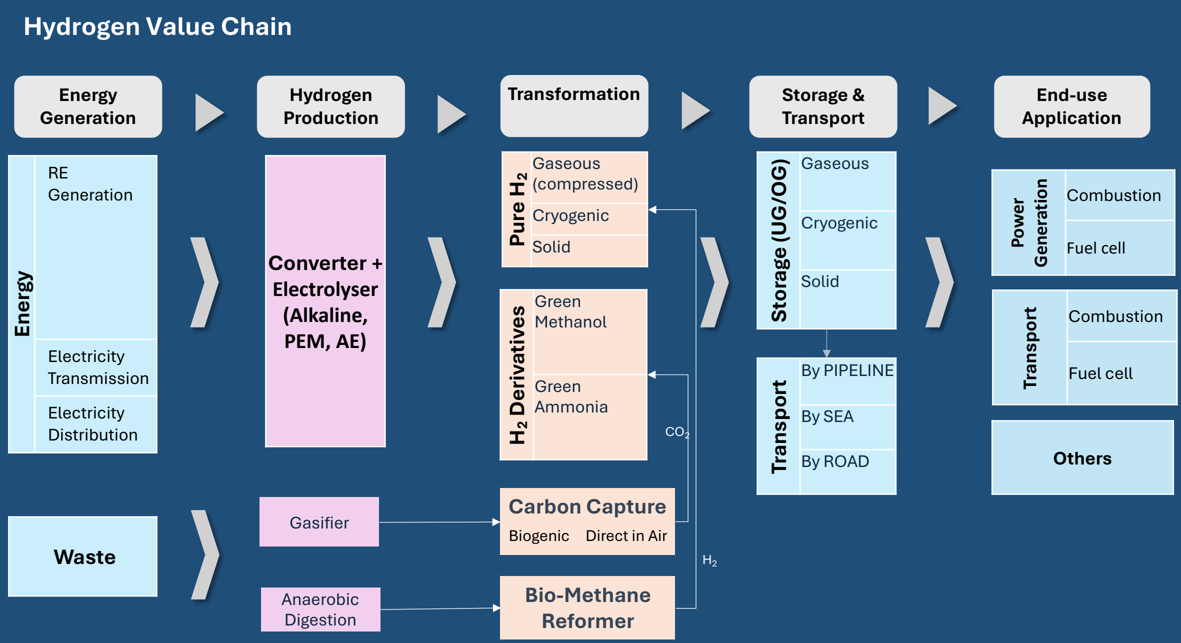


Figure 4: Hydrogen Value Chain

Stages of the Value Chain:

- **Energy Generation/ Renewable Energy:** Renewable electricity forms the foundation of green hydrogen production. In the Maldives, this will primarily come from solar PV (rooftop, ground-mounted, and floating), complemented by emerging wind and ocean energy pilot projects. Given the geographic constraints of land and roof space, floating solar and hybrid systems with storage are expected to play a pivotal role.

- **Hydrogen Production:** Hydrogen is produced through electrolysis, which requires both renewable electricity and a supply of high-purity water. In the Maldivian context, this necessitates coupling with desalination systems. Technology choices (alkaline, PEM, SOEC) will determine efficiency, cost, and suitability for small, distributed island systems.

- **Transformation & Storage:** Once produced, hydrogen must be conditioned and stored. Options include compressed gas, liquefied hydrogen, or conversion into derivatives such as ammonia or methanol. Land constraints, safety standards, and port infrastructure will heavily influence which storage options are feasible on island and which are suited for transport/export.

- **Applications & End Use:** Hydrogen's value is realised when deployed across key sectors. For the Maldives, the most relevant are:
  - Power: displacing diesel in island grids and backup systems
  - Transport: especially marine ferries and potentially aviation in the long term
  - Water: powering desalination while also providing feedwater for electrolysis
  - Tourism & Industry: supporting resorts and small industries as concentrated demand centres

The baseline assessment follows the above hydrogen value chain focused approach to understand the existing landscape across supply-side and demand-side sectors

3. SECTORAL LANDSCAPE

A clear understanding of how different sectors interact with the green hydrogen value chain is essential to assess its potential role in the Maldives. For the sectoral baseline assessment, sectors are grouped according to their relevance either as demand centres, where green hydrogen could be used as a fuel/ feedstock, or as supply-side enablers that provide the renewable energy, water, or waste resources necessary for hydrogen production.

The assessment examines each sector's existing infrastructure, resource potential, technology maturity, energy consumption patterns, and policy environment to determine how it could contribute to or benefit from green hydrogen. This structured approach helps establish a realistic picture of sectoral readiness, identifies opportunities and constraints, and highlights priority areas where green hydrogen can meaningfully support the Maldives' long-term sustainable energy transition.

3.1. Supply-Side Sectors: Potential Green Hydrogen Production Enablers

Supply-side sectors form the backbone of green hydrogen production, as they determine the availability, reliability, and cost-effectiveness of the fundamental inputs required for green hydrogen generation. In the Maldives, renewable energy generation, primarily solar, supplemented by emerging wind and waste-to-energy systems, holds the greatest potential for powering electrolyzers. Equally important are the sectors responsible for water supply and wastewater management, as the availability of sustainable water sources and treatment infrastructure influences the feasibility of electrolysis-based hydrogen production. Waste management systems, including solid waste and sewage treatment, may also offer opportunities for hydrogen generation through alternative pathways such as biogas reforming. Therefore, understanding the existing landscape of these enabler sectors is critical to identifying feasible green hydrogen production pathways and shaping investment priorities for the Maldives' hydrogen development roadmap.

3.1.1. Electricity

Maldives' universal access to electricity was achieved in 2008 however the country has one of the highest cost of power generation in South Asia[4]. Electricity generation in Maldives is mainly diesel-based, shipped in small quantities by boat to each island across the country, which can makes fuel notably more expensive. Understanding the existing diesel systems, island distribution, and solar penetration is critical to assessing hydrogen feasibility (where to site electrolysers, what level of grid flexibility is needed, etc.).

- **Installed capacity:**
  As of mid-2024, the Maldives has an installed generation capacity of ~600 MW. Of this, 68.5 MW is solar PV (about 6 % by generation)[5]. Greater Malé currently has around 140 MW of installed diesel capacity complemented by about 10 MW of solar PV. The other inhabited islands collectively host approximately 208 MW of generation capacity, including around 27 MW of solar PV, with many operating as hybrid solar-diesel systems. Resort islands together contribute roughly 242 MW of capacity, the majority of which is diesel-based, although solar installations amounting to about 31 MW have been added across several resorts[5].

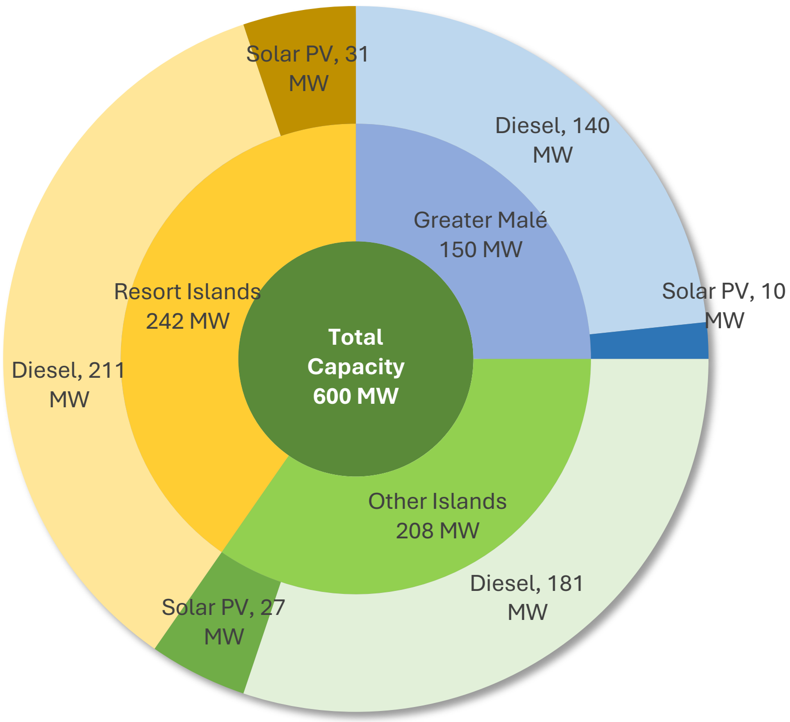
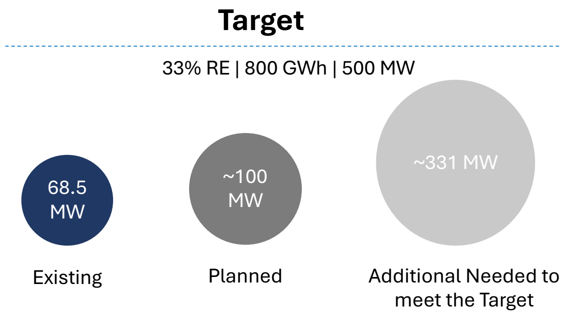


Figure 5: Distribution of Installed Generation Capacities across Maldives

[4] ADB Energy Roadmap 2030: A Brighter Future for Maldives Powered by Renewables
[5] Roadmap for the Energy Sector 2024-2033

- **RE Growth & targets:**
  Electricity demand in the Maldives is increasing at an annual rate of about 5 percent and is projected to reach roughly 2,400 GWh by 2028. To achieve the national target of a 33 percent renewable energy share by that year, the country will need around 800 GWh of renewable generation. This will require expanding installed solar capacity from the current 68.5 MW to approximately 160 MW, including projects already under development. According to the national energy roadmap, integrating an additional 330 MW of renewable capacity by 2028 will demand an estimated investment of about USD 1.3 billion for generation, grid upgrades, and energy storage systems[5].



	Potential (MW)
Greater Malé Region	132
Other Inhabited Islands	74
Resort & Industrial Islands	125
Total	**331**

A 100 MW floating solar project was approved in 2025, to be executed by Abraxas Power, marking the Maldives' largest renewable energy project to date. The facility integrates a 100 MWh battery system and the Abraxas Operating System (AbOS) to optimise power generation and storage. The completion date however, has not been announced yet.

