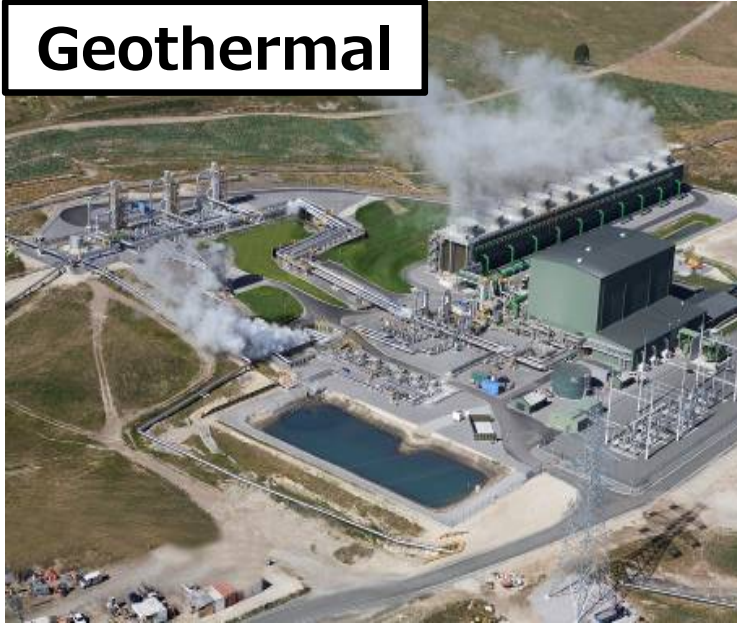


# **Fuji Electric Renewable Energy Solution**

September 15, 2015  
**Fuji Electric Co., Ltd.**

# Power generation by renewable energy

**Geothermal**



**Photovoltaic**



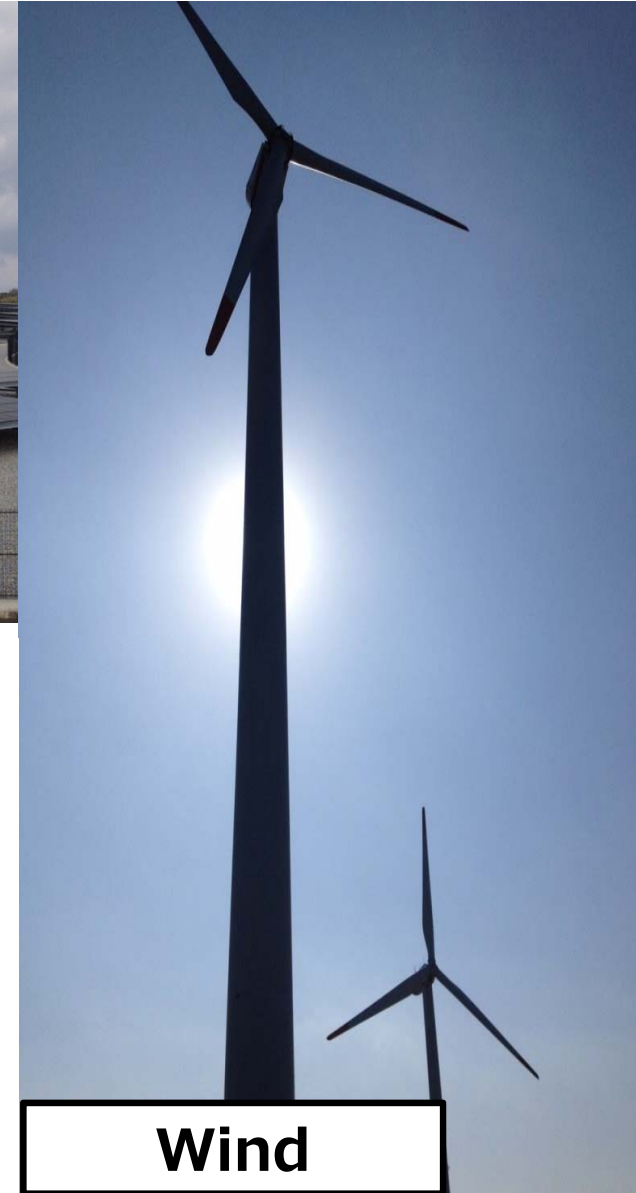
**Micro-hydro**



**Biomass**

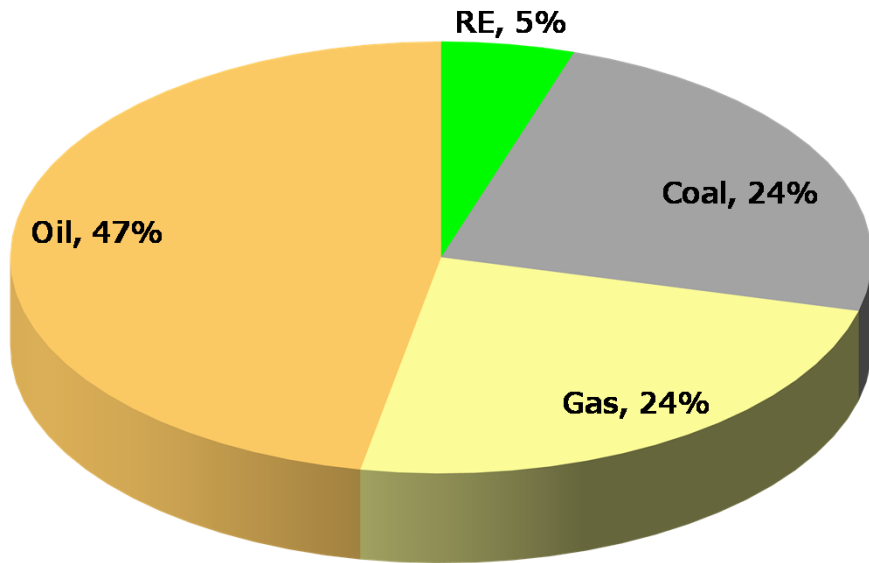


**Wind**

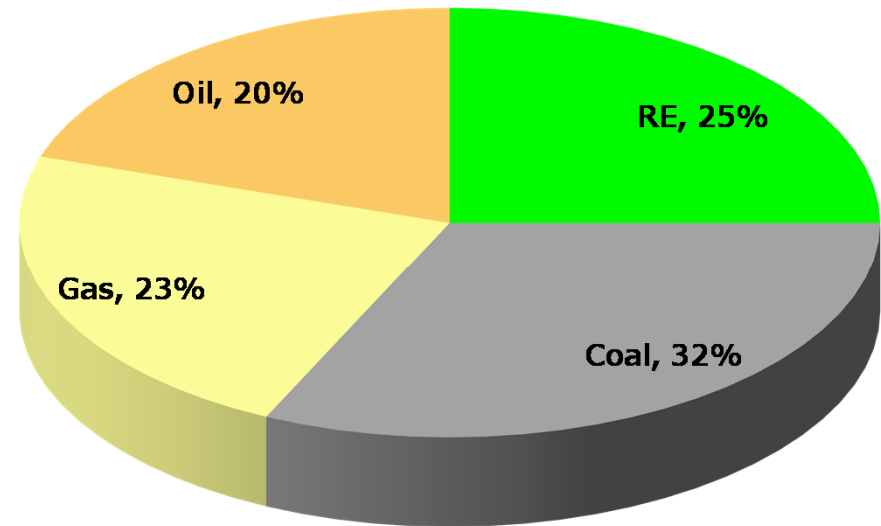


# Energy condition in Indonesia

## 2011 Total Energy Mix



## Vision 25/25



[ Source:2012 Energy efficiency & renewable energy in Indonesia ]

## Share of renewable energy to be lifted up to 25% in 2025

# Energy potential in Indonesia

2011	Potential	Installed capacity	Ratio
<b>Geothermal</b>	29,038 MW	1,226 MW	4%
<b>Photovoltaic</b>	4.8kWh/sq-m/day	22 MW	---
<b>Wind</b>	3 ~ 6m/s	2 MW	---
<b>Small / Micro hydro</b>	770 MW	230 MW	30%
<b>Biomass</b>	50,000 MW	1,618 MW	3%

[ Source:2012 Energy efficiency & renewable energy in Indonesia ]

## Renewable energy in Indonesia

- **Huge potential and large room for further development**

- Advantage**
- Very little CO2 emission
  - Suitable power source of base-load power with the around the clock 24/7 operation unlike solar and wind power.
  - Technically and commercially proven method having long history. The first geothermal power generation was built in 1904.

