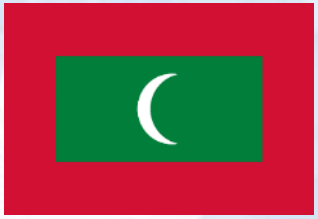


IRENA
International Renewable Energy Agency

The Republic of Maldives Renewable Energy Roadmap Final Workshop - Overview of recommendations

17 September 2015, Kurumba Resort, Republic of the Maldives

Organized by:
The Ministry of Environment and Energy, Republic of Maldives &
The International Renewable Energy Agency (IRENA)

Roadmap Overview

- Review of key renewable energy plans & studies including:
  - *Maldives SREP Investment Plan*
  - *Greater Malé Region Renewable Energy Integration Plan*
  - *Towards a Carbon-neutral Energy Sector: Maldives Energy Roadmap 2014-2020*
  - *Solar PV Integration in the Maldives*
- Modelling of least cost solar PV deployment
  - *Gdh. Thinadhoo & Villingili*
- Goal: supporting RE deployment by identifying:
  - Key barriers & areas for further analysis
  - Recommendations to build on existing efforts

Part 1 - Technology options

Renewable base load power

- Energy storage is key to achieve large RE shares using variable RE like solar PV and wind
- Imported biodiesel in existing diesel generators
- Imported solid biomass in new steam power plants
- Bio-waste to energy
- Future potential for OTEC should be explored


Battery storage

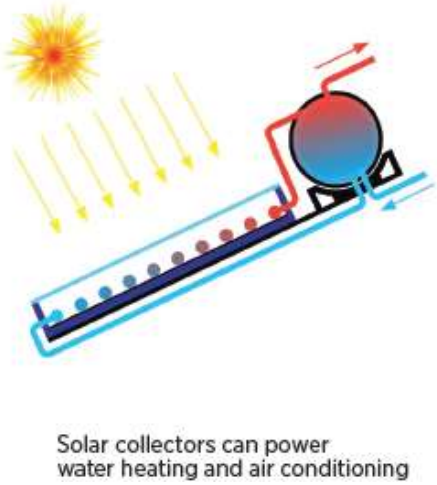

Electricity generation from wastewater biogas
Photo: NREL


OTEC platform
Photo: DCNS

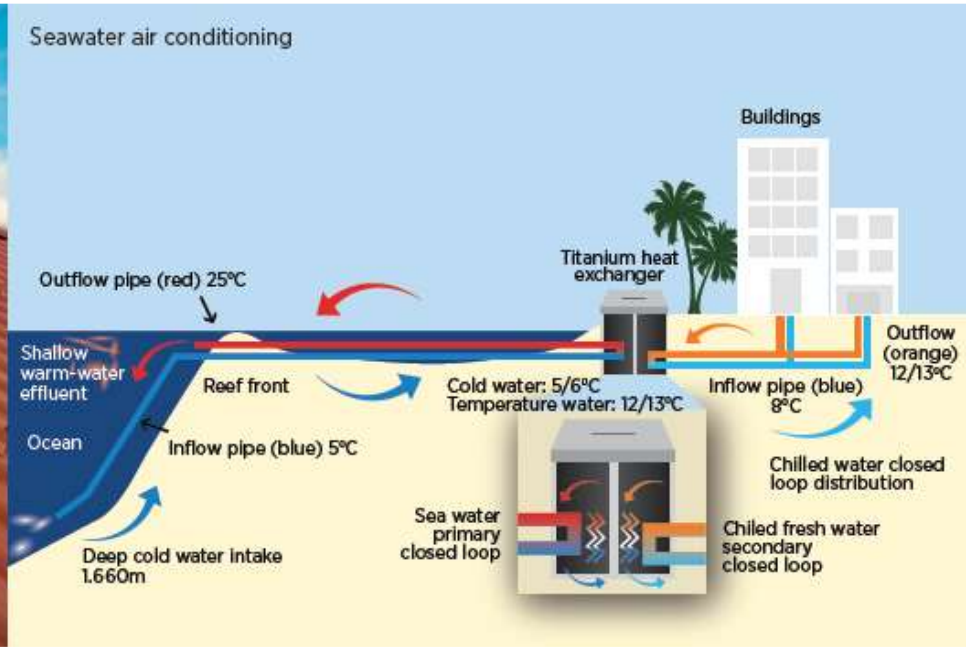
Interconnection

- Needed to connect demand centers to RE generation
- Helps alleviate space constraints and increase the scale of lower cost generation
- It is costly, and as such its value proposition needs to be evaluated vis-a-vis other options (e.g. decentralised modular PV-diesel hybrid systems)
- Existing studies do not examine jointly large-scale RE deployment

