



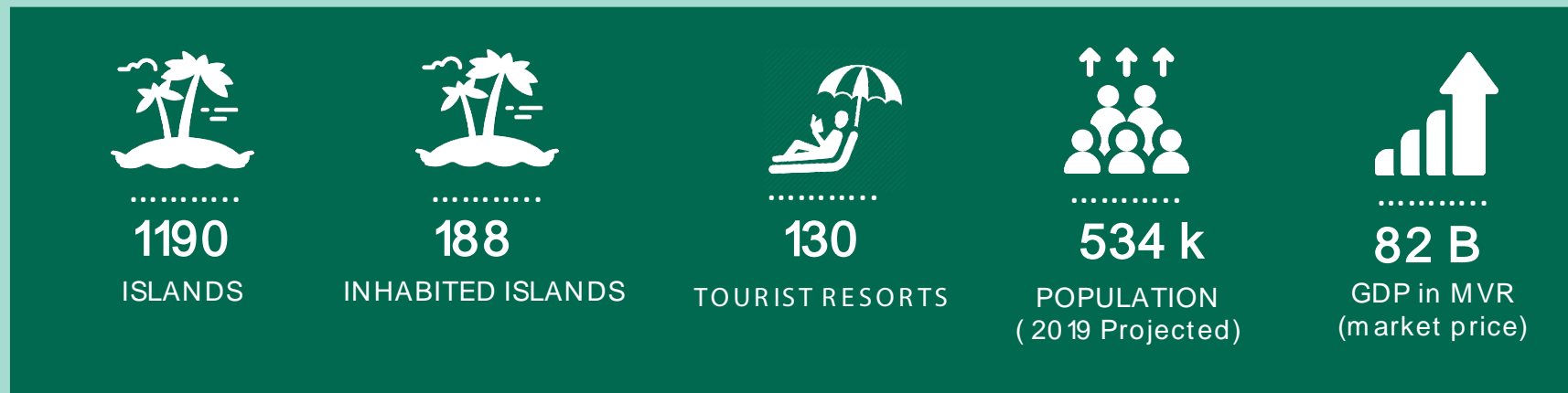
Ministry of Environment,
Republic of Maldives

Maldives: Storage for a renewable future



THE MALDIVES

- *Republic of Maldives is one of the lowest lying countries in the world making it vulnerable to the adverse impact of climate change.*
- *Further, significant dependence on imported oil for meeting its energy needs also has profound effects on economic development of the country.*