In the past, Ministry of Tourism and Environment also established programs to support RE growth in the country. The ASPIRE (Accelerating Sustainable Private Investments in Renewable Energy) funded by World Bank aims to install rooftop solar PV panels in the Greater Male' Region. Because of the World Bank's ASPIRE project, solar tariffs have dropped exponentially over the bidding phases. From Phase I of the project the tariff bids dropped from \$0.21/kWh to \$0.098/kWh in Phase III[6]. The POISED initiative (Preparing Outer Islands for Sustainable Energy Development) with an aim to transform the existing diesel-based energy systems of at least 160 islands into hybrid solar PV-diesel systems (efficient diesel generators, solar PV and energy storage) and install a minimum of 21 megawatts-peak (MWp) in PV installations has been a success for Maldives, resulting in an average fuel savings of 25%.

Figure 6. POSED Project (Solar PV at a School)

Additionally, the government is also rolling out "My Solar" program across 187 islands, a massive expansion designed to bring smaller-scale solar systems for local power generation directly to its communities. This program allows participants to install rooftop solar systems with no upfront costs. Instead, they pay only for the clean electricity generated by the panels, at a rate typically 10% cheaper

[6] CIF Delivers: Establishing a viable market for clean power in the Maldives

than grid electricity derived from diesel generators. The initial pilot phase of the program demonstrated significant potential, installing 320 kWp of solar capacity across 43 islands. This generated approximately 450,000 kWh of electricity annually, displacing a considerable amount of diesel fuel.

- **Island power systems:**
  Nearly all inhabited islands in the Maldives operate as isolated microgrids, each with its own generation and local distribution system. STELCO supplies 35 islands, including the Greater Malé area, which accounts for about 57 percent of the country's total electricity consumption, while FENAKA operates power systems on 152 islands located outside the Greater Malé region[7].

- **Solar deployment in resorts / islands:**
  Resort islands collectively have about 31 MW of installed solar PV capacity, with several properties taking more ambitious steps toward renewable integration. For instance, Soneva Fushi in Baa Atoll has installed 3.2 MW of rooftop solar panels, while Soneva Secret operates a 2 MW floating solar system that meets nearly 90 percent of its electricity demand[8]. Most resorts have traditionally relied on captive diesel generator systems, but solar capacity is being added gradually to reduce fuel consumption and operational costs[9].

Figure 7: 2 MW Floating Solar at Soneva Secret Resort, Makunudhoo Atoll, Maldives[10]

Key interfaces with Green Hydrogen

Green hydrogen and renewable energy systems are deeply interconnected. Renewable energy provides the electricity required for electrolysis, while hydrogen offers long-duration energy storage and operational flexibility that can help stabilize variable renewable resources. In the context of the Maldives, characterized by isolated island grids, heavy diesel dependence, and

[7] AIIB: Maldives Solar Power Development and Energy Storage Solution
[8] PVKnowHow
[9] Maldives Low Carbon Development Strategy, DTU
[10] Ocean Sun

growing energy demand. This synergy presents a significant opportunity to improve energy security, reduce fuel imports, and accelerate the integration of clean energy across the archipelago.

- Renewable power availability: The scale and reliability of renewable energy generation directly influence the feasibility of hydrogen production, as electrolysers require stable, low-cost electricity. Continued expansion of solar PV, wind, and hybrid systems forms the fundamental basis for any future green hydrogen production.
- Grid connectivity and stability: Larger and more reliable grids, such as Greater Malé, are better positioned to integrate grid-connected electrolysers that can operate flexibly based on renewable generation patterns. Smaller or remote islands with weaker grids may instead adopt dedicated solar-hydrogen systems to avoid curtailment and manage intermittency without overloading local networks.
- Curtailment management: As solar deployment accelerates, periods of surplus daytime generation are expected to increase. Instead of curtailing excess energy, this power can be effectively channelled into electrolysis, improving renewable utilization and enhancing the overall efficiency of local energy systems.

With an ambitious RE target to reach 800 GWh by 2028, hydrogen could play a major role in decarbonizing hard to abate sectors while also cutting dependence on fossil imports. Hydrogen can become a strategic enabler rather than a standalone technology in the Maldivian power sector. By linking electrolysers to solar-rich microgrids, hydrogen offers both flexibility and resilience, storing excess solar power and supplying energy during night or cloudy conditions. In larger systems like Greater Malé, it can complement battery storage, while in resort and outer islands, small-scale hybrid PV, H2 systems can gradually displace costly diesel generation. In essence, hydrogen closes the gap between renewable potential and round-the-clock power reliability across the archipelago.

3.1.2. Waste

The Maldives generates approximately 365 tonnes of solid waste per day in Greater Malé, and ~860 tonnes/day nationwide**,** driven largely by tourism and urban population growth. The per capita waste generation averages 1.7–2.3 kg/day, among the highest in South Asia.

- **Composition:**
  Municipal waste consists mainly of organic matter (~65%), plastics (~15%), and paper, metals, and glass making up the remainder, suitable for refuse-derived fuel (RDF) production or gasification-based hydrogen generation as shown in Figure 8

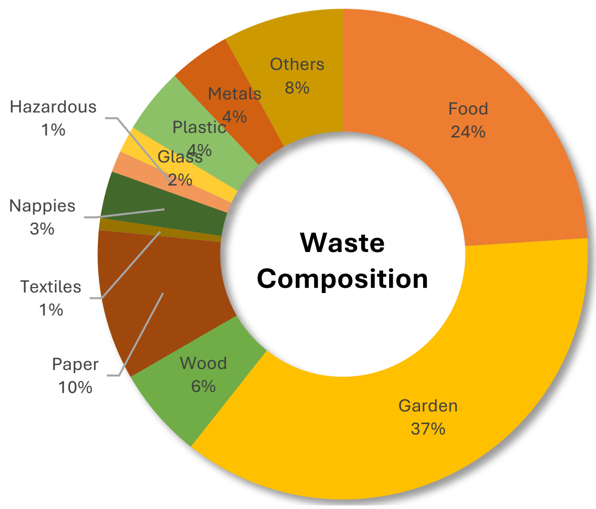


Figure 8. Waste Composition in Maldives, 2022

- **Current Disposal Practices:**
  Waste from most inhabited islands in the Maldives is collected and transported to Thilafushi, the country's main landfill island near Malé. However, open burning and unmanaged dumping remain the dominant disposal methods, leading to significant air pollution, odour, and methane

emissions. Less than 10 percent of total waste is currently treated through segregation, composting, or limited recycling, and even this fraction often faces logistical challenges due to inter-island transport and lack of dedicated treatment infrastructure. Most recyclable materials are either stockpiled or exported in small quantities.

- **Ongoing Waste-to-Energy (WtE) Projects:**

Figure 9. Addu City 1.5 MW Waste-to-Energy Plant Under Construction[17]

The Greater Malé Waste-to-Energy (WtE) Plant, currently under development at Thilafushi Island west of Malé, is designed to process around 500 tonnes of waste per day. Co-financed by the Asian Infrastructure Investment Bank (AIIB), the Japan International Cooperation Agency (JICA), and the Asian Development Bank (ADB), the facility is expected to generate approximately 13 MW of electricity while reducing around 30,000 tonnes of CO2 emissions each year. In parallel, a smaller-scale WtE project in Addu City aims to convert municipal waste into electricity, with an anticipated reduction of about 1.9 million litres of diesel consumption annually.

Key interfaces with Green Hydrogen

Waste management presents a significant challenge for the Maldives due to limited land availability, high logistics costs, and growing waste volumes from both local communities and tourism activities. Green hydrogen unlocks an opportunity to convert these waste streams into valuable energy inputs, creating circular pathways that support the country's broader sustainability and energy transition goals.

- Organic and plastic waste streams can be converted via gasification or pyrolysis into syngas ($CO + H_2$), then refined to produce low-carbon hydrogen
- Integration with WtE plants offers dual benefits, waste reduction and local hydrogen generation for use in power, transport, or industrial heat
- Oxygen and heat from electrolysis can support waste drying and pre-treatment, creating circular synergies between RE, water, and waste sectors

These interfaces highlight how hydrogen can transform waste from an environmental burden into an energy resource for the Maldives. Converting municipal and organic waste into hydrogen or syngas could significantly reduce landfill volumes, lower methane emissions, and generate local clean fuel for power or mobility. For a geographically dispersed nation with high waste transport costs and limited disposal space, integrating waste-to-hydrogen systems within regional hubs or resort islands offers a pathway to circular energy, where waste management, renewable energy, and hydrogen production reinforce each other to enhance both sustainability and energy security.

3.1.3. Water & Desalination

Maldivians depend mainly on rainwater for drinking and groundwater for most other domestic needs. Rainwater is tapped from roofs and collected and stored in various types of tanks. All the islands have individual household as well as community tanks. However, the situation is different in the capital island Male' where the entire population has access to desalinated water distributed through a pipeline network. In Male' it is common for people to use desalinated water for drinking as well as for domestic purposes due to high contamination of groundwater. Tap water provided by Male Water and Sewerage Company (MWSC) is safe for drinking in Greater Male' Region. However, approximately 76% of the total households in the Greater Male' Region prefers bottled water to tap water.[11]

Desalination is one of the Maldives' most energy-intensive services and use diesel generators for their operation. The fishing industry is Maldives' second largest economic sector and an intensive user of refrigeration. Desalination will also be the sole practical source of high-purity water for hydrogen production. It therefore represents both a major electricity load and a strategic feedstock provider for future electrolysis. Understanding its scale, energy demand, and evolving technology mix is critical to modelling hydrogen-linked power systems.

- **National reliance on RO desalination:**
  Nearly all inhabited and resort islands in the Maldives depend on reverse osmosis (RO) desalination to produce potable water, as the country's shallow aquifers are saline and rainfall is insufficient to meet freshwater needs. RO plants are primarily operated by the Maldives Water and Sewerage Company (MWSC), FENAKA Corporation, and individual resort utilities, with most systems powered by diesel-generated electricity.