- Disadvantage**
- Limitation of the development area. (Volcanic area, along with the Ring-of-Fire)
  - Huge drilling cost at the initial phase of the project development.
  - Requirement of the countermeasure for hydrogen sulfide (H<sub>2</sub>S), silica scaling.

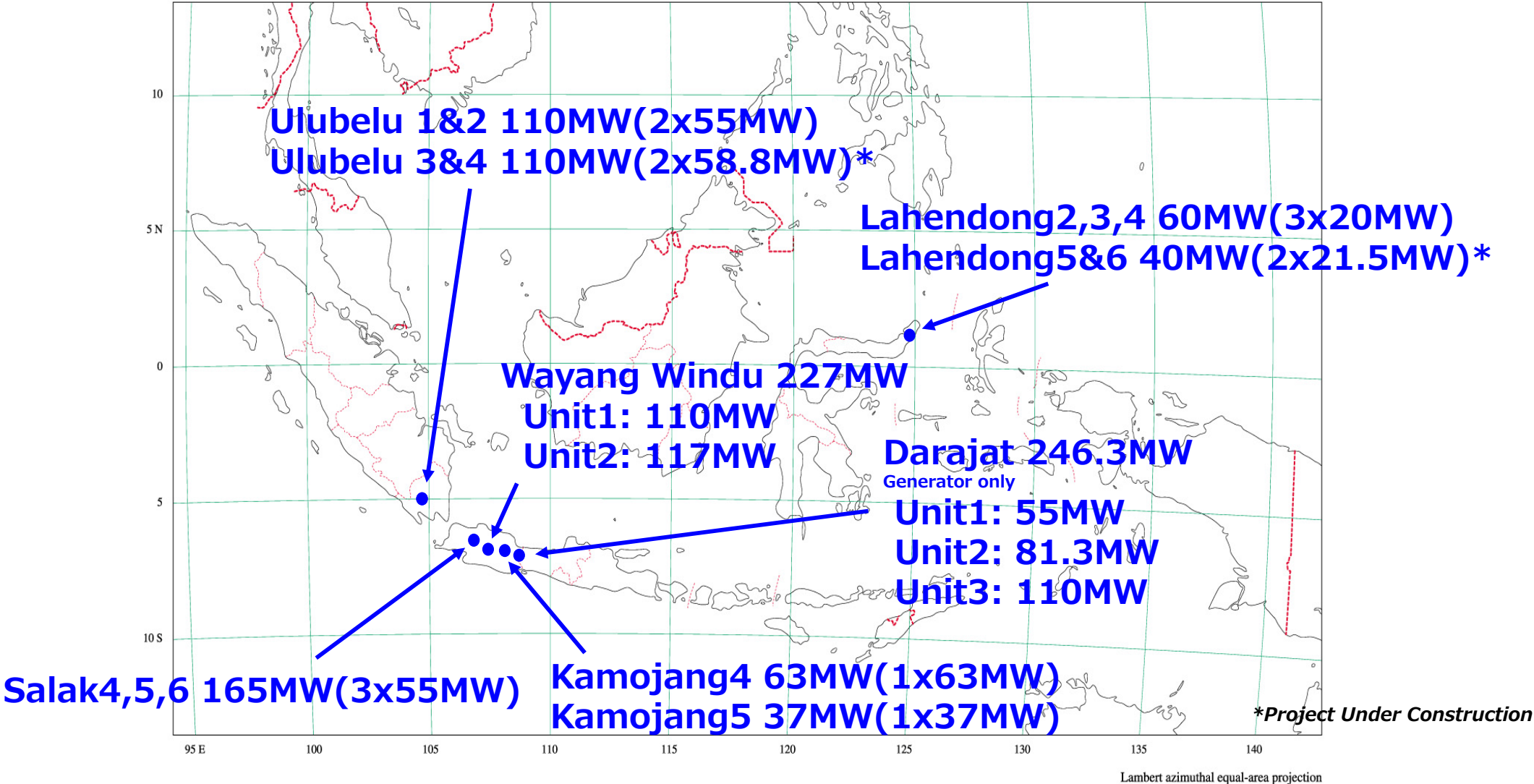
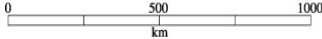
- Our strength**
- Established system integration technology backed up with rich EPC experiences for more than a half century.
  - Total and one-stop solution provider in geothermal power generation industry
  - Various supply experience of our geothermal application all over the world