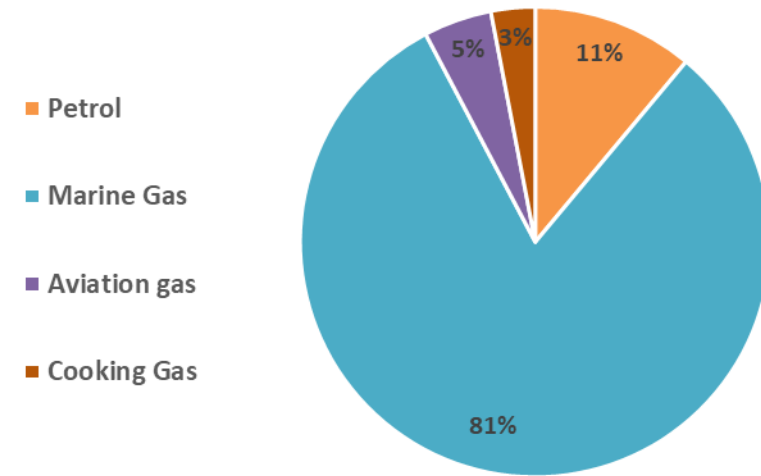
POWER SECTOR



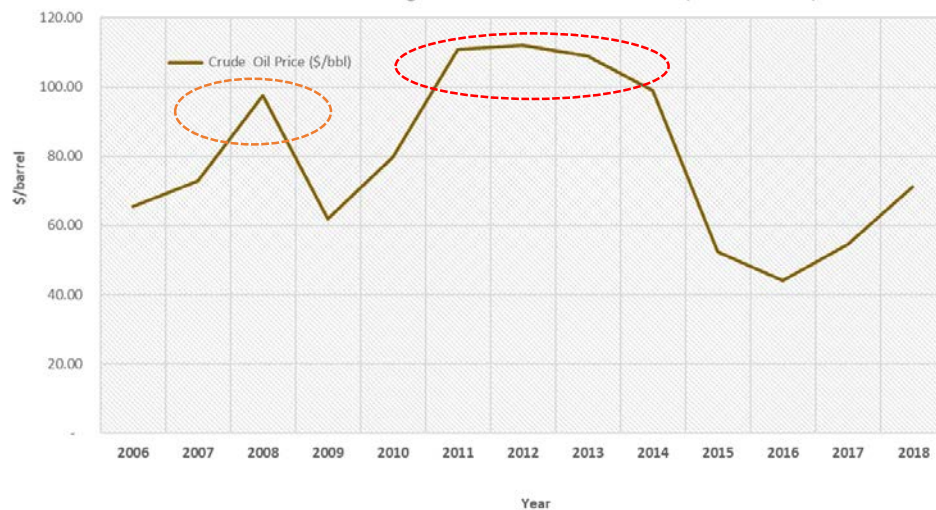
Energy Sector at a glance

- High dependency on fossil fuel.
- Primary uses of energy includes power generation, transportation, cooking
- International fuel price shocks threatens our economy.
- Total fuel bill in 2018 is ~10% of the GDP (Diesel translates to ~ 8%)

Maldives Fuel Import (CIF Values) 2016

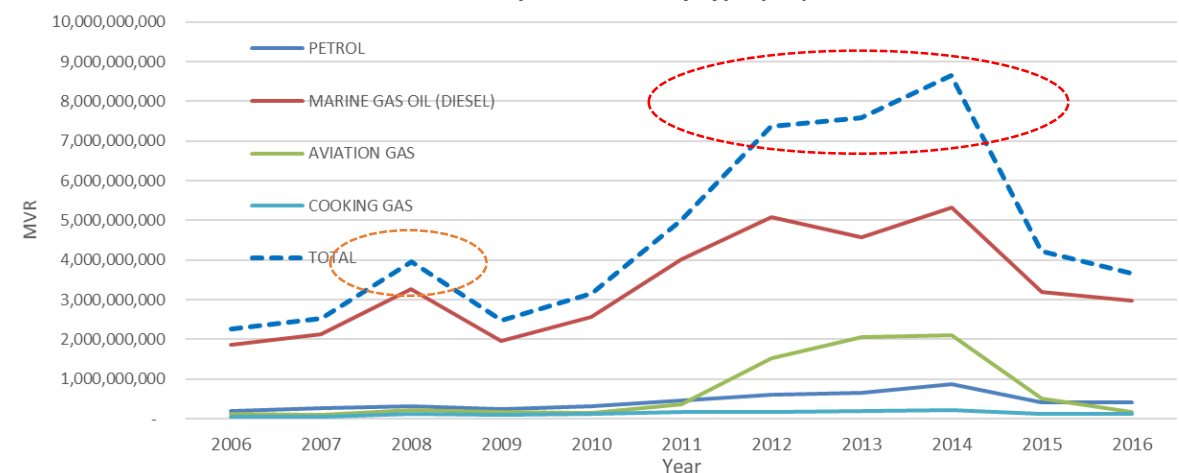


Historic Average Annual Crude Oil Price (2006-2016)