Non-electric RE technologies



Solar collectors can power water heating and air conditioning



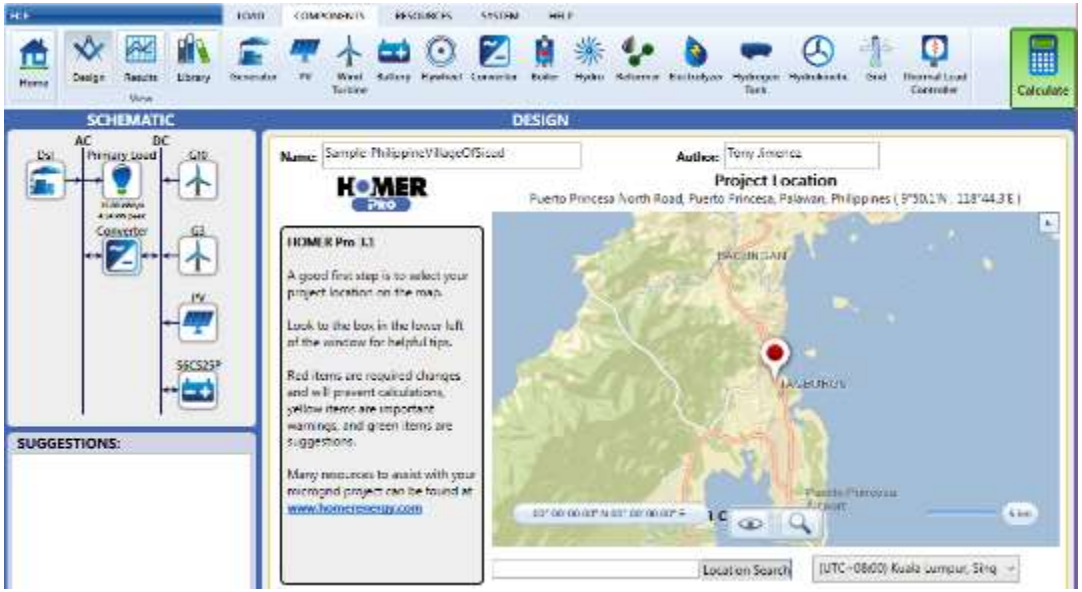
- Reduce electricity demand & deploy RE at the end use
- Solar water heaters & Seawater air conditioning
- Other options worth exploring, e.g. solar air conditioning, biomass-driven absorption chillers, etc.

Floating Solar PV platforms

- Land availability is a key concern in the Maldives
- 45 kWp currently deployed in Maldives
- Estimated* 150 MWp potential, cost below 0.20 USD/kWh

Part 2 - Policy options

Renewable energy targets



- Current RE targets not clearly defined or linked to plans
- Set new targets based on least cost quantitative planning
  - *Economically optimal & technically feasible RE deployment options*
  - *Aspirational 100% RE plan to identify technology mix and cost*

Private PV deployment

Current PV deployment focused mostly on public roof space: *private rooftop space in Male' could host more than what the current PV target aims for*

Encouraging private investment greatly increases RE potential

- Regulations & grid codes allowing grid connection of private PV
- Support schemes and/or market mechanisms allowing private owners to recover investment cost or generate profit

Encourage RE in resorts

- Resort generation, ca. 100MW, is mostly diesel
- Resorts willing to invest in RE vs purchase electricity from RE
- Share information on best practices, technology and cost
- Create a friendly policy environment
- Make biodiesel readily available and affordable

Energy data collection & access

- Collection of and easy access to high quality data is needed
  - *Required for quality RE modeling*
  - *Supports RE planning*
  - *Improves RE operation*
  - Ensure at least hourly data for all generation assets is collected automatically through SCADA systems