- Current aspect in Indonesia**
- World's 2nd richest geo-thermal resource with the potential of 29,000MW.
  - Additional geothermal power plans with the capacity 2,400MW will be developed the next 5 years.

- Our solution**
- Provide the highest performance system of the geothermal power plant.
  - Maximizing the geothermal energy utilization with our flash, binary and hybrid sytem technology.
  - Accurate material selection of the equipment and suitable countermeasure against geothermal atmosphere.

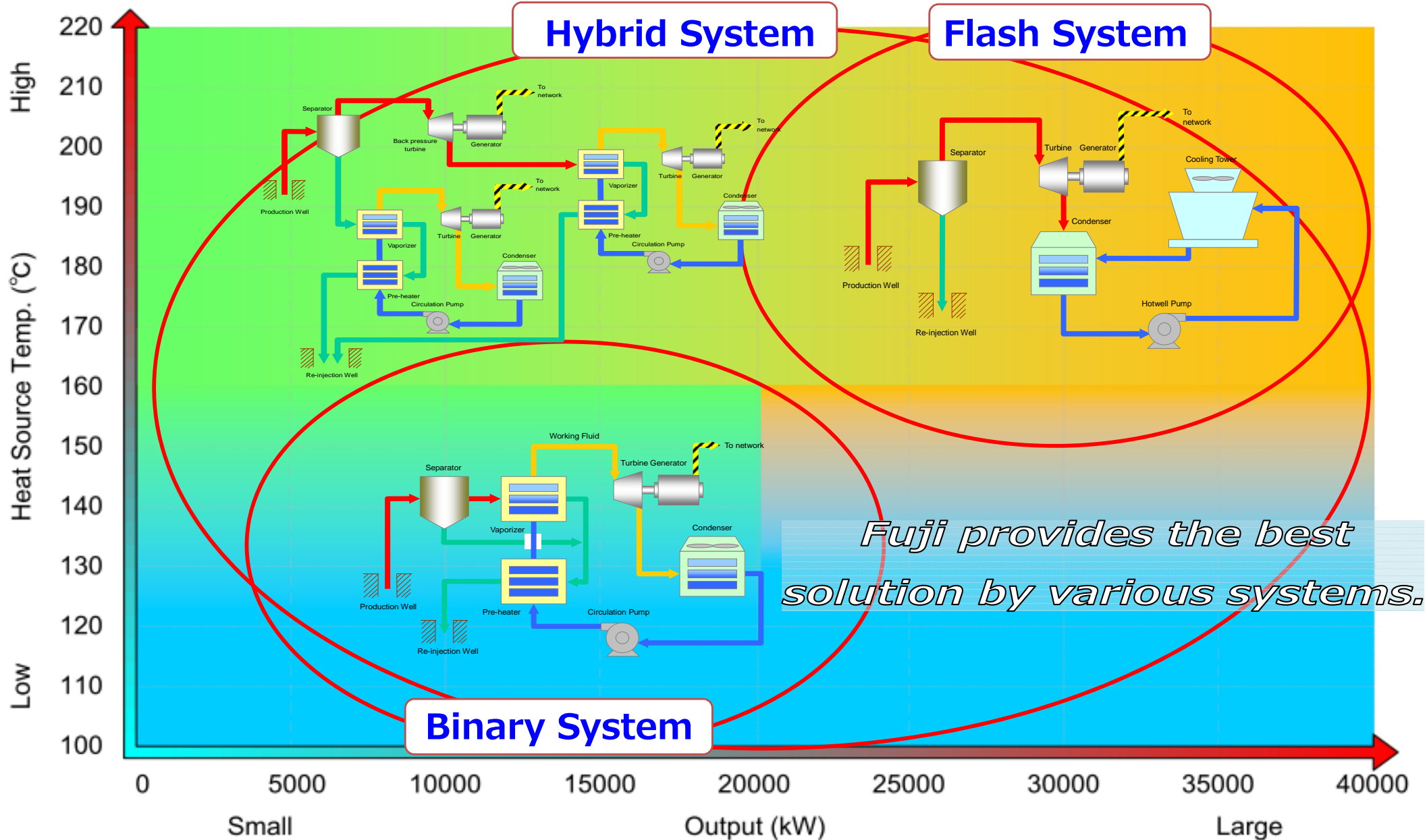
