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YAP RENEWABLE ENERGY DEVELOPMENT PROJECT

PPA Conference Palau 2018

Dean Haley – 28 July 2018

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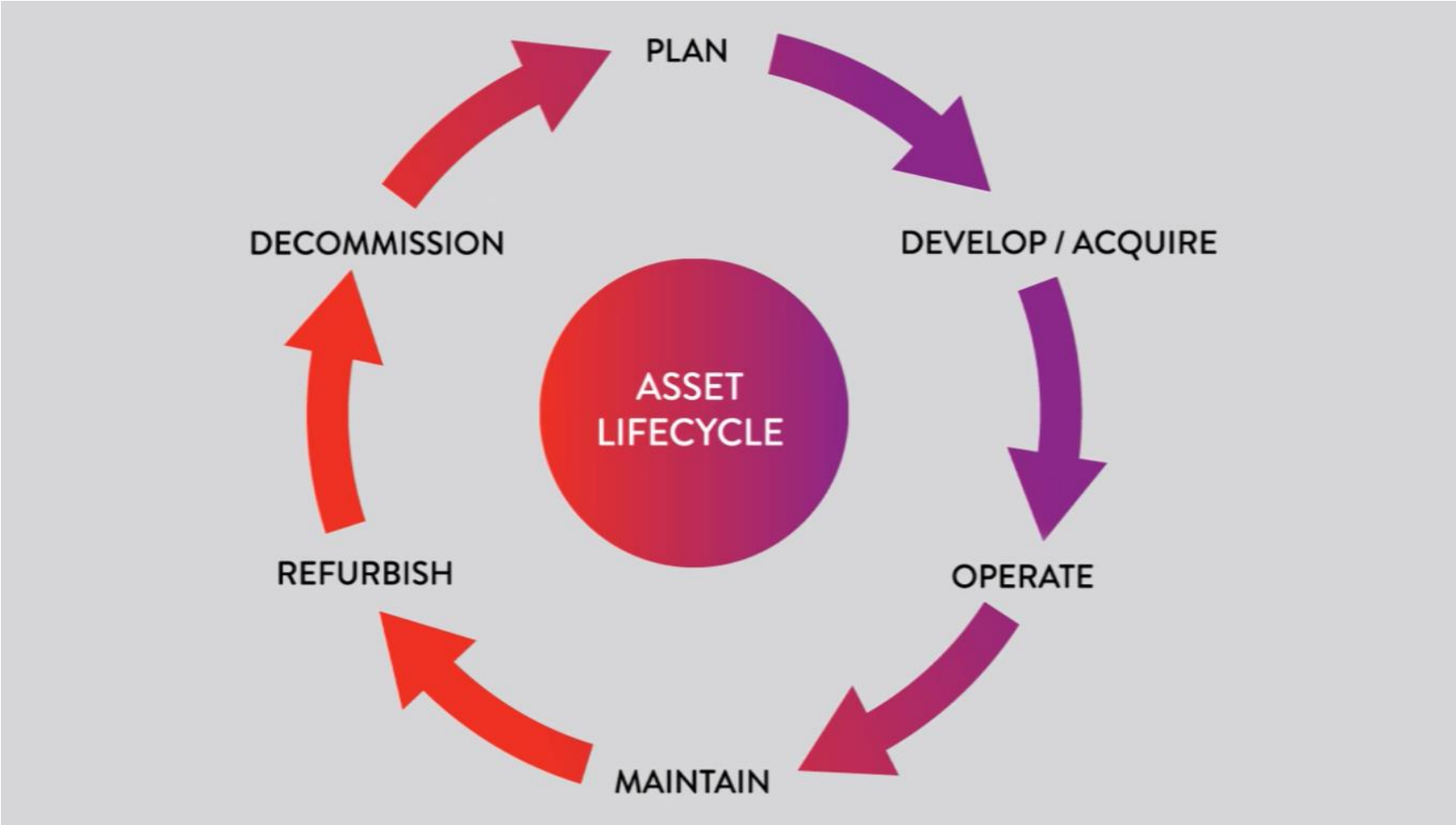
ABOUT ENTURA

- One of the world's most experienced specialist power and water consulting firms
- Part of the Hydro Tasmania group - backed by more than 100 years of creating energy and maintaining power and water assets
- Services covering every aspect of major power and water projects, from strategy, planning, design and construction through to operation, maintenance, risk management and training
- Over 200 staff; expanding business opportunities nationally and internationally
- Broad range of clients across the Asia-Pacific region including:
  - all levels of government
  - electricity and water utilities
  - developers
  - funding agencies (World Bank, ADB)

