Preparing Outer Islands for Sustainable Energy Development (POISED)

Maldives

17 September 2015

Context

- 1192 islands
  - 194 inhabited islands and over 100 resorts
- Access to electricity 100%
- Installed generation capacity
  - Almost 100% diesel
  - 141 MW in inhabited islands, 105 MW in resorts
- Electricity costs vary 30-70 cents/kWh
- About 120 million liters of diesel for electricity
- Subsidies exceeding $40 million annually and significant cross-subsidies between categories

Context….

- Independent isolated grids
- Efficiency and availability of generation
  - Significant variability in diesel use
- Losses and loading of distribution systems
  - Under invested
- Are the grids ready?

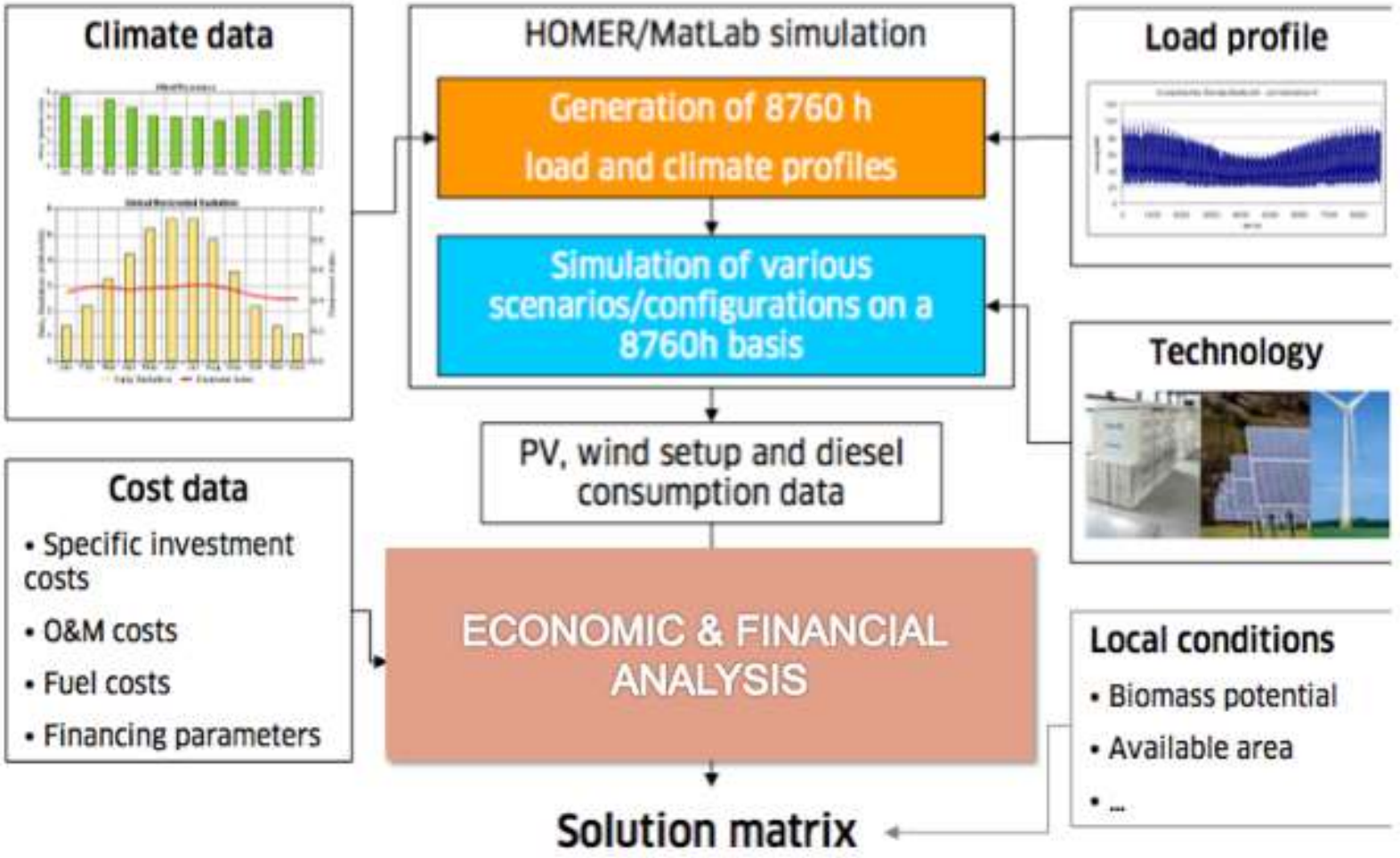
Design Objectives

- Optimum level of %RE penetration
- Minimize diesel fuel consumption
- Financial and economic viability
- Reduce impact on government budget for subsidies
- Minimize CO_2 emissions
- Minimize local environmental impact
- Optimize land-use
- Awareness of context, resources
- Flexibility

Options for Islands

- Type A – Large Islands - Moderate RE
  - Up to 10% of energy or 30%-40% of peak-load
  - No Storage, new generators (where needed)
- Type B – Medium Islands - High RE
  - 10%-80% energy or 90% of peak-load
  - Storage back-up (Security, Grid support)
- Type C – Small Islands - Full RE
  - RE penetration close to 100% (peak <20kW)
  - Storage back-up (security, grid support, load-following)

Design…… – Process



POISED Phase 1

Island	Population	Daily Peak (kW)	Annual Energy (MWh)
Addu City	25,571	3850	22,161
Ga.Villingili	3,460	481	2,684
Lh. Kurendhoo	1,945	165	881
B. Goidhoo	748	69	417
Th. Buruni	579	78	322

