Maldives' Rooftop Solar: Lessons from the Sunny Side

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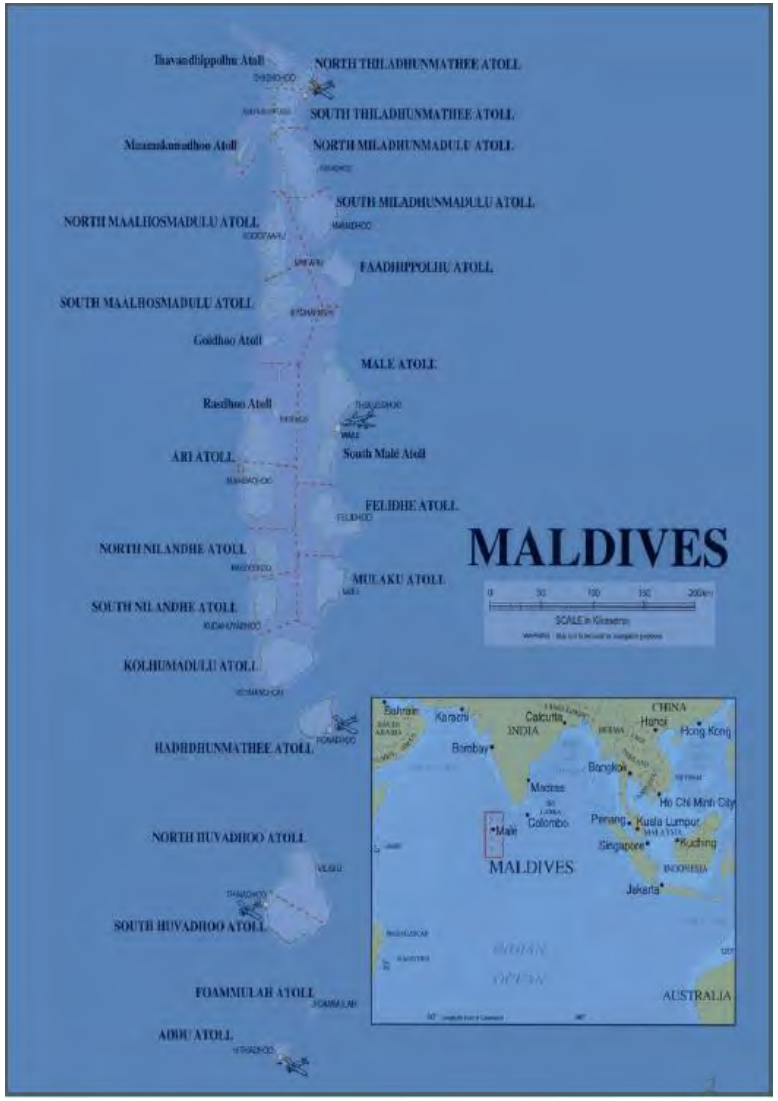
Maldives 101