  Large public RO plants managed by MWSC typically consume around 4.5 kWh of electricity per cubic metre[9] of freshwater produced, while smaller or off-grid systems have higher energy intensities. For instance, a solar-powered pilot project in Magoodhoo produced about 5 cubic metres of freshwater per day using 48 kWh, equivalent to roughly 9.6 kWh per cubic metre[12]. By comparison, global best-practice seawater RO systems operate at around 3-3.5 kWh per cubic metre[13], highlighting the efficiency gap and the potential benefits of integrating renewable or hydrogen-based power sources into desalination operations.

- **Integration of renewables in new desalination projects:**
  In 2024, five new renewable-powered desalination plants were completed across the Maldives under China Aid, marking a significant step toward cleaner water production. The plants were established on the islands of Raa Alifushi, Haa Alif Kelaa, Lhaviyani Olhuvelifushi, Kaafu Kaashidhoo, and Gaafu Alif Dhaandhoo[14]. Each facility has a production capacity of around 200 tonnes, or approximately 200 cubic metres, of freshwater per day. To support sustainable operation, each site is equipped with a 200 kW solar PV system, while the Kaashidhoo plant also includes a 100 kW wind turbine, showcasing hybrid renewable integration in desalination for the first time in the Maldives.

- **Innovation pilots:**
  MWSC, in collaboration with Flocean, has launched a sub-sea desalination pilot designed to

[11] ADB Energy Roadmap 2030: A Brighter Future for Maldives Powered by Renewables
[12] Water Resource Management and Sustainability: A Case Study in Faafu Atoll in the Republic of Maldives
[13] Smart Water Magazine, 2023
[14] Edition.mv

use hydrostatic pressure at depth to reduce electricity use by 30-50%[15] to 2 kWh/m^3. This pilot is expected to inform future hybrid energy-water designs and lower the electricity intensity of feedwater supply for hydrogen production.

Key interfaces with Green Hydrogen

Desalination is essential for meeting the Maldives' freshwater needs, yet it remains one of the most energy-intensive services across the islands, largely powered today by imported diesel. Green hydrogen offers a strategic opportunity to both decarbonize desalination and leverage desalinated water as a critical input for hydrogen production. When paired together, hydrogen and desalination can share infrastructure, lower costs, and create mutual efficiency gains. Global examples such as the integrated solar-hydrogen-desalination model at NEOM, demonstrate how co-located systems can supply both clean water and clean fuel in a highly efficient manner.

- Co-locating electrolysers with existing or upcoming RO desalination plants can remove the need for separate water purification units, significantly reducing capital and operational expenditure.
- Hydrogen-based power solutions whether through fuel cells or hydrogen-fired engines can replace diesel generators currently operating RO plants, cutting emissions and strengthening energy security.
- Electrolysis by-products such as oxygen and low-grade heat can be repurposed within desalination systems: oxygen can enhance backwashing efficiency and biofouling control, while low-grade heat can pre-warm intake water to lower the energy required for RO processes.

These interfaces illustrate how hydrogen and desalination can grow as complementary systems in the Maldives. By pairing electrolysers with RO facilities, islands can simultaneously reduce the cost of freshwater production and generate clean energy locally. Hydrogen can provide a zero-emission alternative to diesel for powering desalination, while oxygen and heat recovery can enhance plant performance. For a nation where desalination underpins daily life yet heavily depends on fossil fuels, integrating hydrogen offers a pathway to make water supply cleaner, more resilient, and self-sustaining across dispersed island communities.

3.2. Demand-Side Sectors: Potential Green Hydrogen Demand Centres

The Maldives presents several promising demand-side sectors for green hydrogen adoption, driven by its unique energy, industrial, and transport needs. Key potential demand centres include transport, particularly ferries and cargo vessels, which form the backbone of inter-island connectivity and are ideal candidates for hydrogen-based propulsion; and sectors that use predominantly use diesel for power generation which can be replaced by GH2-based power such as desalination plants and other tourism-related infrastructure such as resorts and airports, along with small-scale industrial activities like food processing and cold storage, represent emerging opportunities for green hydrogen utilization. Mapping these sectors helps prioritize investment, infrastructure planning, and policy interventions to accelerate the Maldives' transition to a low-carbon economy

[15] Smart Water Magazine, 2024

3.2.1. Transport

Transport is a high-energy, high-emission sector in the Maldives. In particular, marine transport (ferries, service boats) dominates inter-island connectivity and is a prime candidate for hydrogen or hydrogen-derived fuels. For hydrogen planning, it's essential to understand the current fuel use, fleet composition, and logistical constraints.

- **Sectoral contribution and growth:**
  In 2022, the transport sector in the Maldives was responsible for approximately 1.4 million tonnes of CO2 emissions, accounting for about 21 percent of the country's total greenhouse gas emissions. Emissions from this sector have been increasing at an average rate of around 9 percent per year since 2015, largely due to the rapid growth in vehicle ownership and expanding maritime activity.

  As of 2022, transport sector contributed 21% of the national total emissions, accounting for 668 kt of CO2e. The emissions within the transport sector, of which domestic navigation accounts for 50.9% as shown in Figure 10. It includes public and cargo marine transport, resort transportation (passengers and recreation) and liveaboard boats. Domestic aviation contributes to 23.1% encompassing both public aviation services and private (tourism) aviation services. Among land transport, motorcycles contribute 14.9% of emissions, as they represent the most significant portion in the national vehicle fleet. With increasing numbers of resorts and domestic airports, increase in emissions are envisaged.

  Collectively, transport emissions represent about 21 percent of the Maldives' total economy-wide emissions, making decarbonisation of this sector a critical component of the national net-zero strategy[16].

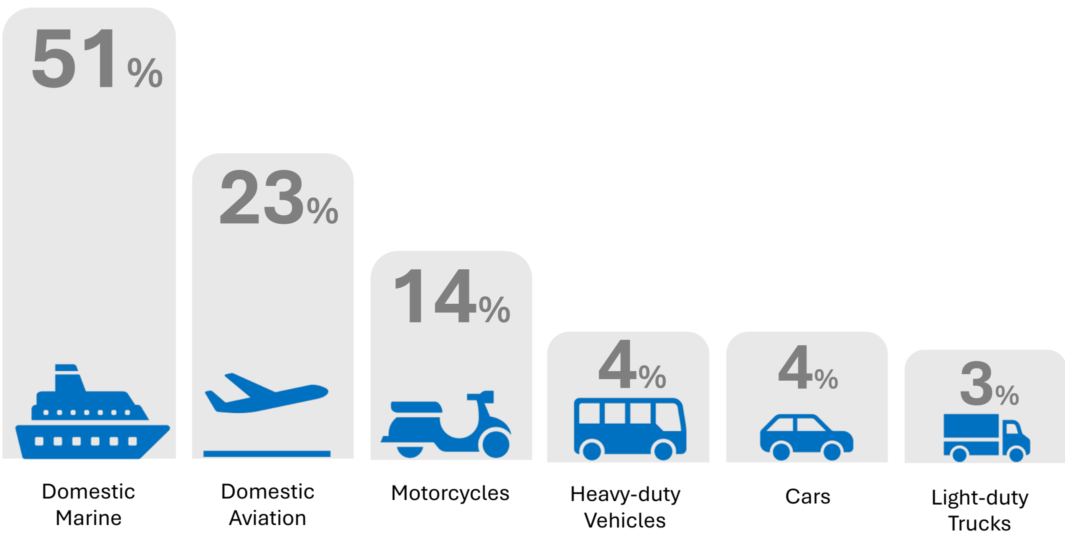


Figure 10: Transport Sector Emission Contribution by Vehicle Type, 2022[17]

- **Energy dependence:**
  Nearly all transport energy in the Maldives is derived from petroleum fuels, with electrification still at a very early stage. The sector's energy intensity is particularly high,

[16] Asian Transport Outlook, 2024
[17] Maldives' First Biennial Transparency Report, 2024

estimated at 113.8 grams of CO_2 per U.S. dollar of GDP, over three times the Asia-Pacific regional average of 32 grams of CO_2 per U.S. dollar[16].

- **Vehicle and vessel stock:**
  As of 2022, the Maldives had approximately 131,000 registered land vehicles, of which only about 4 percent were electric[18], mostly consisting of light two-wheelers. The Greater Malé region alone accounts for around 119,000 vehicles, an estimated 92 percent of which are motorcycles, reflecting the country's dense urban mobility pattern[19]. In addition to road transport, the national maritime fleet comprises roughly 18,000 registered vessels, including ferries, fishing dhonis, speedboats, and service craft, based on extrapolated data from the Statistical Handbook of Maldives 2024[20].

Table 3. Transport Vehicles

Category	Description	Count
Total registered land vehicles	All motor vehicles nationwide	~131,000
Electric vehicles (EVs)	Mainly light two-wheelers and some buses	~4% of total vehicles
Vehicles in Greater Malé region	Concentrated in capital area	~119,000
Motorcycles in Greater Malé	Dominant vehicle type	~92% of total vehicles (109,480)
Registered maritime vessels	Includes ferries, fishing dhonis, speedboats, and service craft	15,025 (2020)

- **Fuel consumption in fisheries transport:**
  The pole-and-line tuna boat fleet, the country's largest commercial marine operation, recorded fuel-use intensity (FUI) between 197 and 328 litres of diesel per tonne of catch during 2010–2014[21]

- **Domestic Aviation:**
  Domestic aviation is an essential component of mobility in the Maldives, serving both residents and the tourism industry. It includes scheduled domestic flights, island–resort transfers, and the world's most extensive commercial seaplane operations. The sector is led by three primary operators:
  - Trans Maldivian Airways (TMA): operating a fleet of over 50 De Havilland Twin Otter aircraft
  - Manta Air: operates a fleet of 15 aircrafts split between both wheel-based domestic aircraft and seaplanes
  - Maldivian (Island Aviation Services Ltd.): operates 23 aircraft, including DHC-6 Twin Otters, Dash-8s

  All domestic aviation currently relies on Jet A-1 fuel, making it a concentrated emissions source in a sector where alternatives are limited. These operators collectively handle a

[18] World Bank Survey: Accelerating the Electric Vehicle Transition in Maldives
[19] Islamic University Study
[20] Statistical Pocketbook of Maldives, 2024
[21] IPNLF Technical Report No.8

significant share of inter-island passenger movement. Seaplanes alone conduct hundreds of flights daily during peak tourist seasons, linking Malé with resort islands that lack airstrips.