SOLUTIONS ACROSS THE WHOLE LIFECYCLE



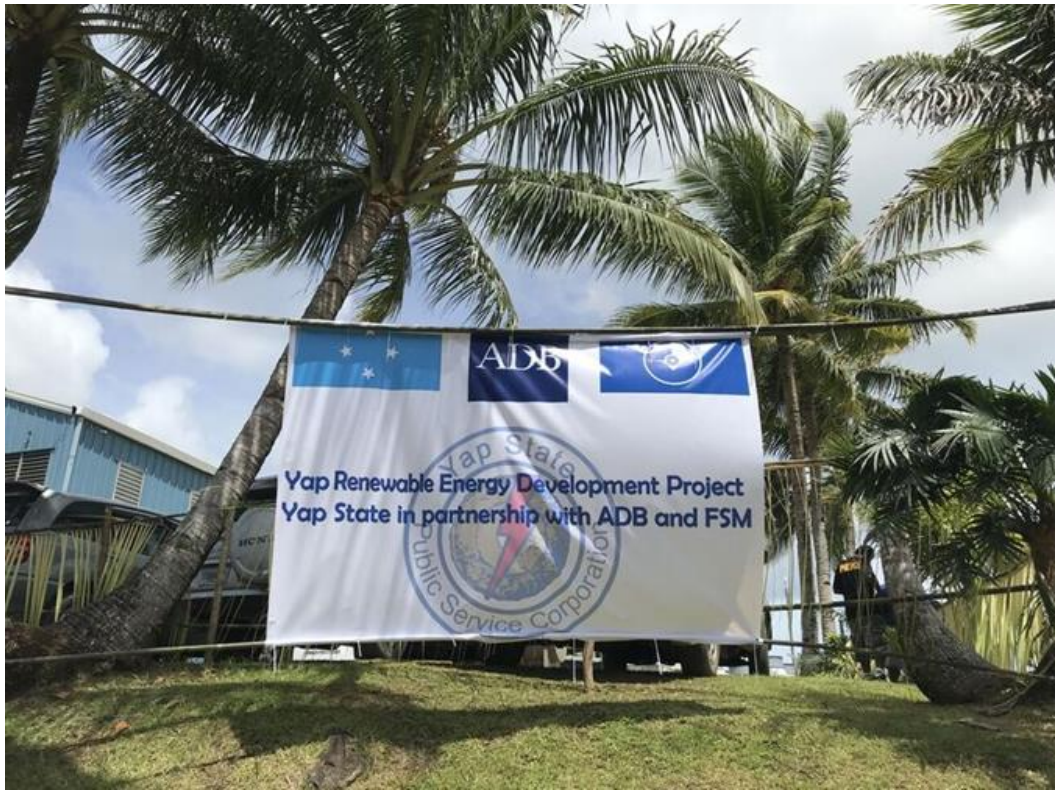
HYBRID RENEWABLES

As the world increasingly embraces renewable electricity generation, and transitions away from costly or emissions-intensive technologies, the need is growing for hybrid renewable energy assets that combine multiple forms of generation and storage.

Our services include:

- renewable energy roadmaps, conception and master planning
- feasibility studies and concept designs
- power systems and grid connection studies
- due diligence assessments
- tender and bid responses
- planning and environmental approvals
- front-end engineering design including power systems modelling, integration design and control design and interface specification
- detailed designs, technical specification, procurement and factory testing
- control code and HMI (operator screen) design and preparation
- owner's engineer role
- project management of site works including construction, installation, pre-commissioning, unit commissioning, system integration commissioning and initial operation
- asset management plans
- operator training
- remote system support
- web dashboards and app development for mobile devices

RENEWABLES ARE OUR FUTURE



Yap State Renewable Energy Transition in Partnership with ADB and FSM

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PRESENTER - DEAN HALEY

- Renewable Energy Engineer with Entura
- Entura were awarded the Design and Construction Supervision (DSC) contract on 29th April 2014
- My role in this project was YREDP Team Leader
- Implementing Agency – Yap State Public Service Corporation (YSPSC)
  - Faustino Yangmog – General Manager
  - Victor Nabeyan – Assistant General Manager and PMU Project Manager
  - Vincent Bouet – YSPSC Chief Engineer
- Funding Agency - ADB
  - Energy Specialist - Mike Trainor

Yap State Public Service Corporation

ADB ASIAN DEVELOPMENT BANK

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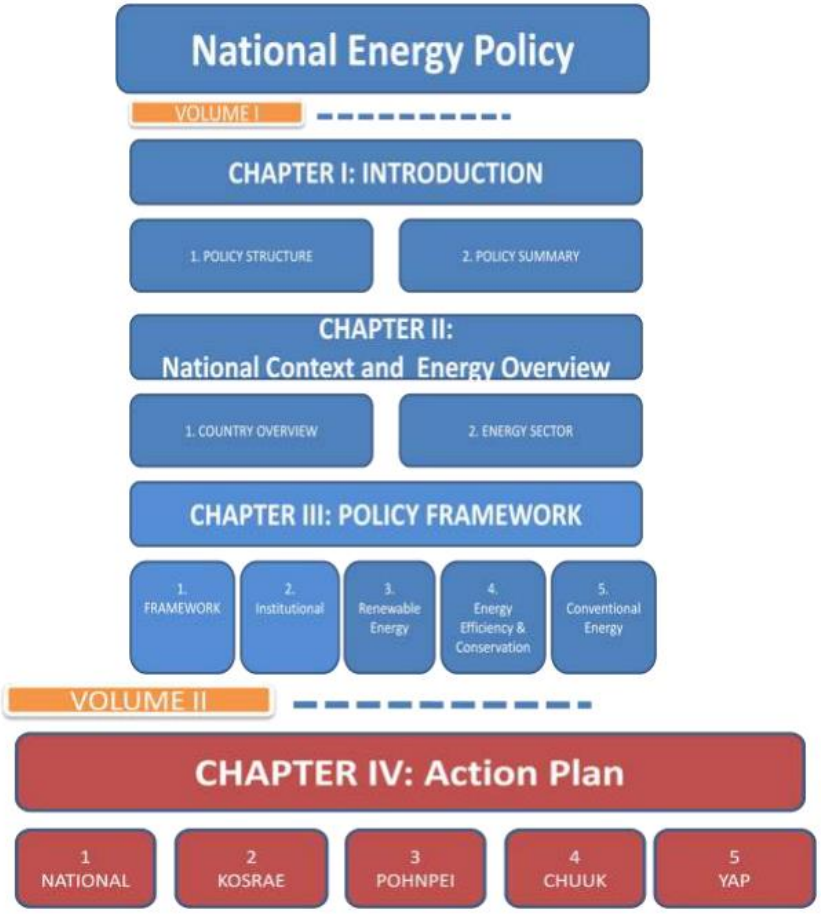
NATIONAL ENERGY POLICY