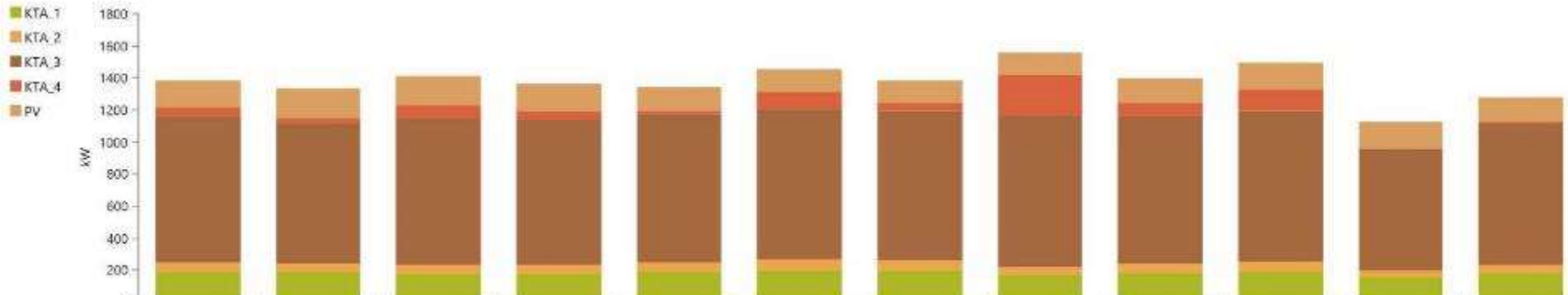
Part 3 – Insights from quantitative analysis and modeling

Power system optimisation

- HOMER was used to optimize the power system of Villingili (the only island with sufficient data made available)

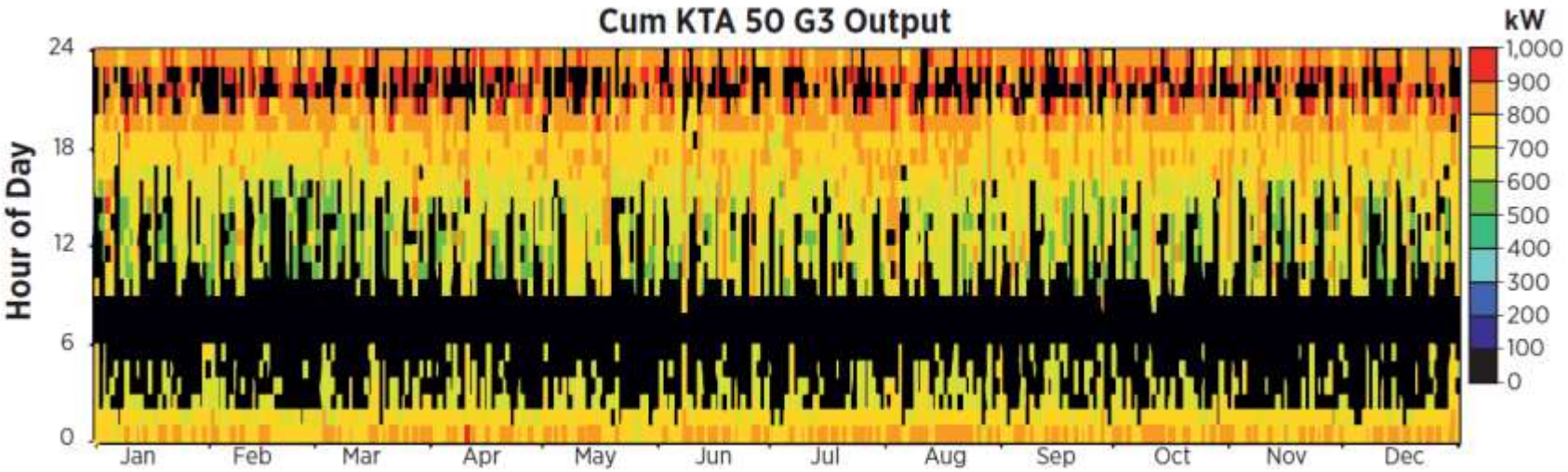
- Similar analysis was conducted for Gdh. Thinadoo, with limited data