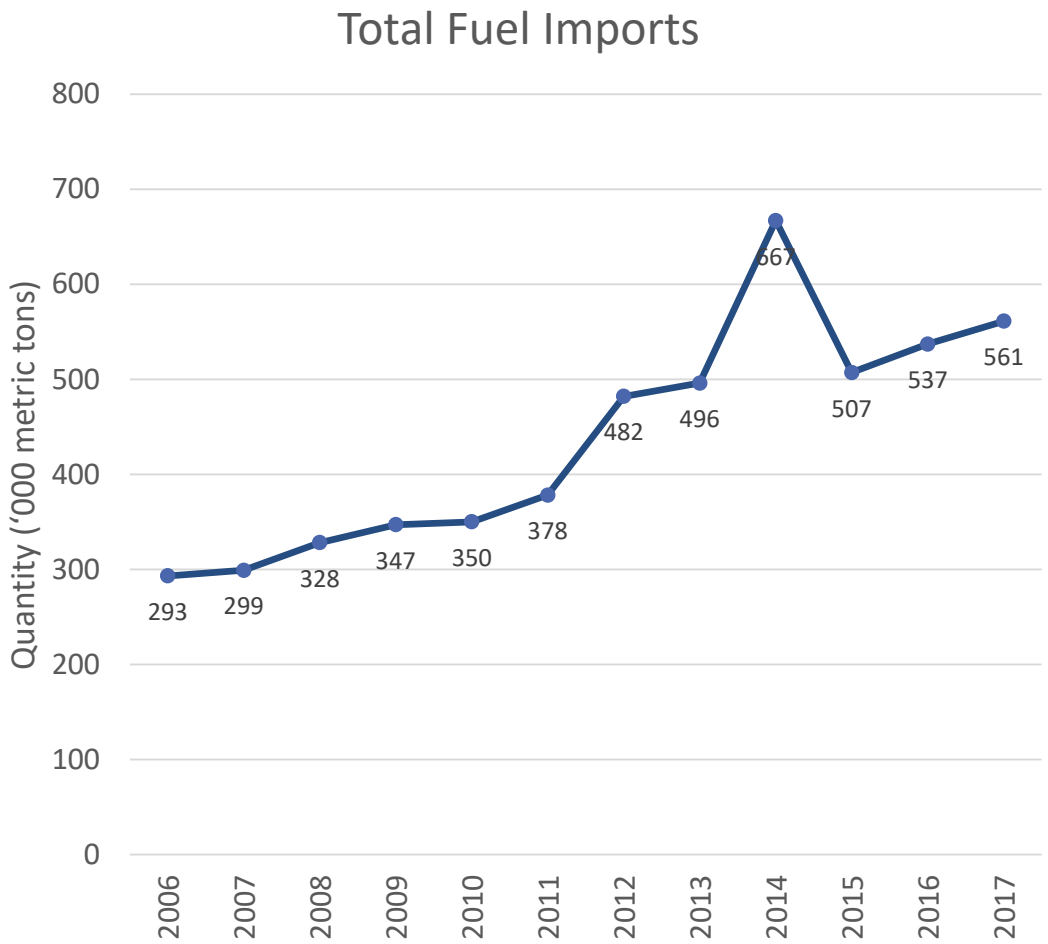


- Geography: Consists of 26 coral atolls with 1,192 islands.
  - 187 inhabited; 123 resort islands; 128 used for industrial and commercial activities
  - Land area 224 km^2 spread over 115,300 km^2 of Indian Ocean - 750km north to south.
  - Susceptible to Sea-level Rise: Highest point is 8m;
- Economy: Country of ~480,000 had $4.3B GDP in 2017
  - Per capita GDP grew 33x between 1980 and 2017 ($268 to $8,980).
  - Tourism and transport contribute ~50% of GDP.
- Tourism: In 2016, ~1.3 million tourists visited Maldives, spending $2.73B or 76% of GDP.

Lights in the Indian Ocean - Electricity Sector Overview

- Achieved Universal Access to Electricity in 2008
- Installed Capacity 345 MW (2017) includes 7-9MW PV
- Two vertically integrated utilities serve all but one inhabited islands - STELCO(35) and FENAKA(148)
- Approved end-user tariff: US¢ 14-50/kWh
- Fuel cost of electricity generation: US¢ 20-90/kWh
- ~USD 30-50M annual fuel subsidy
- Only two IPPs so far of 1.5MW and 0.62MW PV
- RE generation is targeted at 30% of daytime peak load for each inhabited island by 2018-end
- In 2015, Maldives committed to reduce its greenhouse gas emissions by 10 percent by 2030