Hydrogen is not expected to play a direct short-term role in domestic aviation due to technological and certification constraints. However, hydrogen-derived fuels, such as Sustainable Aviation Fuel (SAF) represent the most viable long-term decarbonisation pathway, as they can be used in existing aircraft engines. Ground-side opportunities such as hydrogen-powered ground support equipment or clean energy for seaplane terminals may also emerge earlier.

Key interfaces with Green Hydrogen

Hydrogen is increasingly viewed as a clean fuel alternative for the transport sector, particularly in shipping and heavy mobility where electrification is limited. It can be used directly in fuel cells or converted into derivatives like ammonia and methanol for easier storage and longer range. Countries such as Japan and Norway are already developing hydrogen-powered ferries and port bunkering hubs, demonstrating how maritime transport can transition toward zero emissions while maintaining operational reliability .

- **Fuel substitution in marine vessels:**
  - Hydrogen and hydrogen-derived fuels (ammonia, e-methanol) can directly replace diesel for ferries, inter-island cargo boats, and fishing vessels
  - Hybrid or dual-fuel engines offer a near-term pathway before full conversion to hydrogen fuel cells
- **On-site refuelling and bunkering:**
  - Hydrogen adoption in marine transport will require dedicated bunkering infrastructure at major ports and ferry terminals
  - Locating refuelling hubs in Greater Malé, regional harbours, and industrial fishing ports would maximise utilisation and support future export logistics
- **Policy alignment and incentives**
  - The historical framework of diesel fuel subsidies, mentioned in Section 2.3 could be redirected as temporary hydrogen transition incentives, supporting early adoption through concessional finance or reduced port fees for hydrogen-fuelled vessels

These interfaces highlight that hydrogen could become central to transforming the Maldives' transport system, particularly its marine backbone. By substituting diesel in ferries, cargo, and fishing vessels, hydrogen can cut emissions while lowering exposure to volatile fuel prices. Establishing refuelling and bunkering hubs at major ports would also create the foundation for a clean maritime network that connects regional islands and supports tourism logistics. Redirecting existing fuel subsidies into transitional incentives for hydrogen vessels could accelerate early adoption, positioning the Maldives as a testbed for zero-emission island transport systems in the Indian Ocean.

3.2.2. Ports

Ports are major energy hubs in island economies. In the Maldives, ports support inter-island logistics, fisheries, tourism supply chains, and international shipping. They host heavy-duty equipment, cold storage, bunkering services, and vessel berthing, all of which currently depend on diesel.

- **Port Infrastructure & Activity**

The Maldives operates a distributed port system aligned with its dispersed geography:

- Malé Commercial Harbour (MPL) - the primary national port handling most imports, approximately 400 vessels annually
- Hulhumalé Port - secondary facility supporting cargo and logistics
- Regional ports - including Kulhudhuffushi, Hithadhoo, and Hdh. Hanimaadhoo
- Tourism jetties - hundreds of smaller jetties serving resort supply boats and speedboats
- Fishing harbours - located across islands (more than 70 formal harbours with active vessel traffic)

- **Energy use in ports**
  Port operations in the Maldives rely heavily on diesel across multiple functions. Equipment such as cranes, forklifts, yard tractors, and reach stackers all depend on diesel engines, while cold storage facilities and warehouses also operate using diesel-powered electricity. Docked vessels typically keep their auxiliary engines running for shore power, further adding to fuel consumption and emissions. In addition, bunkering services for domestic boats, as well as ferries and supply vessels operating out of major terminals, rely entirely on diesel. Since electricity supplied to ports is itself generated through diesel-based island grids, virtually all portside activities carry a high embedded carbon and fuel footprint.

Key interfaces with Green Hydrogen

Hydrogen is increasingly being explored as a clean energy vector for port operations worldwide, particularly as ports seek to decarbonise cargo handling equipment, shore power, and maritime services. Hydrogen can be used directly in fuel cells or converted into derivatives such as ammonia and methanol, supporting applications that require high power, long operating hours, or fast refuelling. International ports, including those in Rotterdam, Los Angeles, and Yokohama are piloting hydrogen-powered yard equipment, fuel-cell shore power units, and early-stage bunkering terminals, demonstrating viable pathways for port decarbonisation without compromising operational continuity.

- **Decarbonising port equipment and operations:**
  - Hydrogen fuel cells can replace diesel in forklifts, yard tractors, cranes, and other material-handling equipment
  - Clean hydrogen power can also support cold storage, warehousing, and other high-load port facilities that currently depend on diesel-generated electricity

- **Shore power for berthed vessels:**
  - Hydrogen-powered fuel-cell generators can provide clean auxiliary power to docked ferries, cargo boats, and resort supply vessels, substituting the continuous running of onboard diesel engines
  - This reduces emissions, noise, and air pollution within densely populated port areas

- **Hydrogen bunkering and maritime fuel hubs:**
  - Ports are natural nodes for hydrogen distribution, making them strategic locations for future bunkering of hydrogen, ammonia, or methanol
  - Developing bunkering capacity at Malé, Hulhumalé, and regional commercial ports would enable hydrogen adoption in ferries, inter-island cargo movement, and fishing fleets.

These interfaces illustrate how hydrogen can evolve from a pilot technology into a central component of port decarbonisation in the Maldives. By enabling clean equipment, providing zero-emission shore power, and establishing early bunkering hubs, hydrogen can reduce diesel dependence across major ports and catalyse the transition to a cleaner, modern maritime infrastructure that supports national logistics, tourism, and fisheries.

3.2.3. Industrial cluster

Industrial activity in the Maldives is limited but concentrated in a small number of designated industrial islands and zones. The country has over 20 industrial islands, with the largest clusters located in Thilafushi, Gulhifalhu, Hulhumalé, Kulhudhuffushi, and Addu City. These zones host facilities such as fish-processing plants, ice factories, cold storage units, carpentry and boatbuilding yards, metal workshops, cement and construction material yards, and small-scale manufacturing enterprises. Most of these operations rely almost entirely on diesel for electricity, thermal processes, and machinery, making them significant localised energy consumers despite the sector's small national footprint.

Key interfaces with Green Hydrogen

Direct hydrogen use in current industrial processes is minimal, but clusters located near ports such as fish processing units or logistics hubs could become early candidates for clean electricity supply, fuel-cell based power systems, or hydrogen-derived heat in the longer term.

3.2.4. Resort

The resort industry is the backbone of the Maldivian economy, contributing roughly 28-33 % of GDP and over 60% of foreign exchange earnings. Each of the 170+ resort islands operates as a fully independent utility, generating its own electricity, producing freshwater through desalination, and managing transport. This autonomy comes with high energy demand where most resorts rely heavily on diesel for power, water production, and vessel operations, making the sector one of the country's largest private fuel consumers.

As for the resort islands, the typical diesel power generation installed capacity is 900 kW. These powerhouses operate intermittently when the islands are operating for their guests. Electricity consumption in resorts can be broken down into 40% for air-conditioning, 10% for refrigerators, 10% for desalination plants, 10% for lighting, and 20% for laundry services indicating that more than 60% of the energy consumption in resorts is due to energy use of appliances and buildings

A lot of resorts also operate seaplanes which rely on imported jet fuel. As a result, resorts face high operating costs, significant emissions, and growing pressure from the global tourism market to adopt cleaner energy systems.

Key interfaces with Green Hydrogen

As large, concentrated energy consumers with predictable demand profiles, Resorts represent high-potential early adopters of hydrogen technologies. Green Hydrogen can complement solar deployment in resort microgrids, provide clean fuel for guest and logistics vessels, and supply oxygen and heat by-products that integrate with desalination and heating systems. Since resorts can implement projects independently of national utilities, they offer a practical testbed for first-of-a-kind hydrogen pilots, demonstrating technical and commercial feasibility before wider replication across inhabited islands.

3.2.5. Power Generation and Storage

Diesel fuel remains the dominant energy source for electricity generation across all inhabited and resort islands in the Maldives, placing a heavy burden on both the national economy and energy security. The government spends about $150 million annually to subsidize imported fuels to make the cost of electricity more affordable to Maldivians. Both utilities STELCO and FENAKA rely heavily on government's subsidies.

- **Diesel dependence & costs:**
  The Maldives' isolated power grids are supplied using generators fired with imported diesel. This has made electricity supply expensive with generation costs varying significantly by island size and remoteness. The country's electricity tariffs, especially for businesses, have been among the highest in South Asia. On average, diesel units produce about 3.6 kWh of electricity per litre of fuel in Maldives. With unsubsidised diesel priced at MVR 14-16 per litre (USD 0.90-1.05), plants on major islands generate electricity at roughly USD 0.19-0.33/ kWh. However, in remote islands, costs can rise to as high as USD 0.69/ kWh due to additional fuel transport, storage, and logistics requirements[22].

- **Energy storage:**
  With solar contributing only about 6% of total electricity, grid integration challenges will increase as more renewables are added. Currently, Battery Energy Storage Systems (BESS) are dominating the energy storage market in Maldives with a few public and private projects already using it. The upcoming 100 MW floating solar near Malé (awarded to Abraxas Power) is going to be equipped with a 100 MWh BESS.

Key interfaces with Green Hydrogen

Currently, electricity generation in the Maldives relies almost entirely on diesel, driving high import costs and contributing significantly to national emissions. Green hydrogen produced from surplus renewable energy offers a viable alternative in several ways:

- **Diesel Displacement:**
  Since nearly all electricity is currently generated from diesel, green hydrogen offers a pathway to substitute a portion of diesel-based generation. This reduces import dependence, exposure to fuel price volatility, and system-wide emissions. Introducing hydrogen into the power mix decarbonises not only generation but also the sectors dependant on it like industries, households, tourism, desalination and public services.
- **Long Duration Energy Storage:**
  Hydrogen enables multi-day storage by converting excess solar electricity into chemical energy and reconverting it through fuel cells or combustion during low-generation periods. This complements batteries, which excel at short-term balancing but not seasonal or multi-day storage. Hybrid PV-hydrogen systems can support isolated island grids by providing frequency regulation, backup power, and energy buffering, services that become increasingly important as solar penetration grows.