- General findings from Villingili and Thinadoo apply to most smaller islands



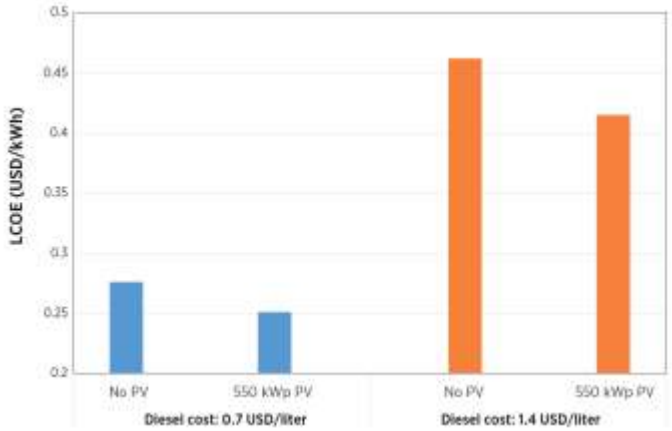
Power system optimisation

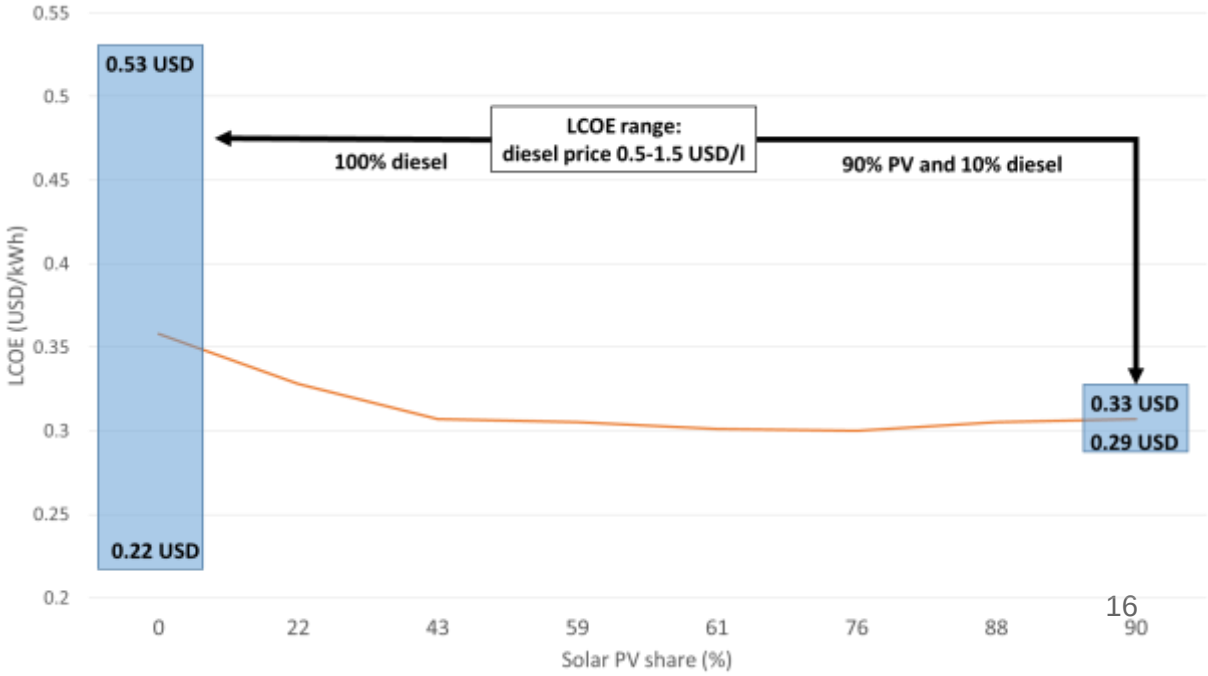
- Opportunity to reduce fuel consumption through optimized dispatching
- Sizing of diesel is important for newly designed systems.
- Battery storage can greatly help in increasing fuel efficiency of existing oversized diesel generators: replacement often not necessary



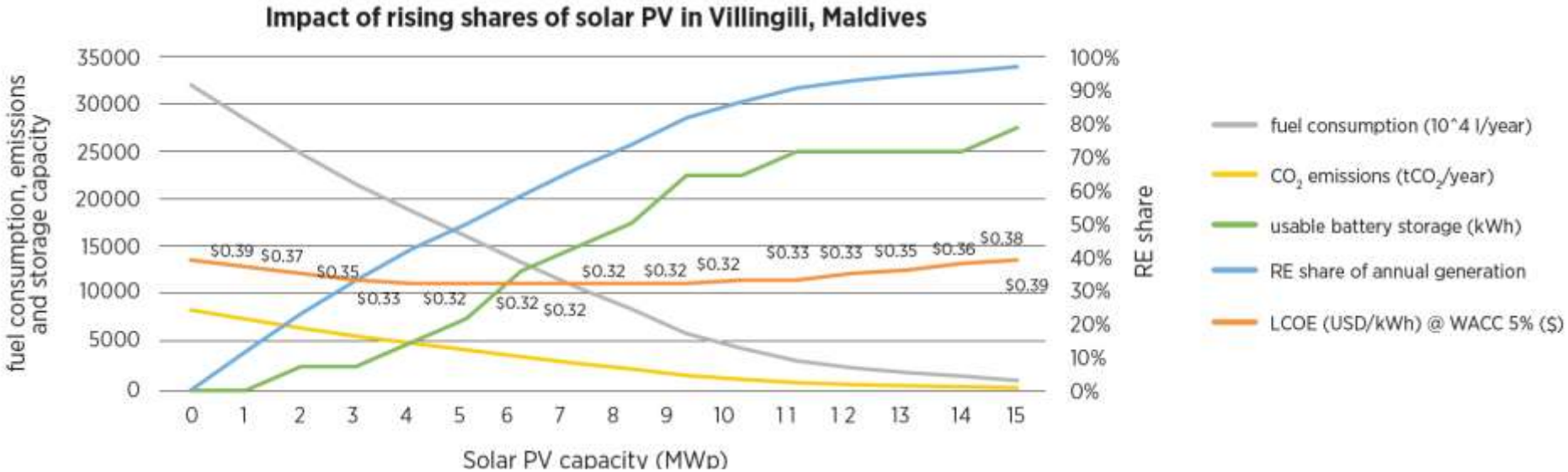
PV without storage insights from Thinadoo analysis