YAP STATE ENERGY ACTION PLAN

- **The National Vision statement for Energy is**
  - To improve the life and livelihood of all FSM citizens with affordable, reliable and environmentally sound energy.
- **The National Objective for Energy is**
  - To promote the sustainable socio-economic development of FSM through the provision and utilization of cost-effective, safe, reliable and sustainable energy services.
- **Yap State's Energy Action Plans**
  - To become less dependent on imported sources of energy by having an increased share of renewable energy sources
    - **30%** of energy coming from renewable sources by **2020**
    - **50%** improvement in energy efficiency by **2020**
    - **50%** of energy coming from renewable sources by **2030**

PLANNING A RENEWABLE ENERGY JOURNEY IN THE PACIFIC

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STAGE 1: PLANNING

- POWER SYSTEM AND RENEWABLE RESOURCE INVESTIGATION
- DEFINE POWER SYSTEM GOALS AND STRATEGY FOR THE JOURNEY

STAGE 2: INTRODUCTION OF RENEWABLES

- UP TO 15% RENEWABLES
- SMALL-SCALE RENEWABLES
- MINOR CHANGES TO SYSTEM OPERATION

STAGE 3: EXPANSION OF RENEWABLES AND INTRODUCTION OF ENABLERS

- UP TO 35% RENEWABLES
- INTEGRATE LARGE-SCALE RENEWABLES
- INTRODUCE ENABLING TECHNOLOGIES
- CHANGES TO OPERATIONAL PHILOSOPHY TO PRIORITISE RENEWABLES

STAGE 4: EXPANSION OF RENEWABLES AND ENABLERS

- UP TO 70% RENEWABLES
- INTEGRATE LARGE-SCALE ENABLERS AND COMPLEX CONTROL SYSTEMS
- MAJOR CHANGES TO UTILITY OPERATION AND MAINTENANCE PROCEDURES

STAGE 5: APPROACHING 100% RENEWABLES

- ADD 'LAST MILE' ENABLERS
- ASSET MANAGEMENT JOURNEY BEGINS

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THE ENTURA TEAM

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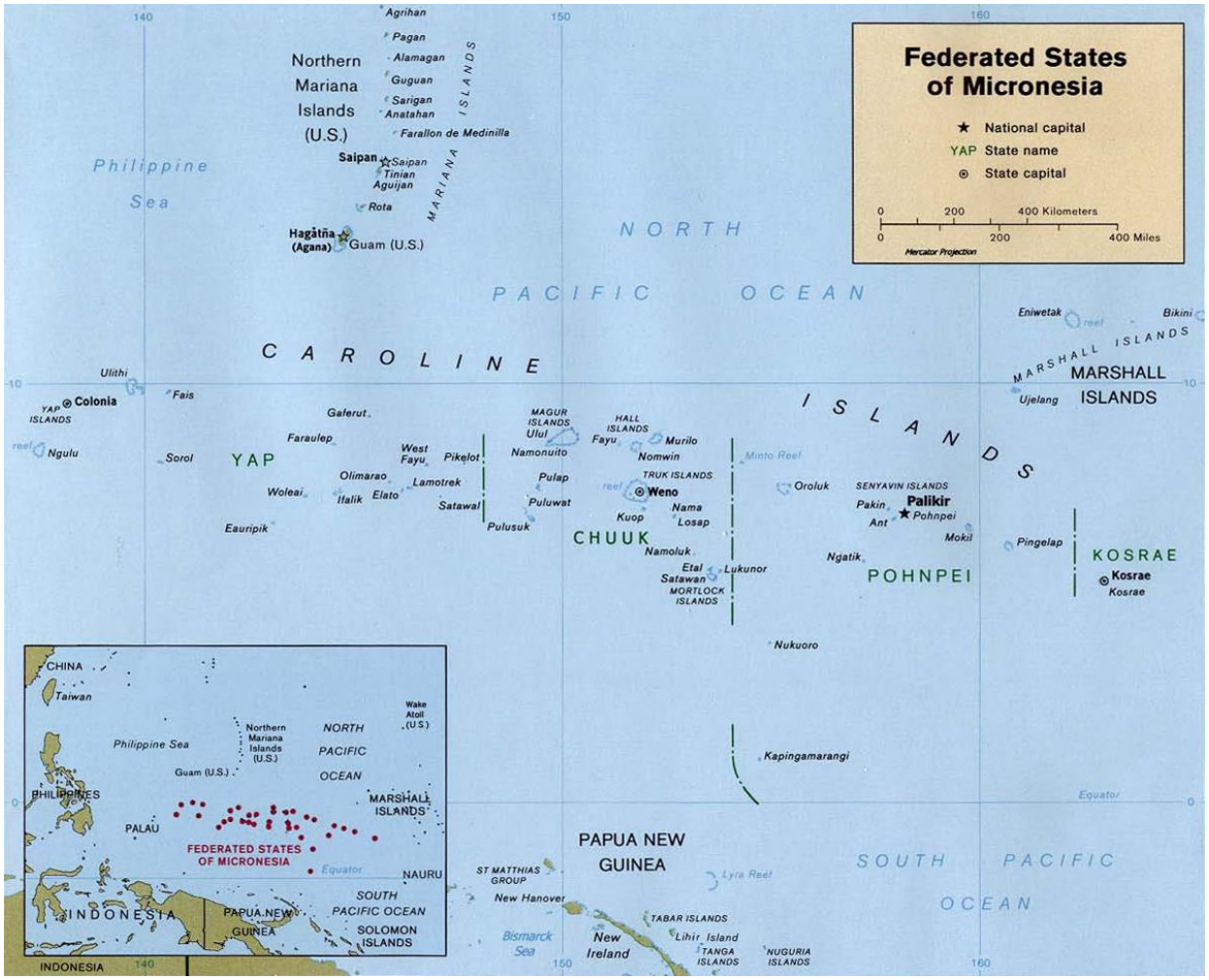
WORKING COLLABORATIVELY WITH YSPSC