# Fuji Electric geothermal in Indonesia

INDONESIA

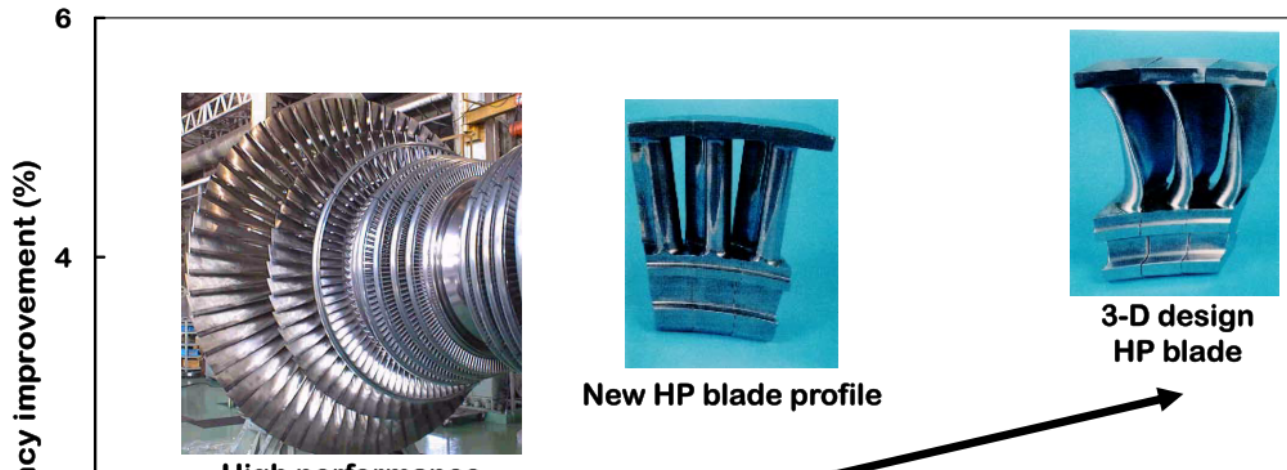


## EPC Experience in 3 Major Islands in Indonesia

# Wider variation of generation system



# Persistent improvement of efficiency



High performance LP blade



New HP blade profile

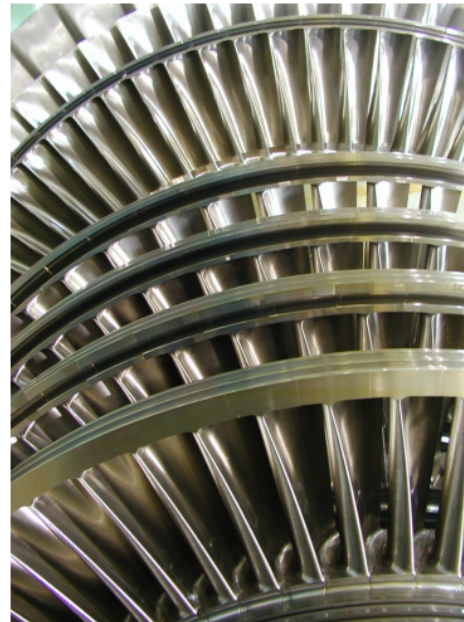


3-D design HP blade

## 3-D Optimum Design of HP Blade

Moving blades

Stationary blades

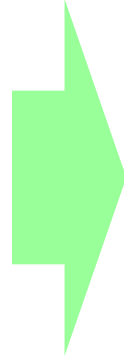




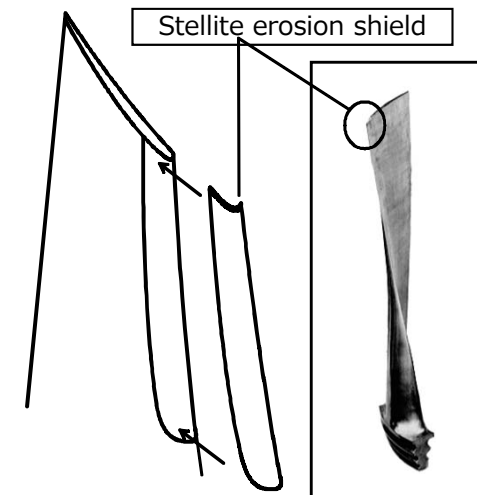
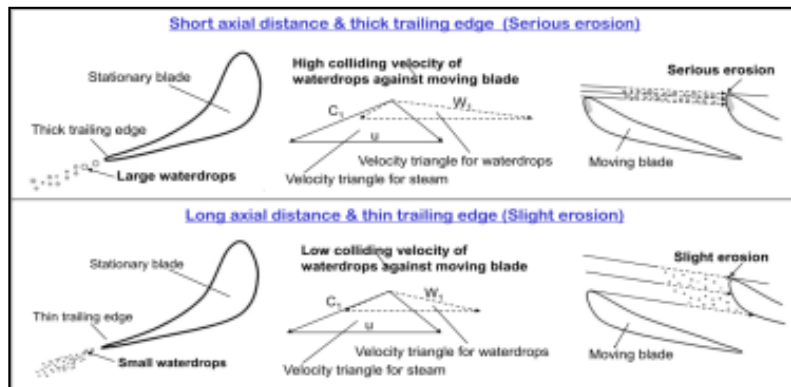
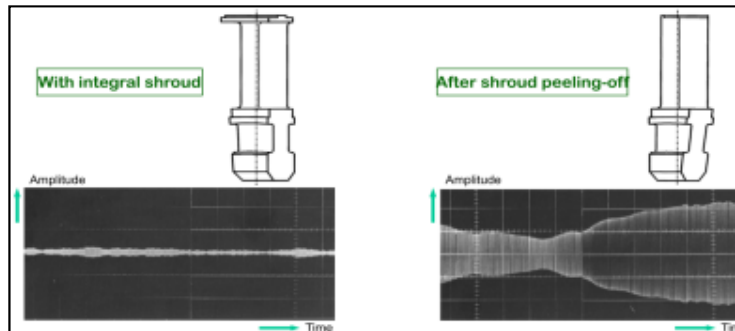