At the Beginning of a Renewables Journey for a Fossil Based Economy

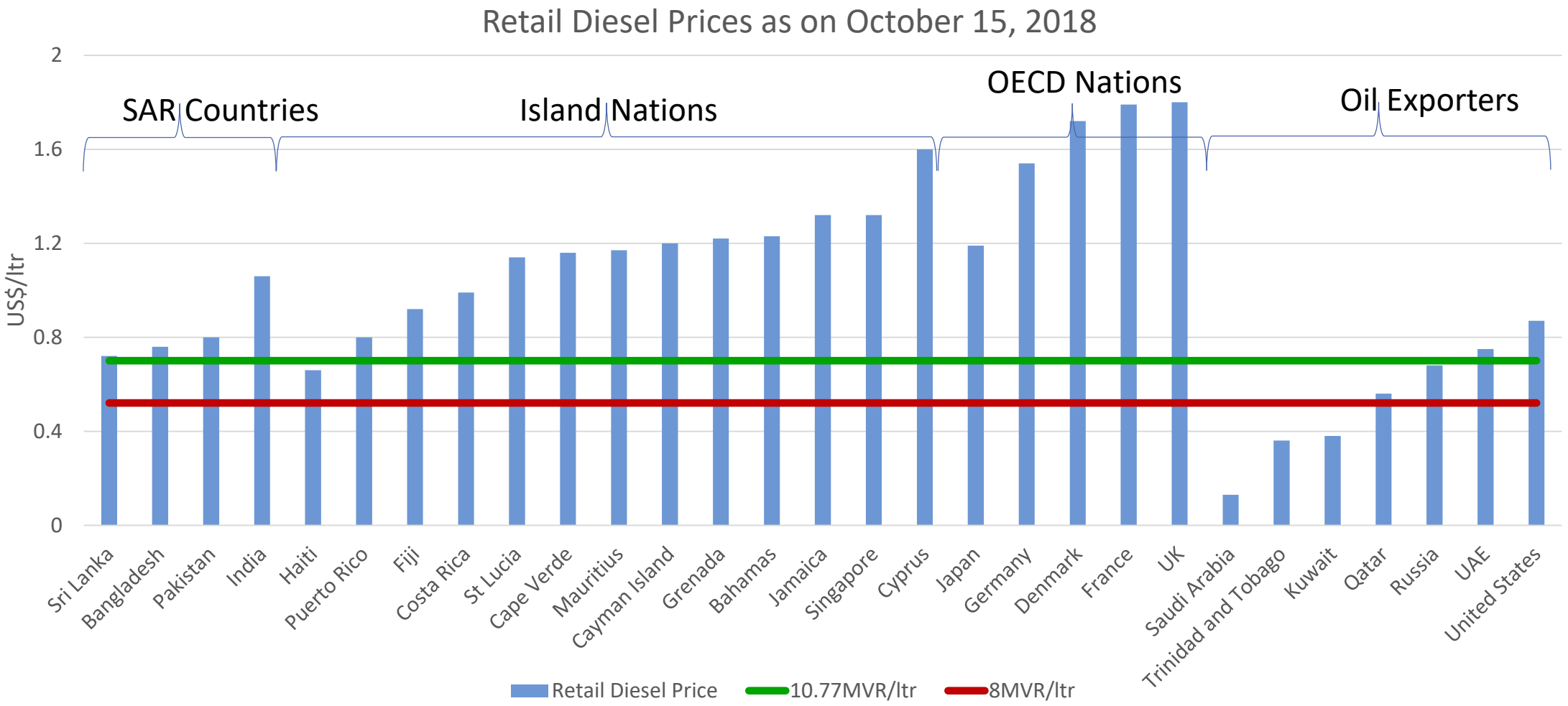


Source: Island Electricity Data Book 2017 (MEE)

- Maldives' depends on fossil imports for inter-island and on-land mobility, and electricity generation
  - making it vulnerable to oil-price shocks.
- Dispersed population contributes to high cost of service delivery[1].
- In 2016, 11.3% of all the imports was refined petroleum products.

[1] Cost of transportation from Male' to smaller islands is at par with the transportation cost from Singapore to Male' .