YAP LOCATED IN THE CAROLINE ISLANDS



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YAP - A TRADITIONAL ISLAND CAPABLE OF MODERN TRANSITION

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A MODERN FULLY INTEGRATED HYBRID RE POWER SYSTEM

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SCOPE OF WORKS

- Wind resource and energy estimate feasibility confirmation
- Power System Studies
- Confirm and Develop Power System Architecture
- Procurement Planning
- Preparation of both Technical and Commercial Bidding Documentation
- Bidding process including bid evaluation
- Owners Engineer during detailed design
- Social safeguards planning and implementation monitoring
- Environmental safeguards planning and implementation monitoring
- Construction Supervision
- Witness Commissioning and Acceptance

COMBINING RESOURCES TO REDUCE VARIABILITY

Combining resources to reduce variability.

Solar and wind resources are often negatively correlated: Solar power peaks in the summer, whereas wind tends to peak in the winter. On the other hand, solar power peaks during the day, while winds tend to be stronger in the afternoon and at night. These correlations make it possible to mix wind and solar resources to yield a combined power output that mimics the demand curve, a phenomenon called natural balancing

Wind and solar energy is a fast-growing share of the global energy mix. But integrating them into power-system operations requires significant adaptations to compensate for their variability. Solutions include increasing the amount of flexible generation within the system, combining, and dispersing variable resources to smooth aggregate output, expanding the transmission network, using smart technology to control supply and demand, and storing electricity.

POWER SYSTEM STUDIES – GRID STABILITY

To estimate the future high renewable penetration power system performance, four worst-case scenarios were conducted and studied:

- Wind farm trip with a single diesel online
- Wind farm trip with two diesels online
- Colonia feeder trip with a single diesel online
- Colonia feeder trip with two diesels online

These simulation scenarios showed that the system frequency and voltage will venture outside their normal operating limits during critical events.

Installation of high speed diesel engines will provide Yap power system with fault ride through capability during the critical events with minimal or no loss of customer load.

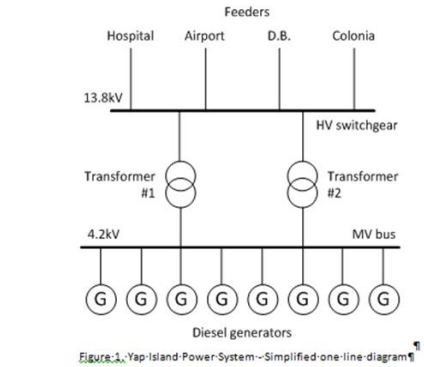
RE INTEGRATION

Wind and solar energy is a fast-growing share of the global energy mix. But integrating them into power-system operations requires significant adaptations to compensate for their variability. Solutions include increasing the amount of **flexible generation** within the system, combining, and dispersing variable resources to smooth aggregate output, expanding the transmission network, using smart technology to control supply and demand, and storing electricity.

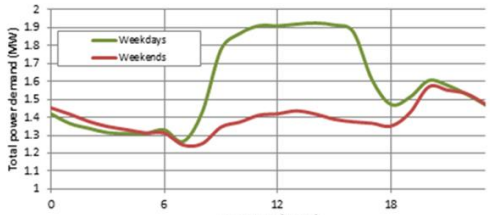
AUTOMATED INTEGRATION AND CONTROL SYSTEM

The control systems of today's smart power-distribution grids have evolved significantly. Such systems improve system reliability by reducing the frequency and duration of outages. They also optimize asset utilization and increase power quality. But the scale of automation and the ultimate configuration of the system need to be considered carefully with each client. The decision to proceed must be based on a sound economic evaluation; it cannot simply echo the mantra of automation.