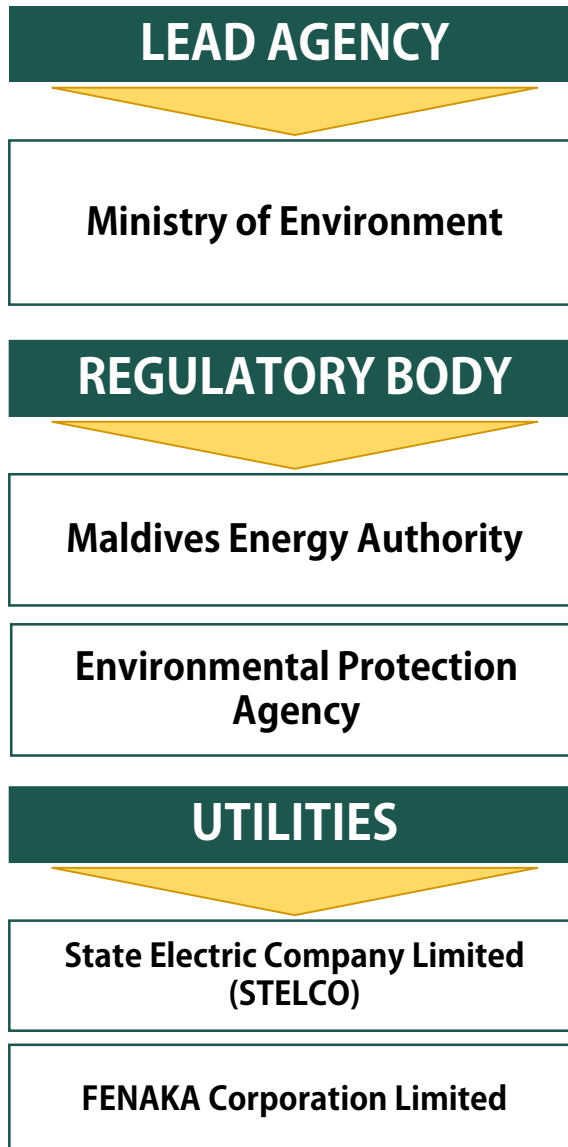
Data Source: World Bank

National Import of fuels by type (CIF)



Data Source: Maldives Customs Services

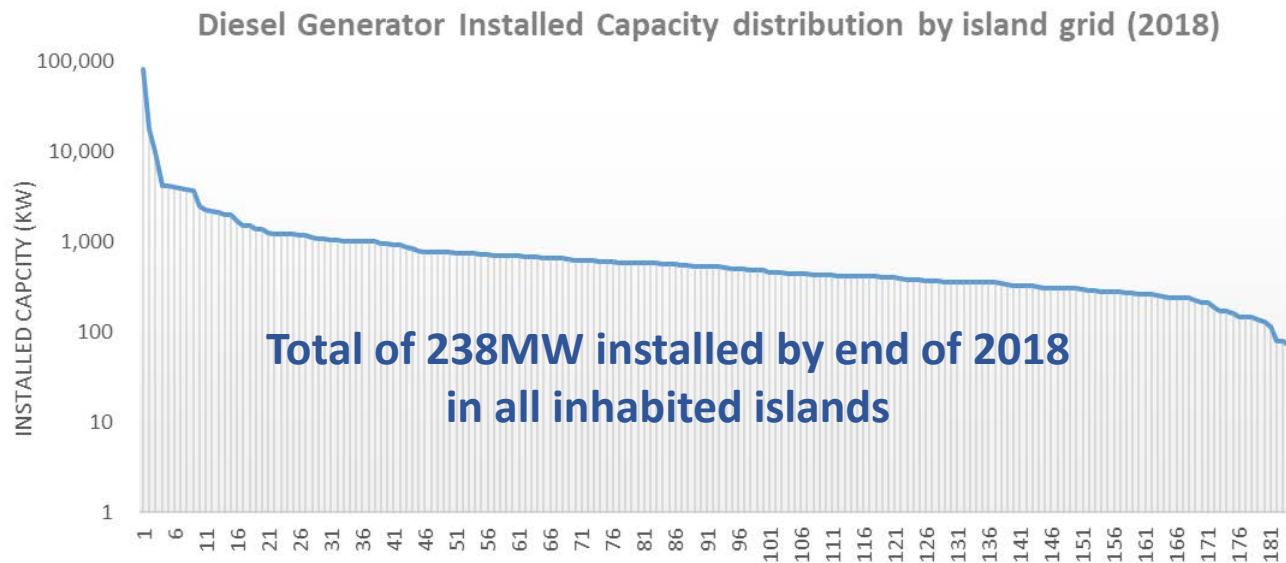
Overall Governance Structure



OTHER KEY GOVERNMENT INSTITUTIONS	
INSTITUTION	ROLE
The President's Office	Overall Policy guidance.
Ministry of Finance	Assistance in external and domestic financing.
Ministry of National Planning & Infrastructure	Higher level-planning and implementation of infrastructure projects
Ministry of Economic Development	Assistance in development of business models to promote domestic and foreign investment opportunities for energy sector development.
Local Councils	Allocation of spaces for infrastructure and overall governance at local level in islands