[22] Maldives' First Biennial Transparency Report, 2024

4. BENCHMARKING OF GH2 ADOPTION PRACTICES

The Maldives is only beginning its green hydrogen journey, yet there is much to learn from other small island and low-emission economies that have already taken early steps in this direction. Countries such as Mallorca, the Canary Islands, Cabo Verde, Sri Lanka, and Mauritius offer valuable reference points because they operate under similar constraints limited land, scattered islands, heavy fuel imports, and high climate exposure. Their initial efforts to pair hydrogen with renewables, enhance energy resilience, and decarbonize mobility and tourism sectors provide practical direction for Maldives' own transition.

To translate these experiences into a usable framework for the Maldives, each benchmark country was evaluated across energy resource strategies, policy architecture, implementation models, priority applications, and contextual relevance. This structured assessment reveals how comparable island systems are designing their early hydrogen ecosystems, and which elements (technologies, financing approaches, regulatory instruments, or end-use opportunities) are most adaptable to Maldivian conditions. The following country profiles summarize these insights to guide Maldives' green hydrogen planning.

Table 4. Benchmarked Country Profiles

Country / Region	Population	Total Emissions	Vehicles (approx.)	Waste Generation per Capita	Tourism Share of GDP	GDP per Capita
Maldives	~515,000	~2.4 MtCO2e (2023)	~131,000	1.7–2.0 kg/person/day	28–33%	~$13,216
Mallorca/ Balearic Islands	~846,000	~5.2 MtCO2e (Balearic Islands)	~800,000	~1.6 kg/person/day	~45%	-
Canary Islands (Spain)	~2.26 million	~17–18 MtCO2e	~1.8 million	~1.4 kg/person/day	~35–40%	~$31,680
Cabo Verde	~0.56–0.65 million	~0.6 MtCO2e	~70,000	~1.0 kg/person/day	~25%	~$ 4,000–4,200
Sri Lanka	~22.3 million	~27–28 MtCO2e	~8.3 million	~1.2 kg/person/day	~5–6%	~$ 4,300
Mauritius	~1.3 million	~4.6 MtCO2e	~600,000	~1.3 kg/person/day	~25%	~$ 11,900

Mallorca/ Balearic Islands

Mallorca, an island in Spain, is emerging as a leading island demonstrator for integrating green hydrogen into a low-carbon energy system, driven by the need to decarbonise tourism, transport, and public services. The island sources renewable power from two dedicated PV farms at Lloseta (6.9 MW) and Petra (6.5 MW), which feed a 2.5 MW electrolyser, expandable to 10 MW for producing around 330 tonnes of hydrogen annually (about 1.5 GWh of stored renewable energy).

Hydrogen deployment is guided by Spain's National Energy and Climate Plan (NECP), the EU Clean Hydrogen Partnership, and the Green Hysland initiative, all of which position hydrogen as a tool for clean mobility and energy resilience. A €50 million EU-backed project led by ACCIONA Energía, Enagás, CEMEX, and Redexis is enabling pilot-scale infrastructure, including a blockchain-based GoO system for certified hydrogen injection into the gas grid.

The GH2 use cases span zero-emission buses and rental cars, power and heat for public buildings, auxiliary energy for ferries and ports, and limited gas-grid blending. Mallorca is not pursuing hydrogen export, instead prioritizing domestic decarbonisation and operational reliability across key island sectors.

Energy Sources	• Two dedicated PV farms: Lloseta (6.9 MW) and Petra (6.5 MW), totalling ~14 MW • Electrolyser capacity: 2.5 MW (pilot stage), expandable to 10 MW • Expected production: ~330 tonnes H_2/year, equivalent to ~1.5 GWh stored renewable energy
Policies for Hydrogen Adoption	• Supported by the EU Clean Hydrogen Partnership and Green Hysland initiative • Regional decarbonisation targets under the Spanish National Energy and Climate Plan (NECP)

	• Hydrogen development framed as a tool for sustainable tourism and transport
Implementation Tools	• €50 million project, with ~30% EU co-financing led by ACCIONA Energía, Enagás, CEMEX, and Redexis in partnership with Balearic authorities • Blockchain-based Guarantee of Origin (GoO) system for certified hydrogen blending in gas grid
Hydrogen Use Cases	• Mobility: Buses and rental cars via dedicated refuelling station • Built environment: Power and heat for commercial/ public buildings • Maritime: Auxiliary power for ferries and ports • Gas grid injection: Part of hydrogen injected into Redexis network with certified emission tracking • Export: None; fully domestic pilot-scale use
Key takeaways for Maldives	• Focus small-scale PV and electrolyser pilots for resorts and ferry terminals • Announce decarbonization targets to promote use of clean technologies like GH2 in multiple sector use (transport, microgrid, ports)

Canary Islands

The Canary Islands present a compelling example of how an isolated, multi-island energy system can leverage hydrogen to support large-scale renewable energy integration, enhance grid stability, and decarbonize maritime operations. With electricity demand of over 8,000 GWh in 2022 and a renewable share of just 21.7%, the region is rapidly scaling up its clean energy capacity toward 2030 targets adding more than 1.7 GW of onshore wind, over 1.2 GW of PV, and 330 MW of offshore wind. Hydrogen plays a strategic role in this transition, supported by a dedicated regional roadmap, EU Green Deal funding, and the Just Transition Fund. It is positioned as a key enabler for energy storage, maritime fuels, and achieving long-term regional decarbonization.

Implementation is driven through strong regional coordination led by the Instituto Tecnológico de Canarias (ITC), which anchors multiple pilot projects across ports, industrial zones, and island grids. Planned infrastructure includes 45 MW of hydrogen turbines for grid balancing and 17 refuelling stations across key islands, aligning closely with the region's renewable energy expansion plans. Use cases span power system storage, public mobility, refuelling networks, and maritime bunkering reflecting a broad, multi-sector approach without an export focus, prioritizing internal energy security.

Energy Sources	• 2022 demand: **~8,055 GWh**, **21.7% RE share**
	• 2030 targets:
	  ○ Wind onshore: **1,706 MW** (up from 576 MW)
	  ○ PV total: **1,283 MW** (up from 262 MW)

	○ Offshore wind: **330 MW** ○ Hydrogen turbines: **45 MW** ○ Refuelling stations: **17** planned
Policies for Hydrogen Adoption	• Regional Hydrogen Roadmap (Green Hysland / Biogreenfinery) • Supported by EU Green Deal and Just Transition Fund • Hydrogen positioned for energy storage, maritime fuels, and regional decarbonisation
Implementation Tools	• Regional coordination via Instituto Tecnológico de Canarias (ITC) • Multiple pilot projects in ports and industrial areas • EU co-funding for infrastructure and 2030 target alignment • Integration with large RE expansion and grid balancing
Hydrogen Use Cases	• Power system storage: Using hydrogen turbines for grid balancing • Transport: Public mobility and refuelling stations for vehicles and buses • Maritime: Bunkering and auxiliary power for docked ships • Export: None yet; focus on regional energy self-sufficiency
Key takeaways for Maldives	• Cluster islands into hydrogen and RE hubs (e.g., Malé, Addu, Laamu) • Establish a technical hydrogen institute or National task force for safety, training, and port standards • Use hydrogen for shore power in Malé and tourism port operations

Cabo Verde

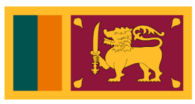
Cabo Verde represents a strong example of how small island nations with limited domestic resources can position green hydrogen as a pathway to energy security and economic diversification. With electricity demand of roughly 580 GWh and a renewable energy share of around 20% (mainly solar PV and wind) the country remains fully dependent on imported fuels. Its national target to achieve 50% renewable energy by 2030 has accelerated interest in hydrogen as a complementary solution for decarbonizing power generation, strengthening resilience, and reducing exposure to volatile fuel prices.

Policy support is anchored in the National Green Hydrogen Roadmap (2024) developed under the World Bank's Accelerating Sustainable and Resilient Energy Transition program. Hydrogen is integrated into the National Energy Transition Plan and framed as a tool for both energy sovereignty and broader economic diversification, including future participation in regional hydrogen markets.

Cabo Verde's implementation strategy begins with donor-supported pilot projects, including a 0.5-2 MW electrolyser powered by 10-15 MW of solar and wind, expected to produce 100–200 tonnes of hydrogen annually. These early initiatives are backed by blended finance/ public funding, development partner support, and concessional loans, alongside policy incentives such as feed-in tariffs and tax exemptions to encourage renewable–hydrogen investment. Initial use cases focus on substituting diesel in mini-grids, public mobility pilots, and small fishing vessels, with export opportunities considered only in the long term.

Energy Sources	• Total electricity demand: ~580 GWh (2022) • RE share: **~20%** (solar PV, wind) • **Target: 50% RE by 2030** • **Fully dependent on fuel imports; no domestic fossil resources**
Policies for Hydrogen Adoption	• National Green Hydrogen Roadmap (2024) under World Bank's Accelerating Sustainable and Resilient Energy Transition program • Hydrogen framed as energy security + economic diversification • Incorporated in the National Energy Transition Plan
Implementation Tools	• Pilot electrolyser: 0.5–2 MW, powered by 10–15 MW PV/wind • Production: ~100–200 tonnes H_2/year for power and transport • Blended finance (public, donor, concessional loans) • Policy incentives: feed-in tariffs, tax exemptions for RE-hydrogen investments
Hydrogen Use Cases	• Power generation: Substituting diesel in mini-grids • Mobility: Public transport and fishing boats (pilot-scale) • Export: Long-term potential for regional hydrogen trade, but not near-term
Key takeaways for Maldives	• Use donor-led pilot financing and concessional structures (like World Bank model) • Demonstrate green hydrogen for diesel displacement in resort microgrids and small islands • Build policy around fuel import reduction and energy sovereignty

Sri Lanka



Sri Lanka is positioning green hydrogen as a strategic pillar in its long-term energy transition, driven by rising electricity demand of approximately 17,000 GWh and a strong renewable energy ambition, moving from a 38% RE share today toward a 70% target by 2030. With more than 30 GW of solar and over 20 GW of wind potential, the country is advancing hydrogen as a complementary solution to decarbonize hard-to-abate sectors and leverage its renewable resource base.