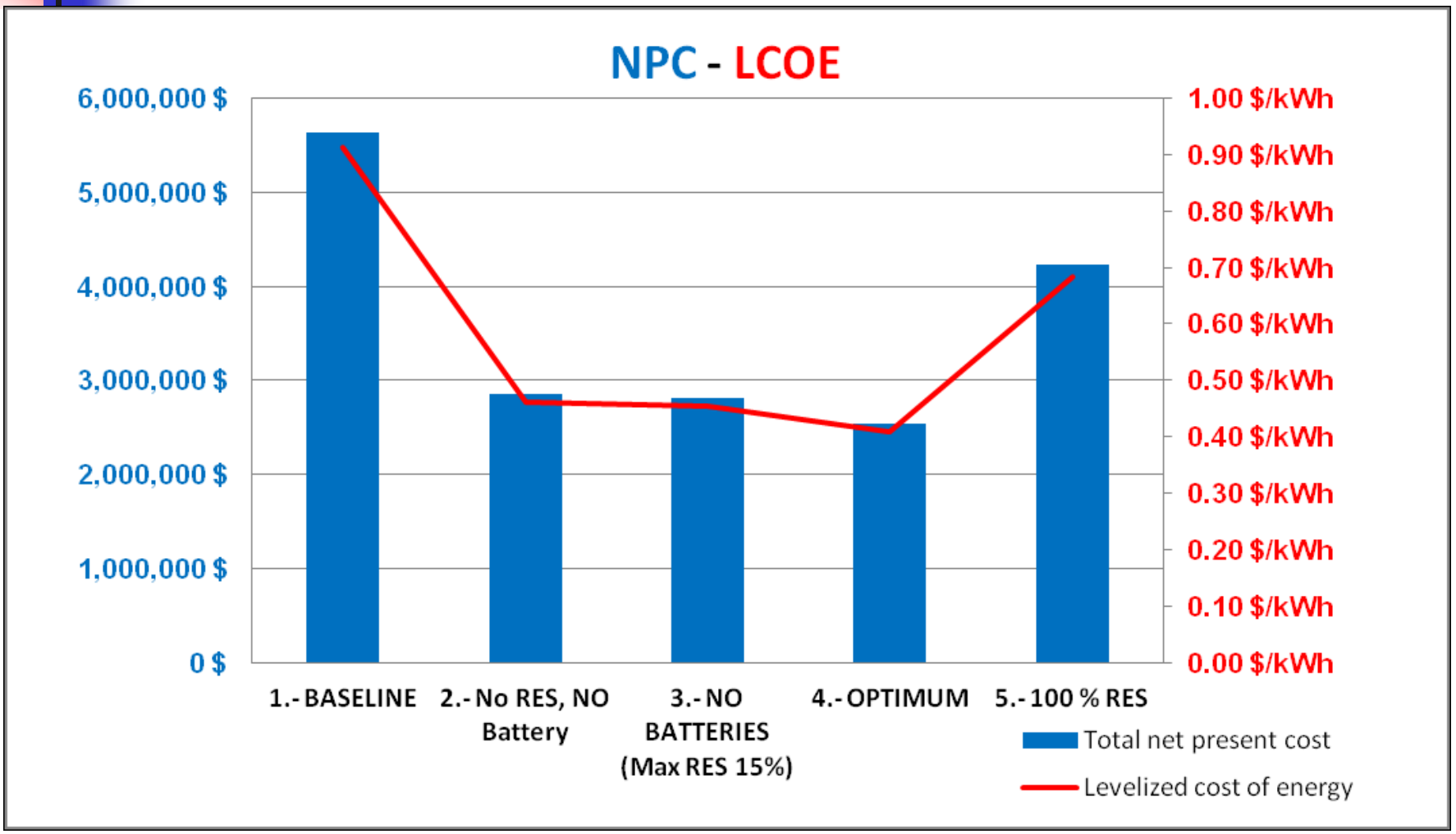
POISED Phase 1

- Islands operate 1-3 diesel generator sets to meet demand
  - through a small low voltage network
- Peak demand often below 50% of installed capacity
  - substantial additional diesel gen set capacity needed for maintenance
  - In several cases, inappropriate generator sizes
  - Sizing issue impact exacerbated with increased renewable energy in the mix

Phase 1 Investment

Island	PV (kW)	Diesel Generation (kW)	Storage (kWh)	Type
Addu City	1600	6850 (1x1500, 3x1000, 3x750)	None*	A
Ga.Villingili	300	800 (1x500, 1x300)	223	B
Lh. Kurendhoo	300	254 (1x104, 1x150)	223	B
B. Goidhoo	200	160	223	B
Th. Buruni	100	100	111.5	B

Cases for G. Buruni



Output – Stability assessment

Island	Conditions	Critical frequency without storage	Critical frequency with storage
Th. Buruni	80% PV power loss	49.47	-
	100% PV power loss	48.7	-
	Sudden load loss of 30%	50.49	-
	PV power loss and load increase	47.41	48.49