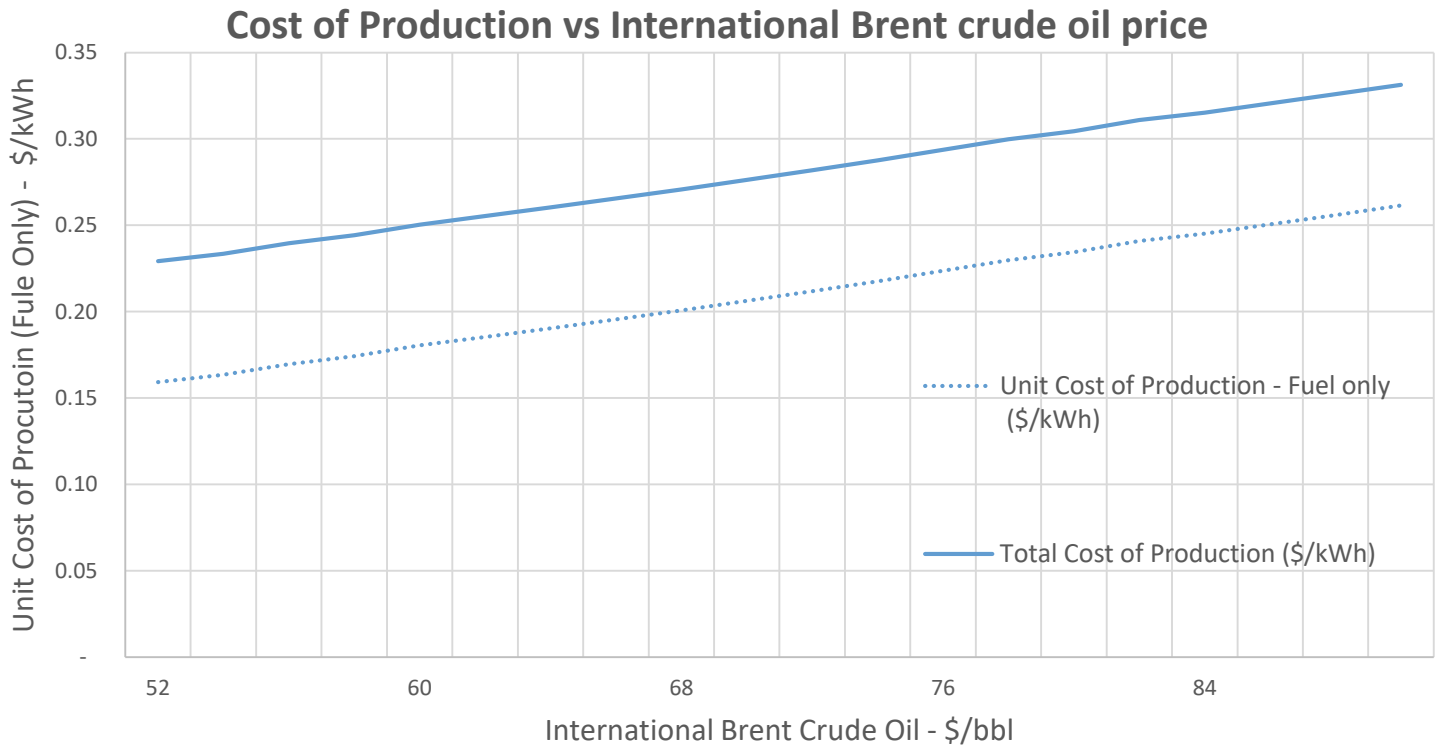
Comparing Global Retail Diesel Prices



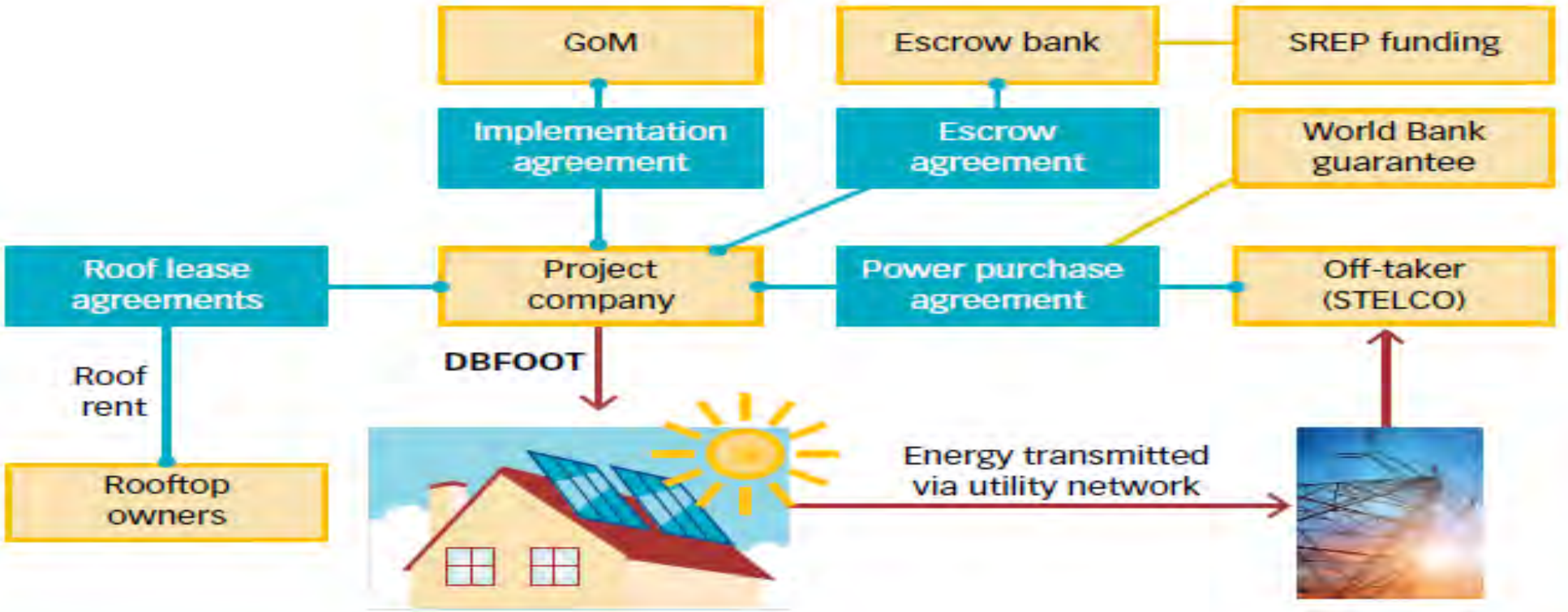
Source: https://www.globalpetrolprices.com/diesel_prices/

Estimating Cost of Diesel-Fired Electricity

- Based on Hulhumale' genset efficiency – the most efficient in the Maldives, the chart shows