Electricity Production

- 100% electrification of all inhabited islands achieved in 2008
- Basic infrastructure is a diesel based power house with primarily LV distribution
- Electricity production accounts for 65% of diesel imports
- Demand growth from 8%-11% typical in most islands.
- Unit Costs of Production from diesel:
 - ❖ Average varies from \$0.22/kWh (larger Islands) to \$0.31 (smaller outer islands)
- Large subsidy payout to absorb fuel price increases and reduce end user tariff.
- Subsidy payout is unsustainable over the long-term due to high demand growth



Data Source: Maldives Energy Authority

Progress on RE integration:

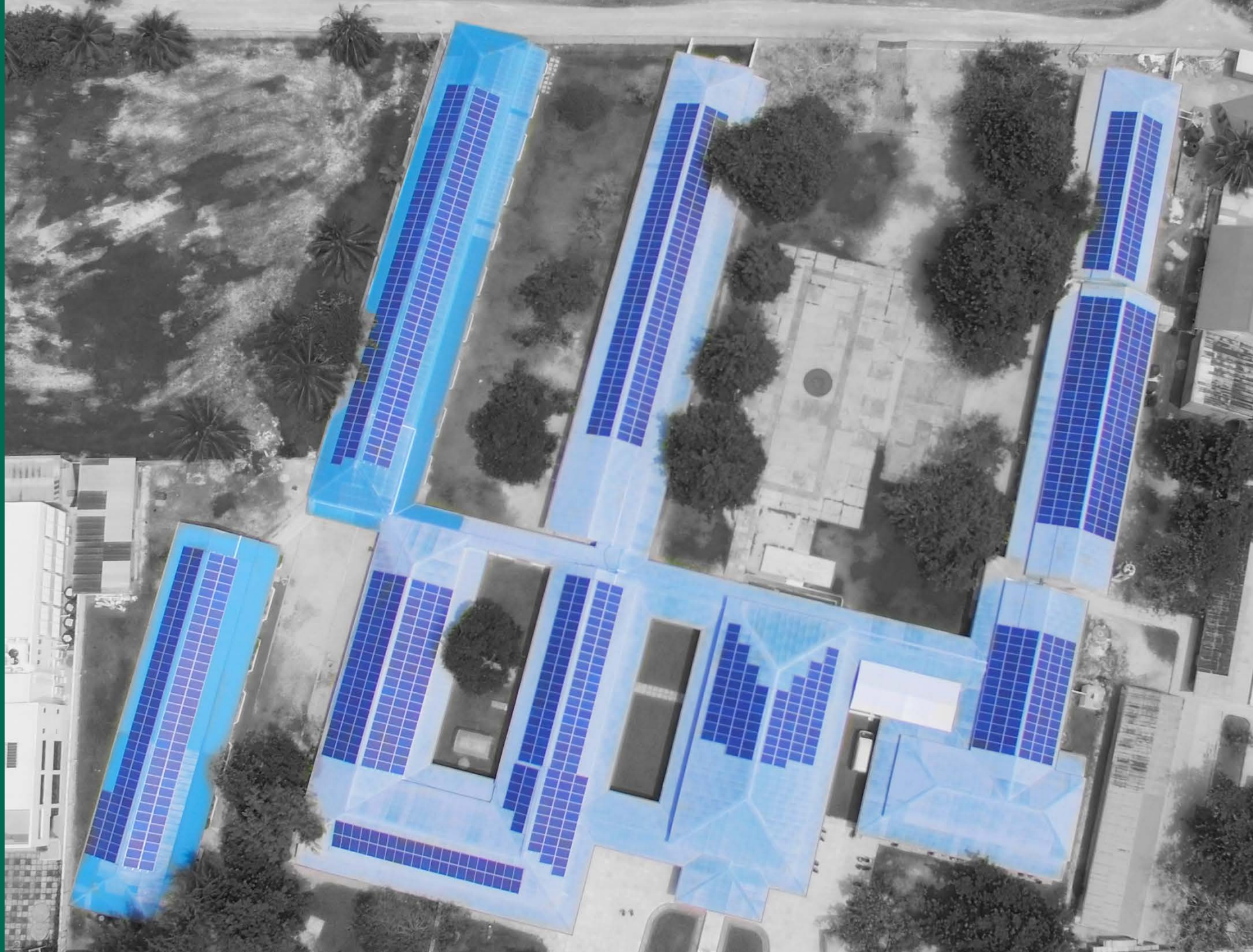
- ❖ Already 16MW of solar PV installed nationwide (accounts to 6% of total installed capacity of inhabited islands)
- ❖ Targets of up to 21MW of solar PV (over the next 2 years)
- ❖ Most recent target to increase RE in energy mix by 70%