B. Goidhoo	80% PV power loss	48.8	-
	100% PV power loss	48.22	-
	Sudden load power loss of 30%	50.60	-
	PV power loss and load increase	47.5	49.27

Financing for POISED

- ADB Financing
  - ADF – $38 million
  - SREP - $ 12 million
  - Additional financing (JFJCM)
- Cofinancing
  - EIB - $50 million
  - IsDB – $10 million
- TA Assistance

Roadmap

- **Sector project** following agreed criteria for future projects
- Plans
  - Solar PV systems
    (rooftops, ground) – 25 MWp
  - Diesel generators
    44MW (replaced as needed)
  - Li-Ion batteries – 7.5MWh
- Phase 2 onwards – Atoll based approach

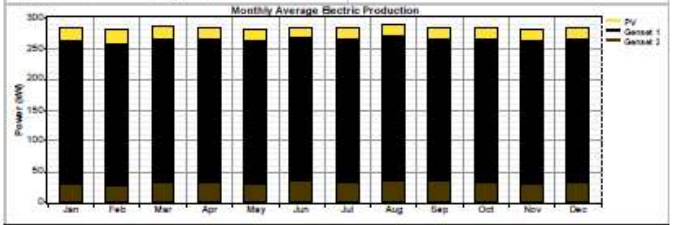
1. ALIF DHAAL MAHIBADHOOL

Atoll. Island: Alif Dhaal. Mahibadhoo

Current situation:	
Installed generation capacity (kW)	460
Population	2235
Measured peak (kW)	370
Energy consumption (MWh/day)	5.2
Specific fuel consumption (L/kWh)	0.306
Expected CO_2 emissions (kg/year)[1]	2,007,410