Policy direction comes through the National Hydrogen Roadmap (2024), led by the Power and Energy Ministry (PDASL) and aligned with the national Long-Term Generation Expansion Plan (2024–2043). The roadmap positions hydrogen as central to decarbonizing transport, fertilizer production, and industrial operations, while also exploring future export pathways, particularly green ammonia exports to India.

Sri Lanka's implementation pathway starts with a pilot phase in Puttalam (2025–27), featuring a 1–5 MW demonstration project expected to produce roughly 1,500 tonnes of hydrogen annually. The country has set a more ambitious medium-term target of deploying 100 MW of electrolyser capacity by 2030. This scale-up is supported through multilateral financing partnerships with ADB, Japan, and the EU, alongside capacity-building efforts driven by universities and PDASL-led technical training programs.

Energy Sources	• Electricity demand: **~17,000 GWh** (2023) • **RE share: 38%**, with 70% RE by 2030 target • Solar potential: >30 GW, wind potential: >20 GW
Policies for Hydrogen Adoption	• National Hydrogen Roadmap (2024) by the Power and Energy Ministry (PDASL) • Aligned with Long-Term Generation Expansion Plan 2024–2043 • Hydrogen positioned as key to transport, fertiliser, and industry decarbonisation
Implementation Tools	• Pilot phase (2025–27): 1–5 MW demo at Puttalam (~1,500 t H_2/year) • Electrolyser target: 100 MW by 2030 • Multilateral funding (ADB, Japan, EU) • Capacity-building through universities and PDASL-led training
Hydrogen Use Cases	• Transport: Buses and heavy vehicles • Industry: Fertiliser and ammonia production • Export: Under study; potential to export green ammonia to India
Key takeaways for Maldives	• Draft a national hydrogen roadmap aligned with energy targets • Use government fleets and ferries as anchor customers • Explore hydrogen-ammonia synergy for regional trade links (India, Sri Lanka, Maldives corridor)

Mauritius

Mauritius is emerging as a promising example of how small island economies can integrate green hydrogen into broader decarbonisation plans, particularly in sectors linked to tourism and industry. With an annual electricity demand of roughly 2,800 GWh and a current renewable energy share of 25%, the country has set an ambitious target of reaching 60% renewables by 2030. Its resource base is dominated by solar PV and bagasse, with limited wind and offshore potential, making hydrogen an attractive option for storage, energy reliability, and sectoral fuel switching.

Hydrogen development is guided by the Draft National Green Hydrogen Strategy (2023) under the Renewable Energy Roadmap 2030, positioning hydrogen as a key enabler for clean tourism, industrial energy use, and port operations. Policy support including revised feed-in tariffs and wider private PPAs, is encouraging early hybrid solar–hydrogen investments.

Current efforts focus on 2–5 MW electrolyser pilots, many paired with floating PV to overcome land constraints. Support from IRENA, AFD, and the EIB, along with co-investment from resorts and industrial users, is driving this early phase. Mauritius targets producing ~400 tonnes of hydrogen annually by 2030 for domestic use. GH2 applications include PV–hydrogen resort microgrids, refuelling for bus fleets and logistics, and hydrogen for industrial heat and backup power. The country is not pursuing export, prioritising domestic decarbonisation and energy resilience..

Energy Sources	• Power demand: ~**2,800 GWh** (2022) • **RE share: 25%**, target 60% by 2030 • Mix: Solar PV, bagasse, limited wind/offshore potential
Policies for Hydrogen Adoption	• National Green Hydrogen Strategy (Draft 2023) within the Renewable Energy Roadmap 2030 • Hydrogen included in energy transition for tourism, industrial and port applications • Policy measures: feed-in tariff revisions, private PPAs for hybrid solar-hydrogen systems
Implementation Tools	• Feasibility for 2–5 MW electrolyser pilots co-located with floating PV • IRENA, AFD, and EIB providing technical and financial support • Early focus on private-sector co-investment (resort and industrial users) • Target production: ~400 t H_2/year by 2030
Hydrogen Use Cases	• Tourism sector: Powering resort microgrids with PV and H2 • Transport: Refuelling for inter-city buses and logistics • Industry: Process heat and backup power • Export: None; focus on domestic decarbonisation

Key takeaways for Maldives	• Develop replicable model for floating PV and H_2 microgrids • Use climate finance and private partnerships to enable resort-led adoption • Integrate green hydrogen in tourism sustainability certification (zero-emission branding)

Hy-SPARC: A Bottom-Up GH2 Pathway guided by International Benchmarks

To design a realistic and scalable green hydrogen pathway, the Maldives can adopt the **Hy-SPARC Framework**, a five-building block model grounded in lessons from other island nations that are already advancing green hydrogen. The Hy-SPARC Framework synthesises the most successful practices observed across benchmarked island economies and adapts them to the Maldives' unique context of distributed islands, high fuel imports, limited land, and strong RE potential. By progressing in sequence from **S**trategy development, **P**ilot demonstration, **A**ligned policies development, **R**esourced mobilization and **C**apacity strengthening, the Maldives can build a low-risk, evidence-based pathway that mirrors global best practices while shaping a uniquely Maldivian green hydrogen policy framework.

Hy-SPARC provides a systematic bottom-up approach that derisks early adoption while creating long-term institutional, financial, and technical readiness.

1. **Strategy Development:** Country should establish a unified national direction through a clear, data-driven green hydrogen roadmap with targets for potential/ priority GH2 applications, incentives, infrastructure development goals and ensure policy coherence across ministries, utilities, ports, and private developers.
2. **Pilot Demonstration:** Country should implement pilot demonstrations in sectors with highest readiness such as resort microgrids, transport (maritime). This will allow to validate feasibility, optimise technical configurations, and build operational confidence. These early pilots will generate real-world data needed to scale solutions across the archipelago.
3. **Aligned Policy Measures:** Country should introduce enabling policies, safety standards and transitional incentives (duty exemptions, tariff structures, subsidies) aligned with learnings from the pilot demonstrations to support the GH2 ecosystem development
4. **Resource Mobilization:** Country should mobilise blended finance from government support, multilateral climate funds, private investors, and resort-sector partnerships given the high upfront cost of GH2 technologies
5. **Capacity Development:** Country should focus on building local GH2 expertise, invest in training programs for utilities (STELCO, FENAKA), port authorities, regulators, and private operators, partner with international Centre of Excellence to accelerate knowledge transfer and establish a local hydrogen knowledge ecosystem

5. GH2 BARRIERS & OPPORTUNITIES

The Maldives stands at a critical juncture where energy security, climate ambition, and economic competitiveness intersect. This section synthesizes key drivers, opportunities, and barriers for developing a domestic green hydrogen ecosystem aligned with the Maldives' national priorities reflecting both the country's constraints and its strategic advantages.

5.1. Drivers

The transition toward a green hydrogen ecosystem in the Maldives is shaped by a set of powerful structural drivers that make the case for early adoption both compelling and inevitable. These drivers span energy security, decarbonisation commitments, renewable resource expansion, circular economy potential, and the growing sustainability expectations within the country's dominant tourism sector. When viewed through the lens of vulnerability to climate change and dependence on imported fuels, green hydrogen offers a pathway to systemic resilience and long-term economic advantage. The following drivers across the Green Hydrogen value chain outline why hydrogen is not merely an option for the Maldives, but a strategic necessity.

A. Renewable Energy (RE) Generation:

- **Rapid Renewable Expansion & Falling Solar Tariffs:** The Maldives is scaling its renewable energy base, with 68.5 MW of installed solar and a target of 33% RE by 2028. Growth in RE such as floating solar and hybrid microgrids can generate surplus daytime electricity that can be diverted to electrolysis, turning variable solar output into stable, dispatchable hydrogen energy.

B. Green Hydrogen Production

- **Energy Security and Import Substitution**: The country currently imports around 0.85 million tonnes of petroleum annually, equivalent to 13.5% of GDP, making the economy highly vulnerable to global price shocks. Green hydrogen offers a domestic, renewable alternative that strengthens energy sovereignty across more than 200 dispersed island grids.
- **Net Zero by 2030:** Achieving the Maldives' Net Zero 2030 pledge requires deep decarbonisation, especially in electricity, transport, and tourism, which remain heavily dependent on diesel. Green hydrogen provides a pathway to clean critical sectors such as diesel backup generation, marine transport, and resort energy systems.
- **Circular Resource Utilisation through Waste-to-Hydrogen Pathways:** Rising solid waste volumes from tourism and urban islands pose growing environmental challenges. Waste-to-hydrogen pathways such as gasification or reforming can convert municipal and resort waste into clean fuel, simultaneously reducing landfill loads and creating a domestic energy feedstock.
- **Declining Technology Costs and Market Timing**: Electrolyser costs have fallen 40% since 2020 and are projected to decline by another 50–70% by 2030, improving hydrogen viability. Solar PV in the Maldives has reached grid parity, with recent PPAs at USD 0.05–0.07/kWh, making renewable electricity an attractive input for hydrogen production. The Maldives can leverage global technology scaling to enter as an early island adopter.

C. Green Hydrogen Storage & Distribution

- **Climate Vulnerability and Energy Resilience:** With an average elevation of 1.5 m, the Maldives is among the world's most climate-vulnerable nations, requiring highly resilient energy systems to safeguard desalination, cooling, telecommunications, and healthcare during extreme weather events. Hydrogen-based backup systems reduce dependence on diesel supply chains that are easily disrupted during cyclones and monsoons.
- **Maritime strategic positioning:** As global shipping lanes move toward green corridors, the Maldives' central location provides long-term potential for hydrogen or ammonia bunkering, strengthening regional maritime relevance.

D. Green Hydrogen End-use Applications

- **Clean Power Generation:** Over 90% of the Maldives' electricity is generated from imported diesel, creating high costs and dependence. Integrating solar, storage, and hydrogen-based backup systems can significantly reduce fuel use, enhance grid reliability, and enable cleaner, more resilient island power networks.
- **Tourism Competitiveness and Sustainability Branding:** Tourism contributes over 60% of GDP and employs roughly 40% of the workforce. As global travellers increasingly prefer low-carbon destinations, hydrogen enables resorts to achieve near-zero-emission operations and differentiate themselves as "100% renewable-powered," elevating Maldives' premium tourism brand.
- **Marine transport:** Marine transport consumes 20–30 million litres of diesel annually. Transitioning to fuel-cell ferries and hydrogen-ready vessels can substantially cut emissions and operating costs, supporting cleaner inter-island mobility.