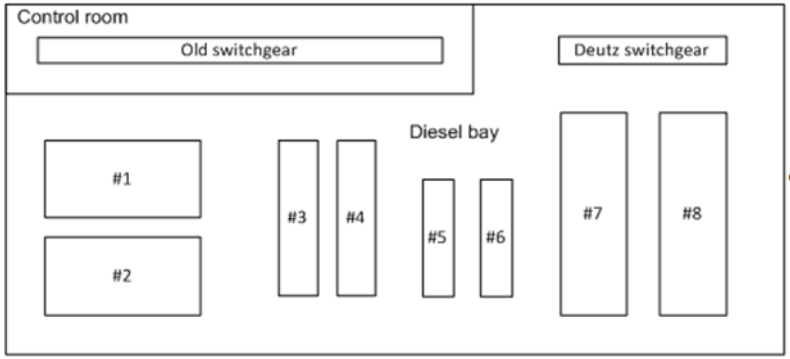
ORIGINAL POWER HOUSE



Figure·1.·Yap·Island·Power·System·-·Simplified·one·line·diagram¶



Figure·2.·Demand·profile·(2013)¶



Figure°A.3:·Power·station·layout¶

REMOVAL OF REDUNDANT DIESEL GENERATORS

REPLACE WITH NEW HIGH SPEED DIESEL GENERATORS

2 * 1650kw Cat 3615C Diesel Gensets

HIGH SPEED DIESELS

1 * 800 kw Cat Diesel genset

REPLACE REDUNDANT SWITCHGEAR WITH NEW MV SWITCHGEAR

UPGRADE TO THE FUEL STORAGE AND TRANSFER SYSTEM INCLUDING INSTALLATION OF NEW DAY TANKS

POWER HOUSE COMMISSIONING

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COMMUNITY CONSULTATION

WIND POWER

- 3 * 275 kW Vergnet wind turbine generators
- Key features
  - Guy wired tilt down tower for typhoon survival
  - Tilt down allows for ease of construction, operation and maintenance
  - Smaller crane size required than for typical monopole wind turbine towers.

WIND TURBINE SITE IDENTIFICATION AND IDENTIFICATION OF CONSTRAINTS

IDENTIFICATION AND PROTECTION OF HISTORICAL SITES FOR PRESERVATION & ENVIRONMENTAL SAFEGUARDS

WINDFARM SITE CLEARANCE

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WINDFARM CONSTRUCTION

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SOLAR PV

	Existing PEC Solar to be integrated New Grid Connected Solar PV Total Solar PV	200 kWp 308.5 kWp 508.5 kWp
1	Sports Complex	194.5 kWp
2	Public Safety Building	25 kWp
3	Early Childhood Education Building	50 kWp
4	Water Treatment Plant	13 kWp
5	Public Works Building	26 kWp