Key Challenges in Power Generation

- Geographic distribution → Limits interconnection of grids and increase scale
- High Cost of Production → Huge amount of subsidy injected (covers capital and operational costs on a need basis)
- Limited trained human resource capacity → Limits efficiency of overall power generation.
- High demand growth → Increase in frequency of capital investments



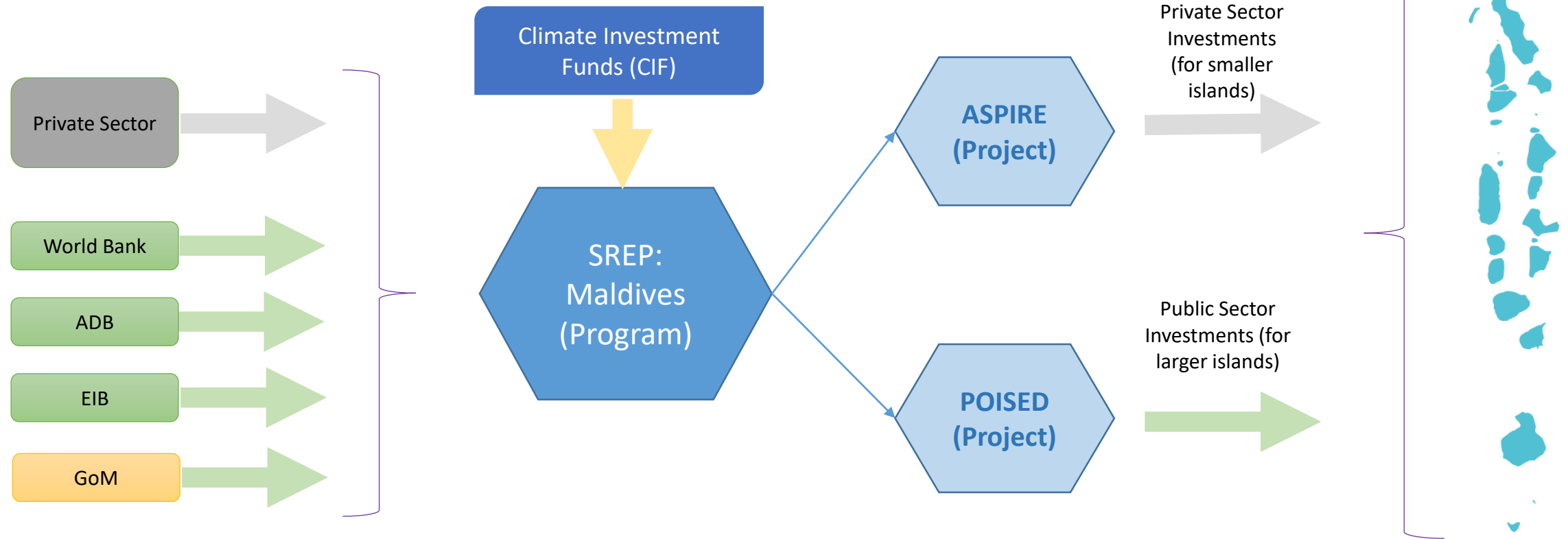
Renewable Energy



Existing Interventions by GoM to promote RE

- ✓ 2012: Duty exemption for renewable energy equipment: Amendment of Import-Export Act & Regulation, and assigning Maldives Energy Authority to administer the process.
- ✓ 2013: Development of regulatory framework (Since 2013 onwards)
 - ✓ 2015: *Operator Licensing Regulation (2015)* → Encourages and caters for utility-scale RE investments
 - ✓ 2015: First Power Purchase Agreement (PPA) → Enabled a reference document for formulating PPAs for private transactions.
 - ✓ 2016: *Net-metering regulation*, to promote end user PV installation, through support from utilities.
 - ✓ Various regulations still under development sector-wide
- ✓ 2014: Scaling-up of Renewable Energy Program (SREP) - Maldives
 - ✓ Public sector investments → Preparing Outer Islands for Sustainable Energy Development (POISED)
 - ✓ Private sector investments → Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE)
- ✓ Ongoing: Development of Energy Act: Expected to address sector-wide gaps on RE development, and strengthen the overall planning, implementation and regulation of the energy sector.