- Impact of PV without storage in terms of cost reduction is limited
- Maximum impact with limited investment
- Deployment of higher shares requires storage and higher investment, but greatly reduces volatility

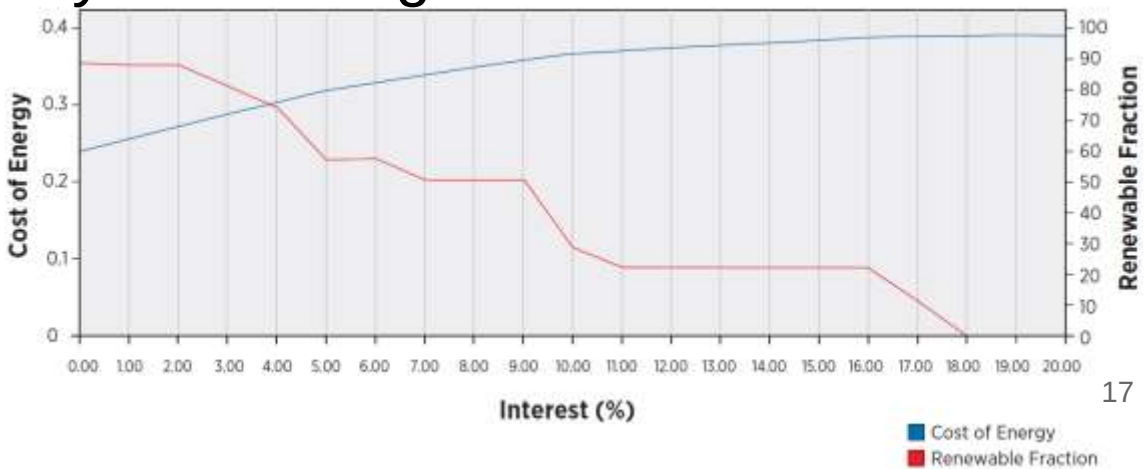




PV with storage
insights from Villingili analysis

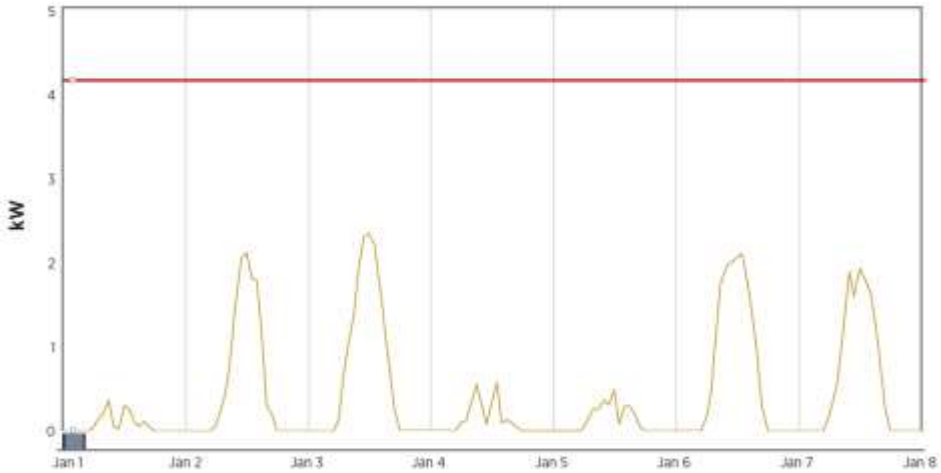


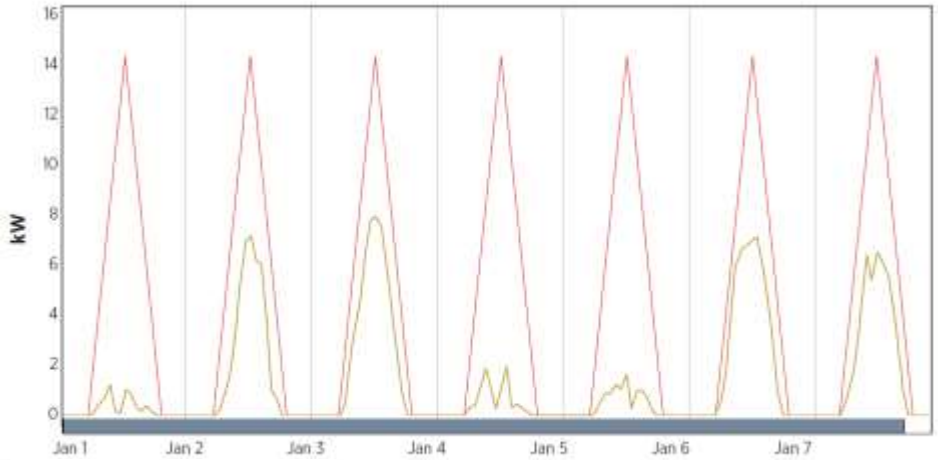
Impact of PV with storage is highly dependent on cost of capital, as is the optimal system configuration

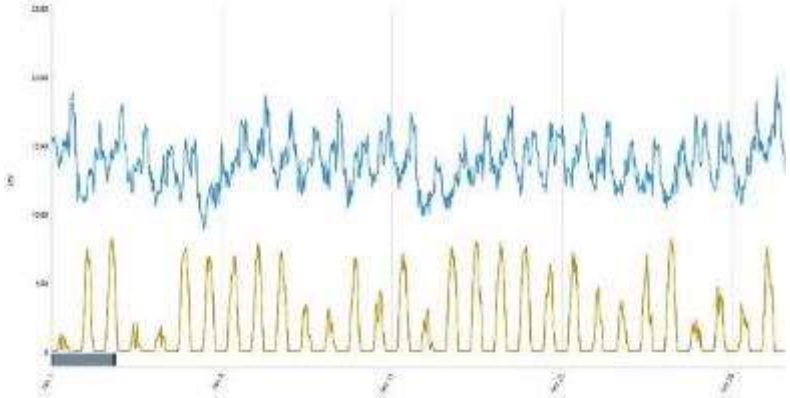


PV with storage
insights from Villingili analysis

- Depending on load shape, the impact of PV (especially without storage) can change greatly: important to reshape the load to minimize system cost







Power system optimization suggested approach

- Define modular PV systems
- Define 3 steps for the deployment of PV:
  - Max PV without storage (up to 60-100% on peak, variable on energy)
  - Least cost system (often includes storage)
  - 100% RE (ideally replace diesel with biodiesel in step 2 system)

- Assess the cost of the 3 steps for each island, and determine which ones are worth going through step 1, and which directly to step 2 (comparatively smaller islands)

Power system optimization conclusions

- Need to clearly define and understand constraints for each island:
  - Space (ground, rooftop, walkways, floating)
  - Budget
  - Technical (some learning curve, but no major challenges)
- In absence of constraints, the optimal solution includes battery storage and large PV arrays: easier to design an optimized system and deploy it at once, than gradually integrating growing shares of variable renewable energy (i.e. PV and wind)
- Male' is the only island where a step by step approach is likely needed, due to large relative scale, space and technical constraints

Recommendations on technology solutions

- **Technology Solutions** to increase RE deployment potential
  - *RE technologies for base load power*
  - *Interconnection between islands*
  - *Non-electric RE technologies*
  - *Floating solar PV platforms*

Recommendations on policy solutions

- **Barriers:** RE deployment limited so far. Discuss barriers in a workshop – TODAY

- **Policy solutions:**
  - *Develop ambitious and quantitatively-supported RE targets (technology mix, cost, policy instruments)*
  - *Supporting PV deployment on private roof space*
  - *Encouraging RE in resort islands*
  - *Improving energy data collection and access*

Thank you
and
looking forward to a fruitful discussion





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