marginal cost of power production at different Brent Crude price projections
- Fixed cost of generation is between 5-7 cents/kWh, while the remaining is fuel cost.



Structure of ASPIRE – A Step Toward the Sunny Side



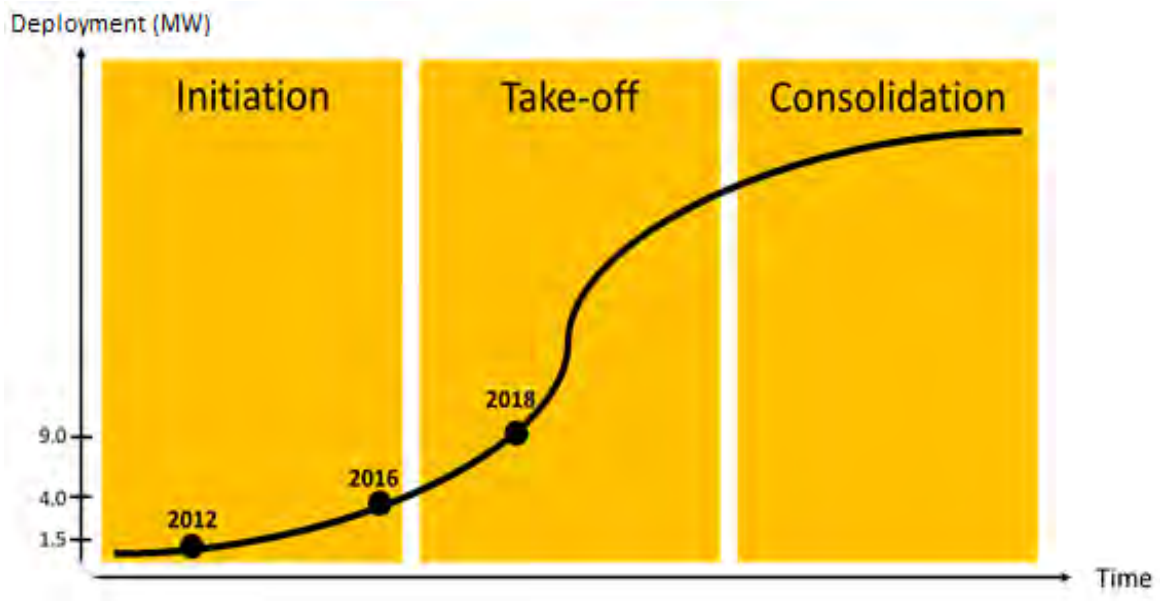
DBFOOT = design, finance, build, own, operate, and transfer.