5.2. Barriers

The development of a green hydrogen ecosystem in the Maldives is constrained by a range of systemic, technical, and institutional barriers that influence both the pace and scale of progress. As a Small Island Developing State (SIDS) with highly fragmented geography and a growing dependence on energy-intensive services, the Maldives must navigate challenges across policy and governance, renewable energy availability, infrastructure readiness, financing, technical capacity, market preparedness, and environmental constraints. These gaps affect every component of the green hydrogen value chain from production, storage, transport, and end-use, shaping the feasibility, cost-effectiveness, and bankability of future hydrogen investments. Understanding these barriers in a structured manner is essential to designing interventions that enable hydrogen to contribute meaningfully to national decarbonisation and energy security goals.

- **RE Generation:** A key barrier at the renewable energy generation stage is the limited availability of suitable land and space for large-scale solar or wind installations, especially on densely populated or geographically constrained islands. Project development is further slowed by lengthy permitting processes, fragmented regulatory frameworks, and the absence of dedicated green hydrogen incentives. Additionally, intermittent renewable energy generation and insufficient grid stability limit the reliable supply of clean electricity required for electrolyser operations. Waste-to-hydrogen options may face scale and consistency challenges, as waste streams are scattered, poorly segregated, and costly to transport, making feedstock supply unreliable for hydrogen production.

- **GH2 Production:** GH2 production faces challenges related to high upfront capital costs, limited availability of low-cost renewable power, and the absence of standardized technical, safety, and environmental guidelines. The lack of local technical expertise for operation and maintenance of electrolysers increases dependency on foreign suppliers, raising overall lifecycle costs. The need for desalinated water also adds to production complexity and cost.

- **GH2 Transformation:** Barriers in hydrogen transformation largely stem from technology maturity and cost constraints. Compression and liquefaction systems remain expensive, energy-intensive, and not readily available at small island scales. The absence of established codes and standards for hydrogen handling, along with limited local safety compliance capacity, further restricts deployment. These constraints make it difficult to achieve economies of scale for midstream hydrogen infrastructure.

- **GH2 Storage and Distribution:** Storage and distribution are constrained by a lack of suitable infrastructure, such as high-pressure storage vessels, pipelines, or inter-island transport systems designed for hydrogen. Logistical challenges, especially transporting hydrogen across dispersed islands further contribute to high operational costs. Safety concerns related to hydrogen leakage, fire risk, and limited emergency response capabilities also hinder infrastructure development and investor confidence.

- **GH2 Applications**: GH2 end-use sectors face uncertainty regarding hydrogen readiness, with most industries and transport applications lacking defined transition plans or techno-economic evaluations. High costs of hydrogen-compatible equipment, limited availability of demonstration projects, and unclear demand signals all slow market creation. Sectors such as marine transport, tourism facilities, and backup power systems require tailored use-case development, but limited policy support and financial incentives restrict early adoption.

5.3. Opportunities

While the Maldives faces distinct challenges as a small island nation, it also possesses substantial opportunities to establish a niche but impactful green hydrogen sector. Rising renewable capacity, abundant solar resources, and waste-management pressures create favourable conditions for green hydrogen production, while tourism and marine transport present early, high-value demand centres. The below outlines these production and utilisation opportunities, highlighting where the Maldives can gain early wins and build momentum.

A. Production Opportunities

- **Solar-Powered Electrolysis:** Solar-powered electrolysis represents the Maldives' most practical and scalable near-term hydrogen production route. By co-locating electrolysers with grid-scale solar installations or floating solar arrays, the country can directly convert surplus daytime generation, otherwise at risk of curtailment into clean hydrogen. The most suitable sites include the Greater Malé region, which has the highest demand concentration, followed by Addu City and mid-sized inhabited or resort islands that already host solar infrastructure.

  Initial small scale hydrogen pilots can gradually scale in line with rising demand and improved technology economics. This model also aligns well with the Maldives' solar expansion plans, with 68.5 MW already installed and another 100 MW under development. Integrating electrolysis with existing desalination facilities further strengthens the value proposition by ensuring a reliable supply of high-purity water and enabling shared infrastructure, which reduces operating costs and enhances overall water-energy efficiency.

- **Waste-to-Hydrogen Pathways:** The Greater Malé region produces around 365 tonnes of waste per day, contributing to a national total of approximately 860 tonnes, with a composition 65% organic matter, 15% plastics, and the rest paper, metals, and glass well suited for gasification or biogas-to-hydrogen processes. If 30-40% of these waste streams are converted, the Maldives could generate 5–10 tonnes of hydrogen per day. This approach offers twin benefits as it reduces landfill volumes and environmental pressures while producing a valuable domestic energy feedstock. Financially, waste-to-hydrogen systems can leverage tipping fees to offset production costs and enhance project viability. Applicable technologies include gasification for mixed waste and biogas upgrading with reforming for organic-rich fractions.

B. Hydrogen End-Use Application Opportunities

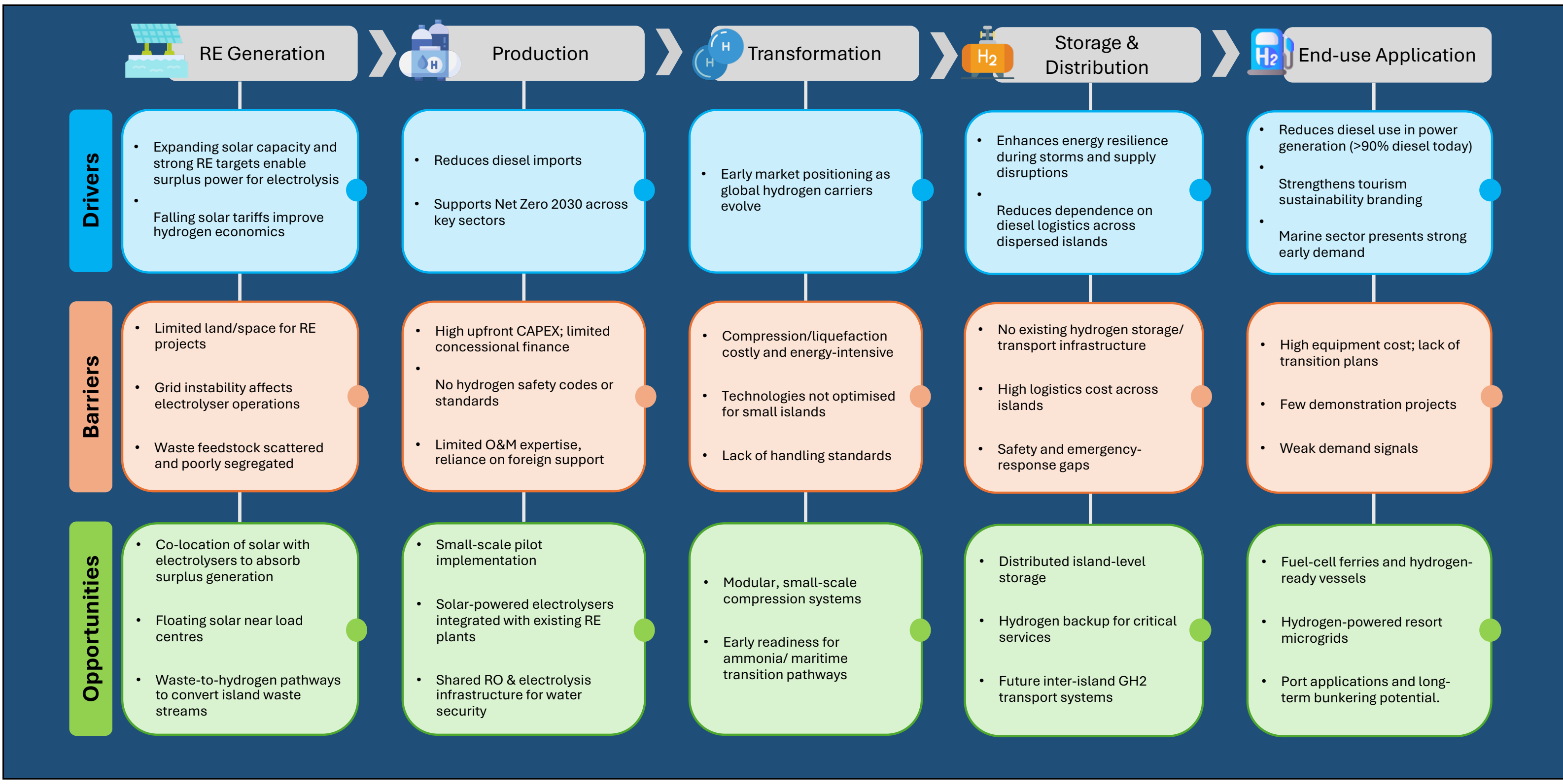
- **Power Generation and Storage**: Hydrogen can play a pivotal role in strengthening island microgrids by providing seasonal energy storage and replacing diesel-based backup systems. While batteries address short-term intermittency, they cannot manage multi-day or seasonal variability, an increasing challenge as renewable penetration grows. Integrating hydrogen allows excess solar generation to be stored and converted back to power when needed, enabling higher renewable shares, improving system reliability, and significantly lowering emissions.

- **Transport**: Decarbonising the transport sector presents one of the Maldives' largest opportunities for hydrogen deployment. Introducing fuel-cell ferries, hydrogen-ready cargo vessels, and fuel-cell electric vehicles supported by refuelling hubs in Malé and Addu can dramatically cut transport emissions, which currently account for nearly 48% of national CO2. The marine sector alone consumes 20–30 million litres of diesel annually, and transitioning to hydrogen-based propulsion can meaningfully reduce fuel imports while improving operational efficiency and resilience.