Proposed Hybrid System

Photovoltaic (kWp)	100
Total diesel (kW)	460
- Genset 1 (kW)	280
- Genset 2 (kW)	
- Genset 3 (kW)	180
Batteries (kWh)	26,9
Battery inverters (kW)	100
RES penetration (%)	6.43
Expected CO_2 emissions (kg/year)[1]	1,785,238



Comments

It is proposed that the main genset be replaced. The proposed model limits PV to 100kWp due to limited available surface for its installation.

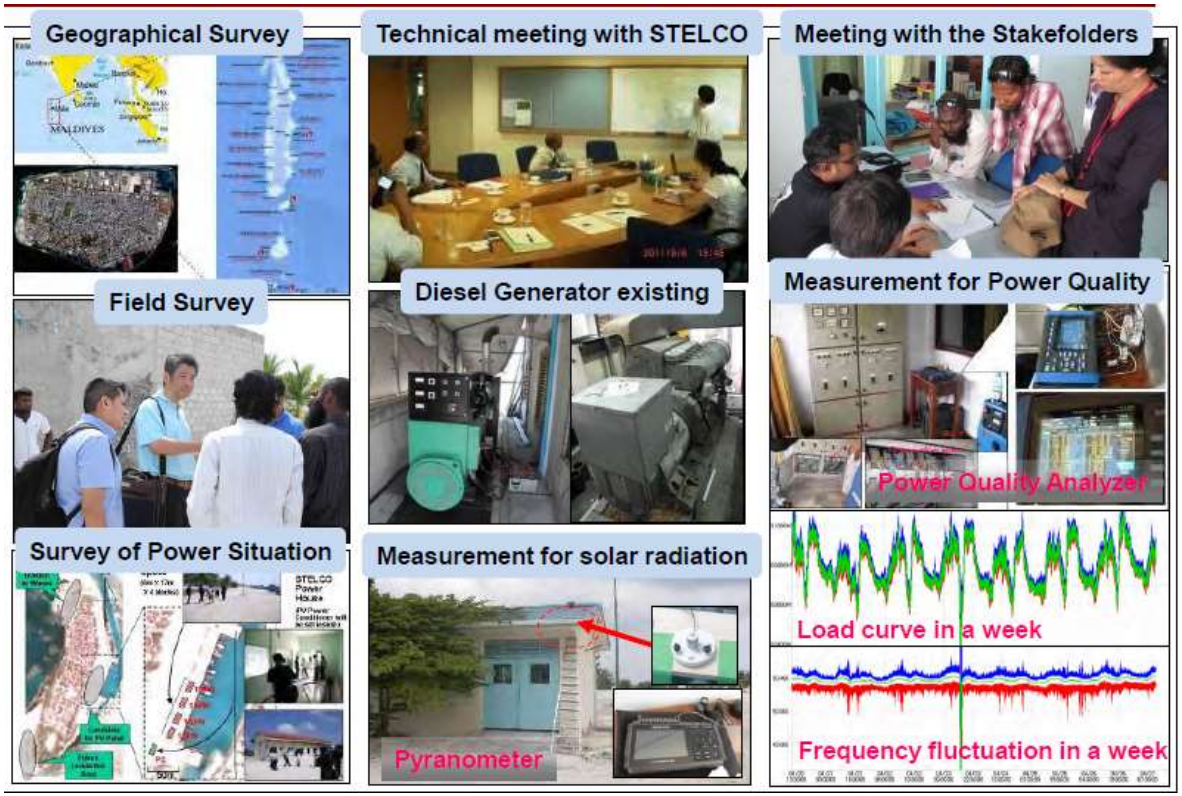
The proposed model is distributed and has low RES penetration.