ASPIRE – $16 Million IDA-Guarantee; $ 11.6 Million SREP Grant

- ASPIRE target 20 MW PV generation using private sector models.
- Hulhumale' 1.5MW Sub-Project for Roof-top Solar PV
  - Commissioned in March 2018, supplying power to the utility servicing Male'.(STELCO)
  - Under a 20-year Power Purchase Agreement (PPA) there is a fixed USD denominated tariff, payable in Maldivian rufiyaa (MVR).
  - Many lessons learned including co-benefits for Ministry of Housing and Infrastructure.
- Upcoming ASPIRE bids
  - 5MW bid for Greater Male' – STELCO Offtaker (Link road canopy and Hulhumale Rooftops').
    - PQ has been released
    - Using "cost-buydown" component to cap price at acceptable level.
  - 1-2 MW bid for Addu Island – FENAKA Offtaker
    - Second largest population after Male' with a load around 7MW
    - Through ADB's POISED a little over 1 MW PV I in operation

Building Blocks for a Sustainable Energy Transformation

- Analyzing the Market and its Potential
- Clear Legal and Regulatory Framework for Green Investments
- Outreach and Proper Risk Sharing
- Building FI Appetite for RE Risks
- Mitigating Credit and Political Risks
- Improving Operations through Information Flows
- Enabling Disruptive Technologies
- Informed Decision-Making through Integrated Resource Planning



Phases of Deployment of Solar PV in the Maldives

Pioneering Change: ASPIRE Phase 1 Sub-Project on Hulhumale'

- In 2014-15 had a limited number of participants despite wide outreach
  - Business environment testing limits of private risk-taking
  - Political flux
- Forex Risks – Finding middle ground in a complex political economy
- Securing Social-Housing Roofs – Compliance with Best Practice is time consuming
  - Ensure consent by ALL households; Grievance Mechanism.
  - Allocated project site changed twice – hard-fought co-benefits.
- Getting Guarantee Effectiveness – 2 years after bid allocation and PPA signing (twice)
  - Contract signed on 2015
  - Commercial operations March 2018
  - Actual construction time ~6 months!

Lessons:

- We can't manufacture time
- Patience and conviction matter

Hope for the Sunny Side – Ambition, Perseverance and Lessons Well-Learnt

- PV cost trajectory makes 10-15 cents/kW roof-top PPA prices achievable
  - 5MW Phase 2 is an important next step
  - Battery storage integrated with e-mobility is a real possibility
  - Feasibility of Marine Floating PV is needed for deep PV penetration and storage-hybrid viability – especially on the two large islands
- Build a large (green) tent for success
  - FIs, Utilities, State Trading Organization (STO), Male' Airport Company Ltd. (MACL), and even resort islands must all think green
  - Bank of Maldives (BoM) has availability of "Green Loans" which can facilitate penetration on private roofs - needs demand aggregation and local RE know-how
  - Seeding aggregators is critical for accelerating net-metering
- Deepen local capacities with global best practice, self-help and a lot of "learning-by-doing"
  - SCADA, storage integrated with e-mobility and VRE implementation
  - Techno-economic assessment of hybrid operations (PV + storage)
  - Marine Floating PV and implementing appropriate options

Hard-Won Foundation to Transformational Renewables Future

Thank You!