Scaling-up of Renewable Energy Program (SREP) - Maldives



- Formulated through support mainly from World Bank and ADB.
- One of the key investment programs rolled out by GoM to scale-up renewable Energy
- ASPIRE leverages private sector financing under PPA model, backed by guarantees
- POISED utilize public finance to implement PV project in smaller islands.

Progress with SREP

- POISED:
 - Completed and ongoing - 9MW cumulative installations in 44 islands (3 atolls and 5 pilot islands)
 - Includes batteries from 50kWh — 300kWh
 - PV in energy mix ranges from 10% to 50%
 - Nationwide surveys done through major part of the country
- ASPIRE:
 - 1.5MW (rooftop) running for 1.5years under PPA
 - 5MW (rooftop & land) at evaluation/award stage
 - Sub-project formulation underway with World Bank

Existing Challenges for RE Deployment

- Limited land space → Limits RE potential such as that for solar PV with existing technologies
- Smaller scale → Higher unit costs
- High capital costs of storage → Without storage, it would be difficult beyond 15% of energy demand by solar PV
- Limited experience in other commercial technologies → No commercial pilots for wind as of date.
- Untapped resources → Maldives with 97% the country being ocean with apparent potential for waves, tidal, ocean currents, OTEC. But limited research and development done to show commercial viability.

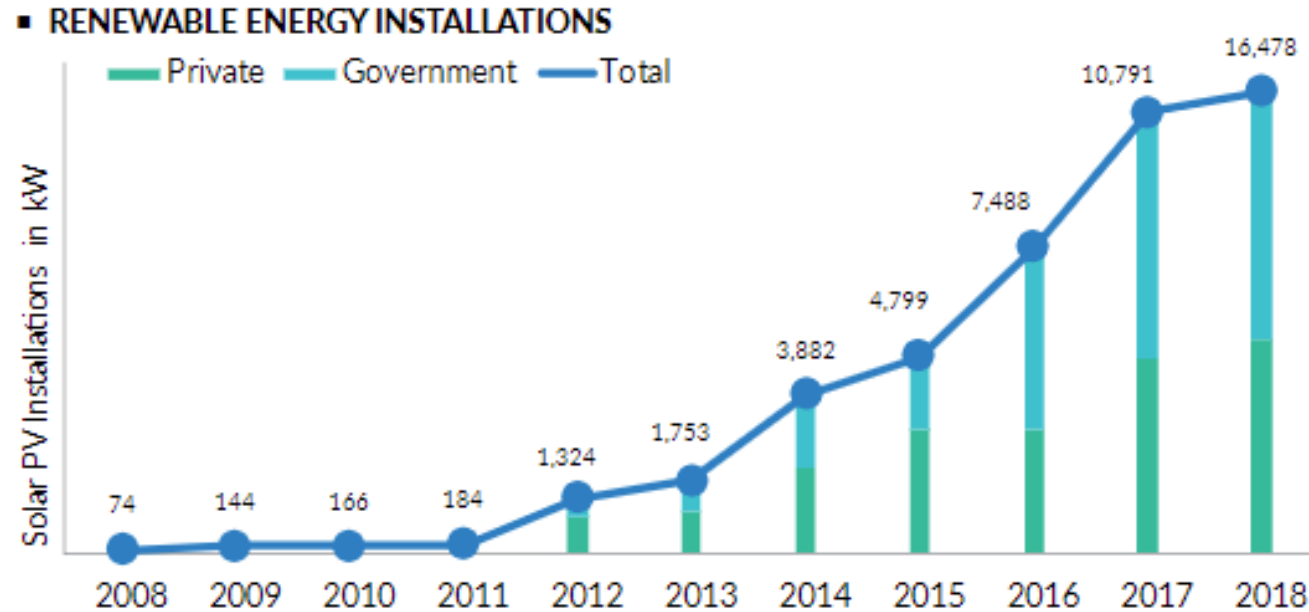
Some images.....