Other support

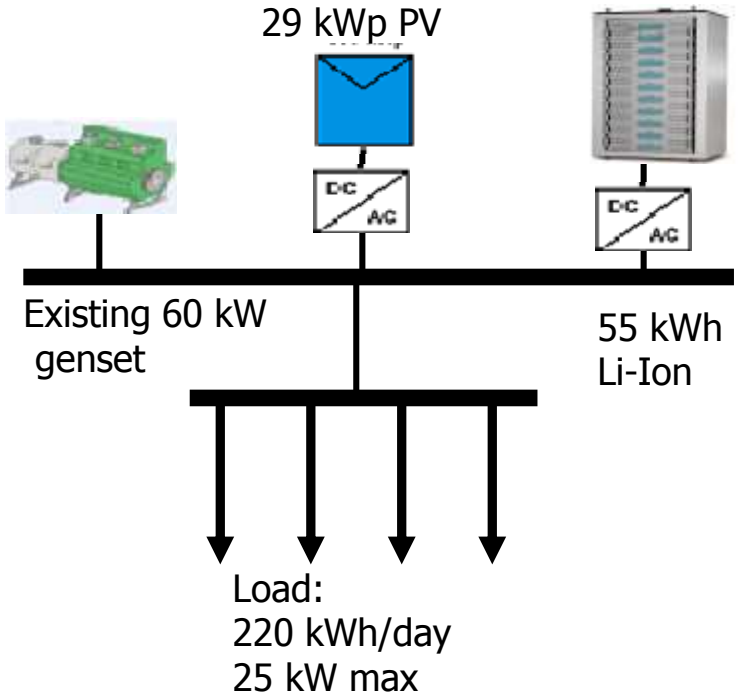
- 2 related pilots
  - Rakheedhoo (Lithium ion storage)
  - K. Dhifusshi (ice-making)

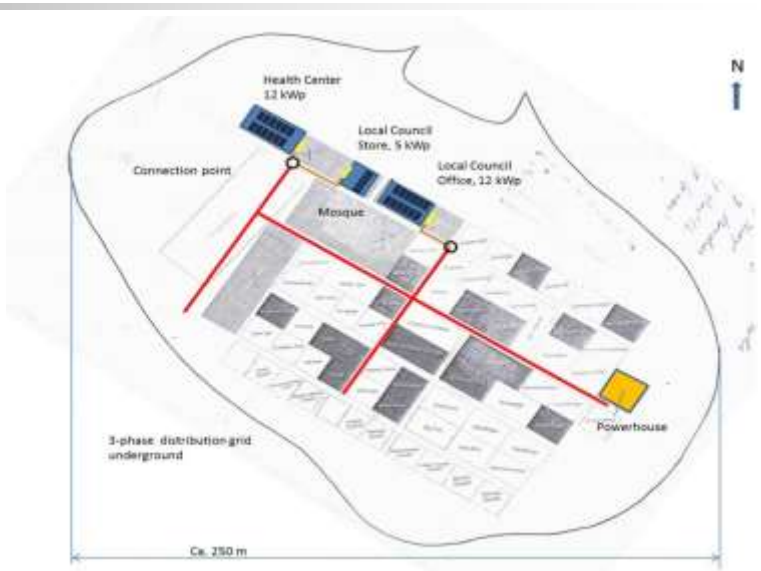
K. Dhiffushi

- Global Sustainable Energy Partnership led effort
- Island demand 50-100 kW
- PV installation of 40 kW
- Ice machine to help address intermittency challenges while providing economic benefits