EXISTING PEC SOLAR 200 KW

SPORTS COMPLEX 194.5KW

SOLAR INSTALLATION BY YSPSC

PUBLIC SAFETY BUILDING 25KW

WATER TREATMENT PLANT 13 KW

CIVIL ENGINEERING AND MAINTENANCE BUILDING 26 KW

EARLY CHILDHOOD CENTRE 50 KW

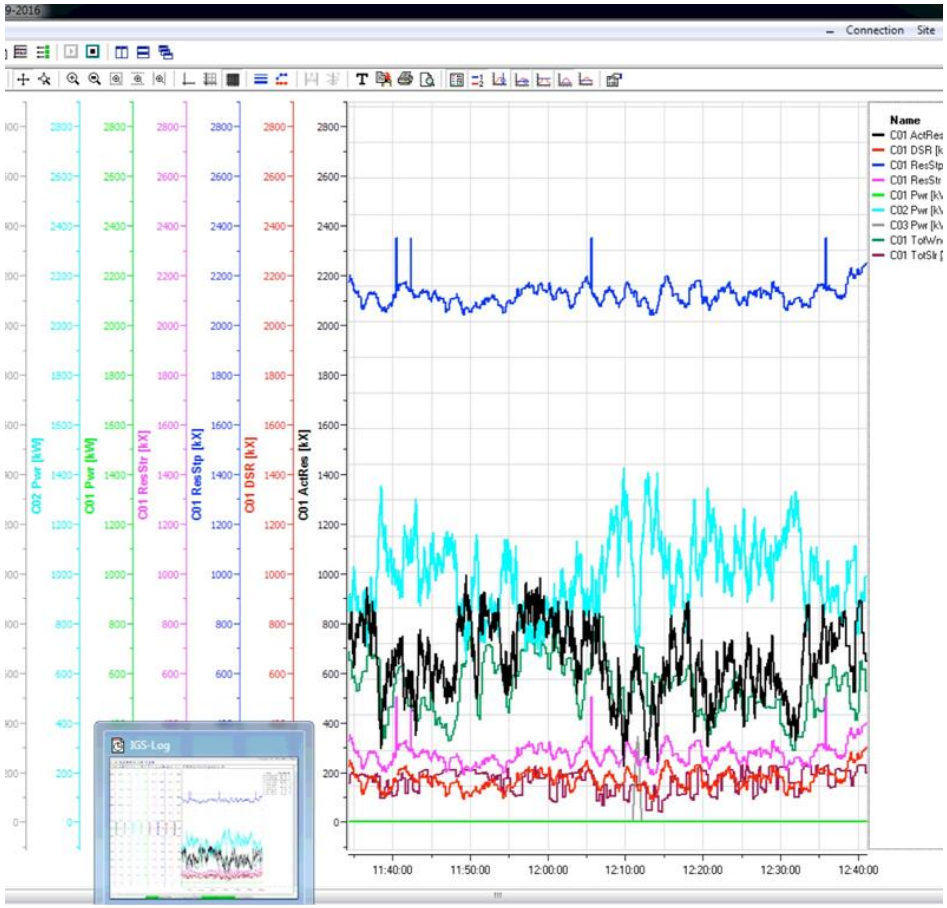
ISLAND WIDE COMMUNICATIONS NETWORK

OPENING CEREMONY

Left to Right – Hon. Ted Rutun (Yap Legislature Speaker), Jim Lynch (Deputy Director General, Pacific Department, ADB), Hon. Tony Ganngiyan (Yap Governor), HE Peter Christian (FSM President), James Gilmar (Chairman, YSPSC Board of Directors).

INTEGRATION AND CONTROL

CURRENT PERFORMANCE – 1 HR PERIOD



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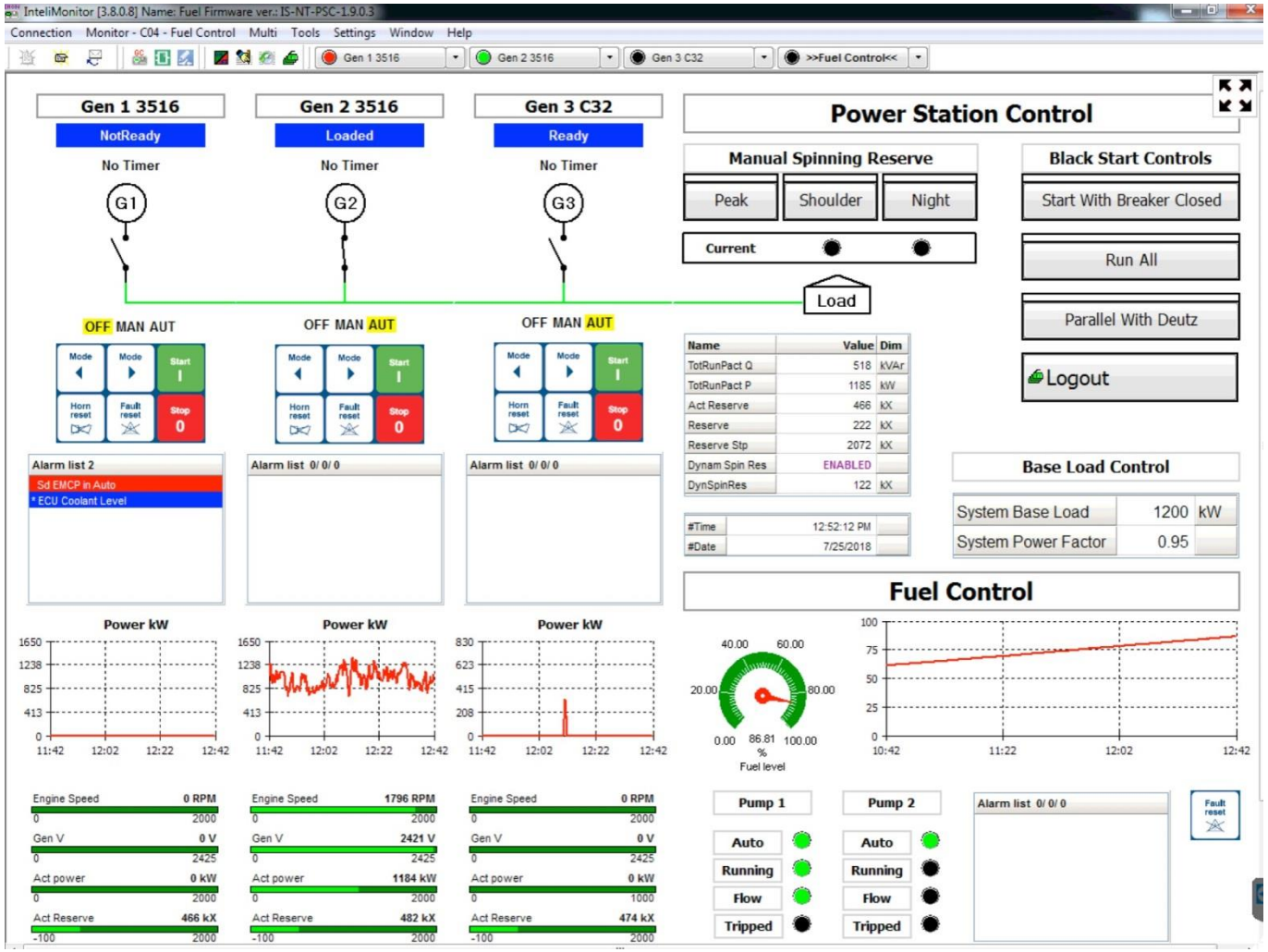
OPERATION