- Selected sites (among over a 100s of sites in over 45 islands)



Progress of RE implementation at national level

- Primarily solar PV use in electricity production
- Other sources such as wind, ocean currents, tidal resource assessment ongoing
- Rapid growth of solar PV installations both from private and public sector



Source: Ministry of Environment

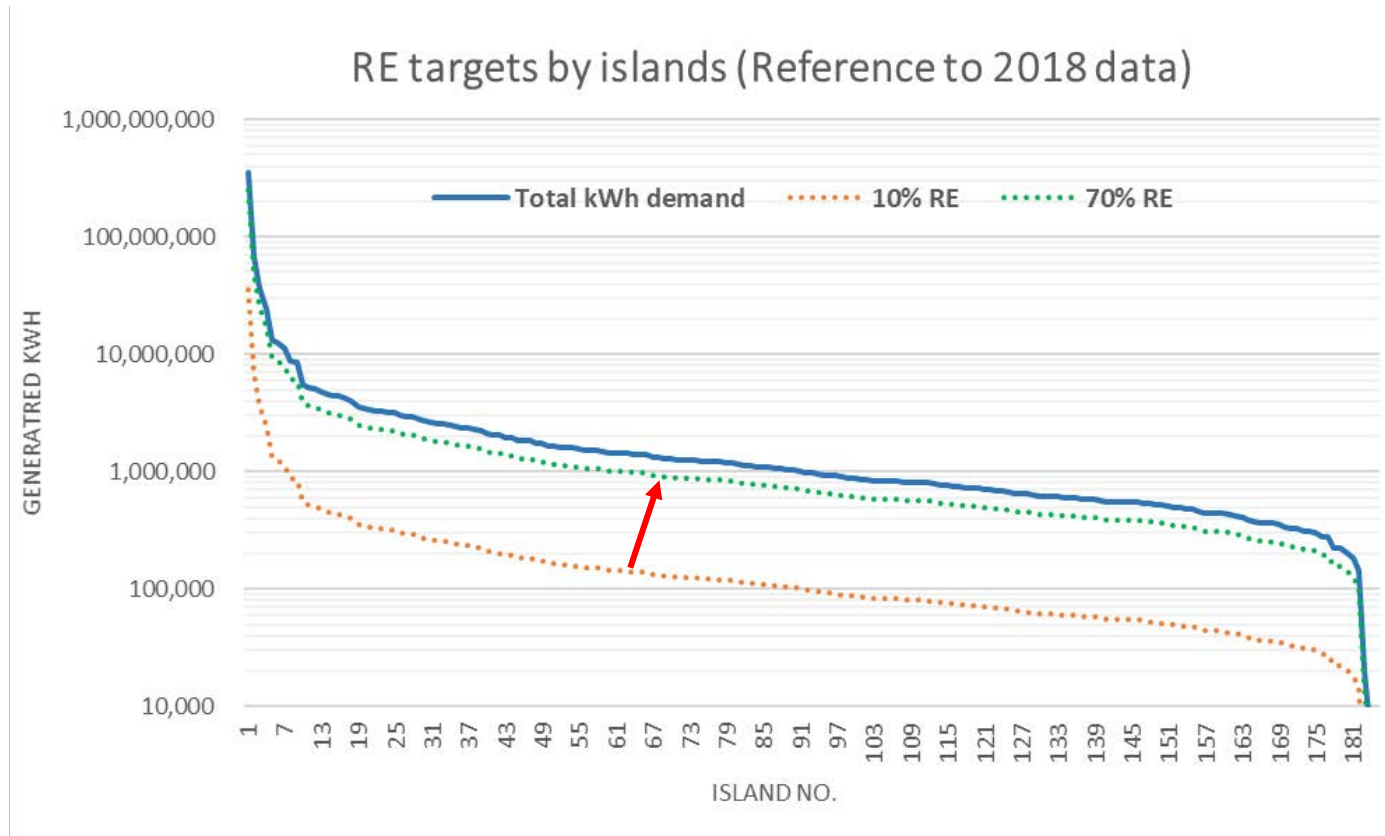
- Total of 16.5MW of solar PV installed by end of 2018 (Nationwide)
- Over 10MW contributed by SPREP (ASPIRE and POISED)
- Larger installations in private sector are contributed mainly from resorts.