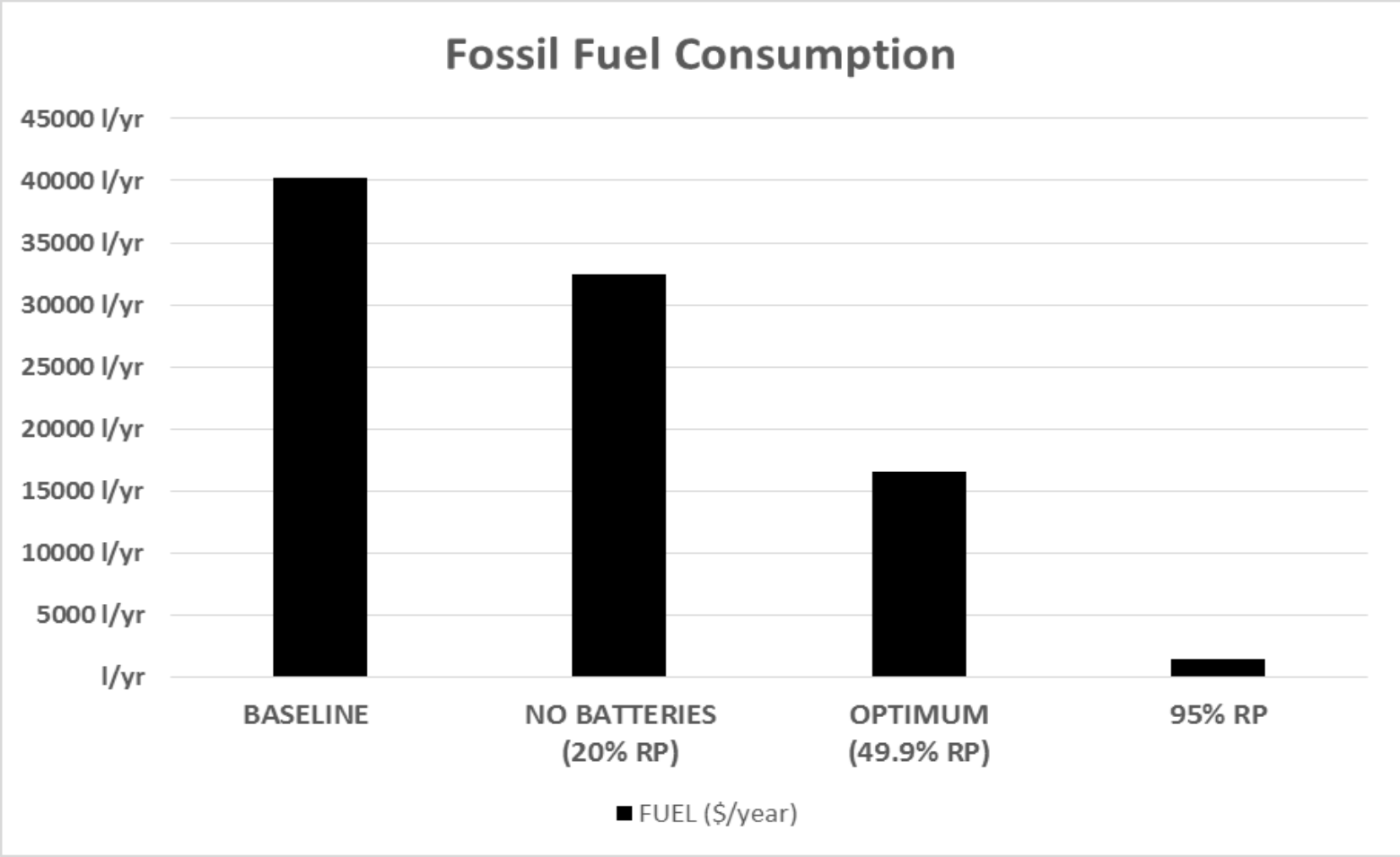
Rakeedhoo - Configuration





Island	Data
Electricity Demand	80.3 MWh/yr
RE penetration	49.9%
Solar Power	29 kW
Wind Power	0 kW
Storage Capacity	55 kWh
Diesel Power	60 kW

Rakheedhoo – Drop in Fuel Consumption

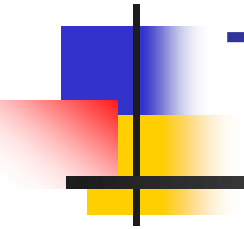


Other Assistance

- Under POISED
  - Project Management Unit assistance
- TA support for MEA

Challenges

- Improving data reliability
- Transition period for utilities
- Low carbon development with adequate reliability while factoring in the cost
- Attracting private sector investments
- Disruptive changes in technology and cost and need to retain flexibility



Thank you