- **Tourism and Resorts:** Hydrogen also offers strong value for the tourism sector, where resorts increasingly seek sustainability differentiation and "100% renewable-powered" branding. By adopting hydrogen-based power systems integrated with RO desalination and shifting logistics boats to hydrogen, resorts can create fully self-sufficient clean microgrids. Given that 168 resort islands currently operate diesel-based systems consuming 75–120 million litres of fuel each year, hydrogen can greatly reduce diesel dependency, enhance energy independence, and eliminate transport and storage risks while offering quieter and cleaner operations thereby making these key advantages for luxury market positioning.

- **Maritime and Ports:** Within port environments, hydrogen can be introduced through bunkering terminals and fuel-cell auxiliary power for docked vessels. These applications reduce harbour emissions and noise, improve air quality, and provide an early demonstration of hydrogen's role in maritime operations. Establishing such infrastructure in key ports sets the stage for wider adoption across the maritime value chain.

- **Maritime and Export Potential:** Looking ahead, the Maldives can use its strategic location to develop hydrogen or ammonia bunkering terminals that serve regional shipping routes. This positions the country within emerging green shipping corridors and opens pathways for future export opportunities. By building early capabilities, the Maldives can access markets that scale far beyond domestic demand, anchoring long-term hydrogen sector growth.



Conclusion

The baseline assessment highlights that the Maldives is uniquely positioned to explore green hydrogen as part of its long-term energy transition, even as diesel remains deeply embedded across power, water, transport, and tourism systems. The country's dispersed island geography, strong solar resource potential, and growing dependence on desalination and mobility create both challenges and opportunities for integrating green hydrogen into its future energy landscape. While current renewable penetration is limited, the ongoing RE progress such as floating solar initiatives, hybrid microgrids, waste-to-energy projects, and resort-driven renewable investments, form a critical foundation for future hydrogen readiness.

Across sectors, the assessment finds that green hydrogen can be a strategic enabler that complements renewable energy expansion and enhances resilience. Its most compelling early applications lie in marine transport, energy storage and production, resort energy systems, and water-energy integration where hydrogen can support diesel displacement, provide long-duration storage, and unlock decarbonisation pathways that batteries or conventional renewables alone cannot fully address. Utilities, transport operators, and resorts have signalled early interest in innovation, but also emphasised the need for enabling policy frameworks, technical standards, capacity building, and financial support.

International benchmarks from island economies show that early green hydrogen ecosystems evolve through coordinated strategy development, blended financing, structured policy support, and sustained collaboration across public agencies, private developers, and development partners.

As the Maldives advances toward its Net Zero 2030 objective, green hydrogen can serve as an important tool to reduce fuel imports, enhance energy security, and position key sectors, particularly tourism and transport as global sustainability leaders. However, the challenge of cost of GH2 production and end-use needs to be evaluated in detail to inform decision makers on the sector prioritization and subsequent development of the ecosystem. Therefore, the next phase of this study will build on the baseline findings to conduct detailed techno-economic analysis for potential GH2 applications followed by identifying viable pilot sites, and outlining a national policy framework that aligns green hydrogen development with Maldives' broader climate, economic, and resilience goals.

Annexures

Annexure-1: List of Primary Consultations

Category	Stakeholder/s
Public Utility Company	Malé Water and Sewerage Company (MWSC) • Mr. Furugan Ibrahim • Mr. Ali Ahsan • Mr. Zayan Adam
Transport Operator	Maldives Transport and Contracting Company (MTCC) • Mr.Abdulla Farish • Mr. Abdulla Shimau
Resort	Soneva Secret • Mr. Ishaan Singh

Annexure-2: Summary of Meeting Minutes with the Stakeholders

Consultation-1: Malé Water and Sewerage Company (MWSC) | Monday, 1st December

The consultation with MWSC provided a high-level understanding of the current water production, desalination, and utility operations in the Maldives, with relevance to identifying potential pathways for clean energy and hydrogen integration.

1. Water Production and Desalination Landscape
   MWSC operates a network of reverse osmosis (RO) based desalination plants across the Greater Malé region and selected outer islands. These plants vary in capacity depending on island demand, reflecting a mixed centralized and decentralized operational structure. RO remains the dominant technology for potable water production across MWSC-operated sites

2. Energy Use in Water Production
   Desalination is an energy-intensive process, with the majority of energy demand attributed to high-pressure pumping inherent to RO systems. The energy supply for these operations currently comes primarily from diesel generators, supplemented by grid electricity in the capital region. Several islands have solar PV systems in place, but their contributions vary and are generally supplementary. Diesel generators continue to serve as the main backup power source across sites

3. Water Demand and Consumer Segments
   Water consumption serves a combination of domestic, commercial, and institutional users, with domestic consumers forming the largest share. Tourist resorts operate independently of MWSC's network and were outside the scope of this discussion.

4. Fuel Supply and Logistics

MWSC relies predominantly on diesel for its operational energy requirements. Fuel procurement is routed through national distributors, and MWSC maintains internal logistics capabilities to support transport and supply continuity across its service islands.

5. Variability Across Islands
   Operational characteristics differ by island depending on local water resource availability, energy infrastructure, waste treatment systems, and demand profiles. Certain islands exhibit attributes that may make them suitable candidates for future clean energy pilots, including hydrogen-related demonstrations. One such island is Dhuuvafaru, where MWSC is the sole utility company providing water, electricity and waste management services.

6. Opportunities for Hydrogen Integration
   MWSC expressed interest in exploring the role of hydrogen in future operations, particularly in:
   - Supplying treated water suitable for electrolysis, with further purification achievable through additional treatment stages if required
   - Assessing hydrogen-supported or hybrid power solutions for desalination or critical backup applications
   - Considering collaborative pilot projects where hydrogen technologies could be tested alongside conventional systems.

Consultation-2: Maldives Transport and Contracting Company (MTCC) | Monday, 1st December

The consultation with MTCC provided insights into the current public transport and ferry landscape in the Maldives, including fleet characteristics, operational practices, and perspectives on future low-carbon transition opportunities, including the feasibility of hydrogen.

1. Overview of MTCC Operations
   MTCC is the primary public transport operator in the Maldives, overseeing both land transport (buses, taxis) and marine transport (ferries, speedboats) across multiple islands and regions. Their portfolio includes a mix of conventional and high-speed ferries, public buses, and supporting transport services under government contracts and subsidies.

2. Land Transport Fleet
   MTCC operates a diversified fleet of public buses, including city buses, coaches, minibuses, and a limited number of electric buses.
   - MTCC has initiated the deployment of electric vehicles (EVs) in Malé and Hulhumalé, supported by a small number of fast-charging stations.
   - Expansion of EVs is under consideration, though charging infrastructure investment and renewable energy availability are key constraints.
   - Bus routes typically involve short to medium-distance, frequent round trips
   - The Government plans to introduce additional electric taxis, though charging will initially depend on diesel-based electricity.

3. Marine Fleet and Ferry Operations
   MTCC manages a substantial fleet of high-speed and conventional ferries, which form the backbone of inter-island transportation.

- High-speed vessels and larger conventional vessels differ in size, operational range, and fuel consumption patterns
- Some vessels are MTCC-owned, while others are rented or leased depending on operational needs
- Maintenance is handled by MTCC's internal engineering capability, though vessel construction is outsourced
- Current vessels primarily rely on diesel/petrol-powered engines, and no hydrogen or alternative-fuel pilots have been conducted to date

4. Subsidies and Financial Structure
   Under government transport programs (including initiatives like RTL), capital expenditure for vessels and certain operational components is subsidized. Fuel and maintenance costs for public transport services also receive government support, reducing operational burden but creating limited incentive for fuel switching.

5. Clean Transport Initiatives & Technology Considerations
   - MTCC has not yet explored hydrogen-powered transport, citing a lack of pilots, infrastructure, and investment pathways.
   - Electrification is underway at a limited scale; however:
     - Charging infrastructure is still minimal
     - Renewable energy integration is limited, and
     - Cost of electric ferries and marine charging infrastructure remains a major adoption barrier
   - EV charging currently relies on the diesel-dominated grid, and no major renewable energy charging plans exist in the near term.

6. Potential Areas of Interest for the Future
   While MTCC is not currently pursuing hydrogen initiatives, the consultation highlighted potential future opportunities such as:
   - Feasibility assessments for low-carbon ferries on short or frequent routes
   - Integration of renewable-powered charging hubs for land and marine EVs
   - Pilot projects exploring hydrogen in auxiliary systems, port operations, or selected transport corridors

Consultation-3: Soneva Secret Resort | Tuesday, 2nd December

A consultation was held with the Soneva Secret's engineering and management personnel to understand the resort's current energy profile, renewable energy systems, diesel dependency, and potential touchpoints for future low-carbon or hydrogen-based solutions. The discussion provided valuable insights into the operational challenges of island-resort energy systems and Soneva's broader sustainability ambitions.

1. Renewable Energy Deployment
   Soneva Secret has invested significantly in a floating solar PV system, supported by a battery energy storage system (BESS). The resort aims to achieve very high renewable energy penetration, following the success of similar systems at other Soneva properties.

2. Diesel-Based Power Systems

Diesel generators continue to serve as backup and supplemental power, especially during low-solar periods. Fuel logistics and generator operation remain important cost and operational considerations, reinforcing the resort's long-term focus on expanding renewable energy and improving system efficiency.

3. Marine Transport Fuel Use
   The resort operates several marine vessels relying on conventional fuels, representing a major non-electricity source of fuel consumption. Earlier trials with alternative propulsion technologies faced challenges due to the harsh marine environment, making boats a harder segment to decarbonize in the near term. This remains an area of interest for potential future pilots as technology evolves.

4. Investment, Policy Support & Incentives
   Soneva highlighted that renewable energy deployment has benefited from import duty exemptions, which have supported the financial viability of solar and storage investments. Continued policy support will be crucial for accelerating clean-energy adoption across resorts.

5. Opportunities for Hydrogen Integration
   While the resort is currently focused on maximizing renewable penetration and efficiency, potential longer-term touchpoints for hydrogen include:
   - Backup or hybrid power solutions to reduce diesel reliance
   - Future low-carbon marine transport pilots
   - Participation in sector-wide demonstrations if hydrogen supply chains emerge in the Maldives