Island level targets for solar PV

- Pre-2018 target: 10% of energy (30% of day peak in kW)
- ✓ New 2019 target: 70% of energy

Why storage is important

- Findings of Technical Assessments:
 - Without storage only 10-20% RE penetration
 - With storage, up to 100% possible
- New Target of 70% will require significant amount of storage
- High RE fraction needed to have national level impacts





ADOPTING ELECTRICITY STORAGE



Experience of Storage in Maldives

- Early pilot RE projects used lead-acid batteries, but were not successful due to maintenance issues.
- Small scale storage is already being experienced in smaller islands under POISED Project (Public sector investment), ranging from 50 - 300 kWh, and RE penetration of 15-50%
- A recent assessment titled *Maldives Energy Transition* was carried out with support from WB consultants that looked at cost-benefit of large-scale storage, for 5 islands cases with different electricity demand, PV penetration levels, and resulting overall economic benefit of combined use-cases for storage. PV sizes range from 0-12MW while battery sizes vary from 3MWh to 44MWh depending on PV capacity and demand of island.
- Executive summary of assessment launched during Climate Summit by Minister of Environment.

Challenges and barriers for storage deployment:

- High costs of storage:
 - Unit cost of storage still high, especially for smaller scale
 - Cost can vary significantly based on overall system design, and the features of the energy management system adopted.
- Technology uncertainties:
 - Reliability of benchmarking is difficult
 - Storage is sensitive to environmental parameters
 - Proprietary hardware/software may limit integration of plants source from different manufacturers
 - Limited experience of local utilities to troubleshoot
- No regulatory interventions:
 - No local regulations on storage technology (to promote storage or ensure safety standards)
 - International experience is limited
- Environmental aspects:
 - No current way of disposing or recycling
 - Will require exporting battery systems to recycling plants at end of life

Key actions needed for storage scale-up

- Incentives for storage projects (such as duty exemption, external & local financing, etc.)
- Capacity building for utilities to operate and manage storage technologies
- Knowledge exchange globally
- Develop and fine-tune business models applicable for the country.
- Development of regulations (Safety, Environmental)
- Explore new storage technologies



NEXT STEPS



Our approach to achieving new RE targets:

- Roll-out of Large-scale projects & programs :
 - Public investments (through utilities)
 - Private investments (through PPAs and similar mechanisms)
 - Roll-out of net metering programs and incentives
 - Investments in grid infrastructure
 - Investments in energy storage
- Maximizing RE use
 - Retrofitting existing rooftops of public buildings PV
 - Integrating solar PV as integral part of government construction contracts
 - Integrating PV standards into building codes
 - Mainstream PV concepts for urban planning (such as canopy structures for walkways)
 - Roll out and build experience on floating solar PV

Next Steps:

- Over 20MW solar PV installation under consideration for large islands.
- Preliminary surveys & assessments carried out
 - Secure land and lagoon areas
 - Power system surveys
 - Rapid assessment of environmental impacts
- Consideration to be made for:
 - Strengthening the existing electricity network
 - High RE penetration (minimum 50% and above)
 - Land-based PV and floating solar PV
 - Storage sufficient to cater for grid stability and excess energy
 - Capacity building for utilities to own and operate large-scale grid connected energy storage
- Detailed assessments and preparations underway with support from World Bank, for sub-project formulation and roll-out

A National Commitment:



DR. HUSSAIN RASHEED HASSAN

Minister of Environment

ENVIRONMENT / MALDIVES

“We are targeting 70% of clean power production by 2030”

What is your vision for the energy sector regarding renewable power generation capacity?

The Maldives relies heavily on fossil fuels. 10 percent of our GDP is spent on fuel imports. We have very ambitious goals to reduce that dependency. Currently the country has a power generation capacity of 400 MW, however, our total energy demand is approximately 180 MW and only 6 percent (16 MW) of this demand is met with solar power. We are in the process of installing more solar capacity, through [STELCO](#) and [Fenaka](#). We have made a Nationally Determined Contribution (NDC) commitment under the [Paris Agreement](#) to have 24 percent of our energy produced through renewables by 2030. However, now we are targeting 70 percent of clean power production within that period. I believe that this can be achieved.



Thank You

For Questions
& Comments:

Akram Waheed
Ministry of Environment / Maldives Energy Authority
akram.waheed@environment.gov.mv