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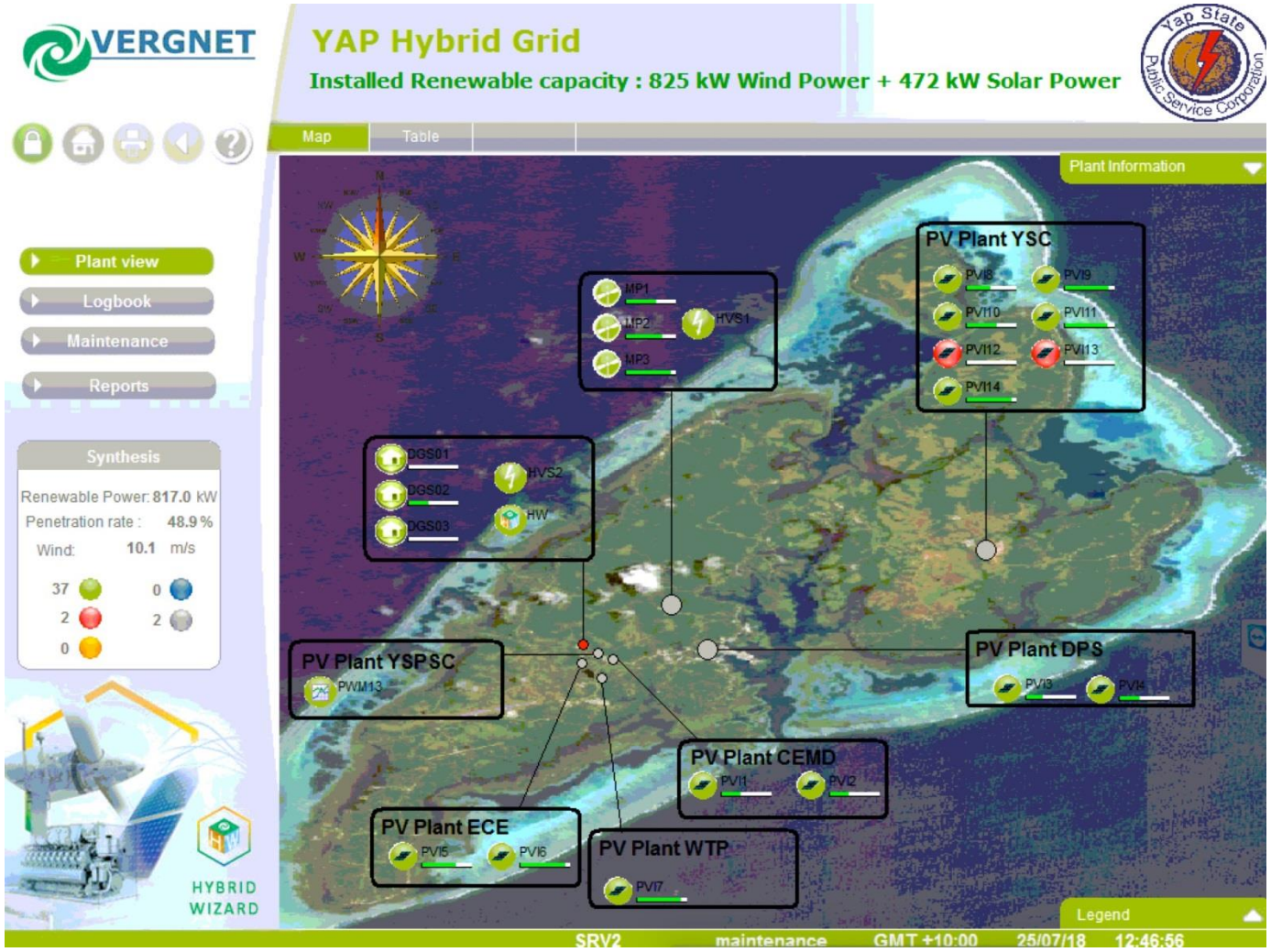
HYBRID GRID



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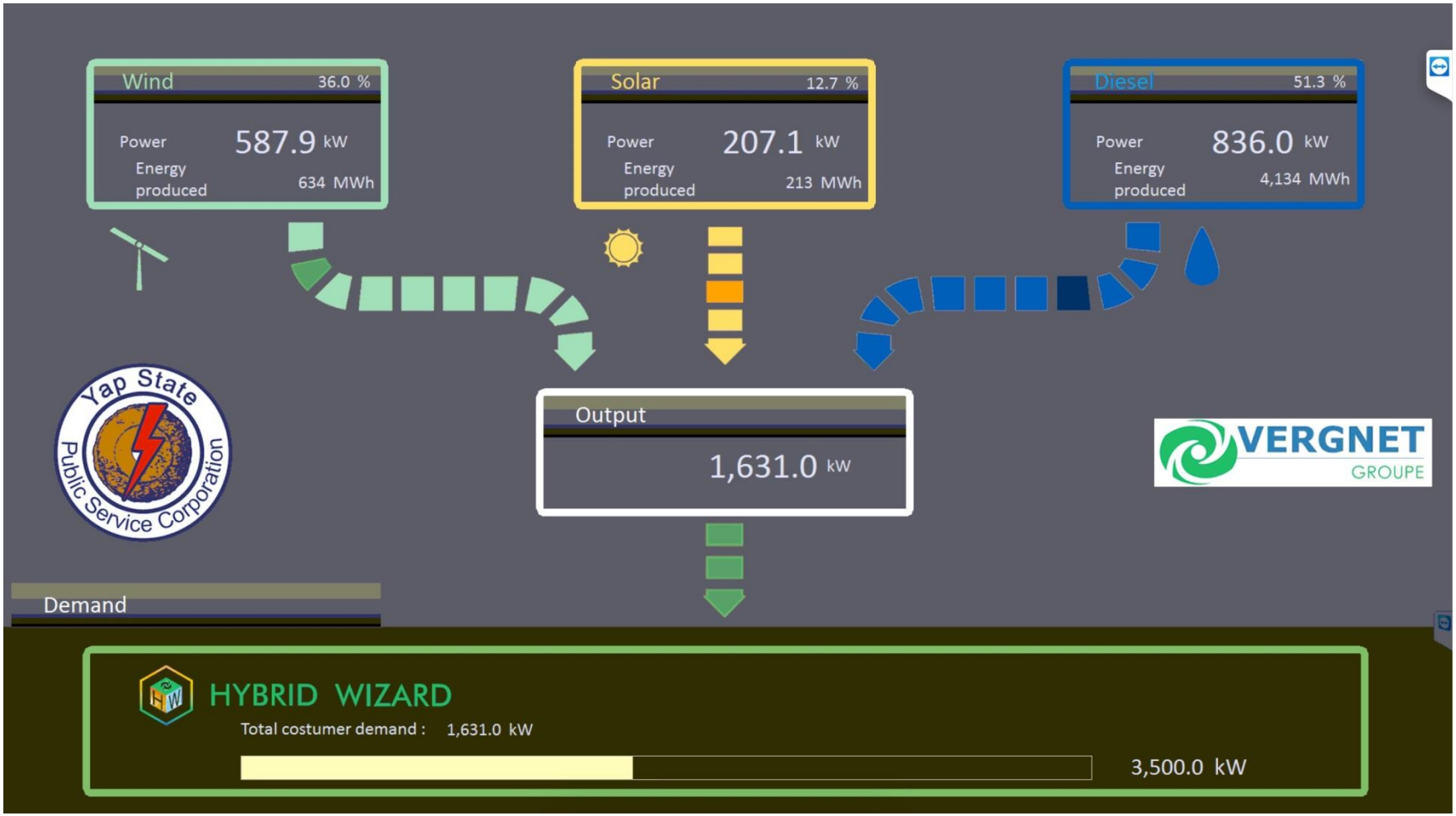
Wind
36.0 %
Power
587.9 kW
Energy produced
634 MWh
Solar
12.7 %
Power
207.1 kW
Energy produced
213 MWh
Diesel
51.3 %
Power
836.0 kW
Energy produced
4,134 MWh
Yap State Public Service Corporation
Output
1,631.0 kW
VERGNET GROUPE
Demand
HYBRID WIZARD
Total costumer demand : 1,631.0 kW
3,500.0 kW

ACHIEVEMENTS TO DATE

- Since the commissioning**, no outage** has been attributed to the introduction of the renewable energy facilities, Wind & Solar.
- The reliability was not impacted.
- The weather conditions were not favourable to produce important renewable energy. A few windy conditions, with a lot of variability of RE have shown that the supervision and control system is **performing as expected**, curtailing RE if necessary to keep stability and diesel generator(s) under minimum load.
- The **Dynamic Spinning Reserve** plays its role and we can observe the small peak generator coming on line when necessary.
- The system reached **60% of RE penetration** without any energy storage.
- Under particular conditions, the small peak generator connects & disconnects quite often, thus we look forward to the introduction of an Energy Storage System.
- The full RE potential will be observed during the trade winds season. At present, the rainy season shows limited RE production in very few occasions.

DIESEL DISPLACEMENT

Average diesel displacement:

- So far, the wind farm has produced **602 MWh**
  - MP1 318.4 MWh
  - MP2 135.1 MWh
  - MP3 148.5 MWh
- The solar farms (ABD project only, PEC excluded) have produced 264.167 MWh since their installation.
- Approximate Diesel Displacement so far:
  - 866167 kWh / 14 = **61,869** US Gall. @ $USD3.9/ gallon - **$USD241,3000**
- Diesel displacement in non-wind period ie Solar only:
  - 264167 kWh / 14 = 18,869 US Gall

INGREDIENTS FOR SUCCESS

- Commitment from National and State Governments
- Capable and Competent Executing Agency
  - Executive management
  - Operational management
  - Operators
- Community Engagement
- Renewable readiness
- Acceptance, Resilience and Preparation for Disruption

CONTACTS

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