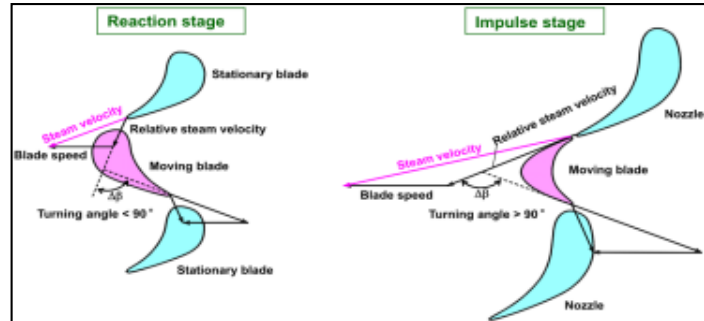
# Countermeasure against geothermal steam

## Issues by geothermal steam

- ❑ Impurities (Silica etc.)
  - Solid particle erosion
  - Choking of blade path
- ❑ Non condensable gases (H<sub>2</sub>S, CO<sub>2</sub>, etc.)
  - Corrosion
  - SCC (Stress corrosion cracking)
- ❑ Wet steam
  - Erosion



## Fuji Electric's countermeasures



- Advantage**
- Less limitation of installation area. (Energy source is given from the sky.)
  - Functionable as distributed power, applicable in the remote area not equipped with the robust transmission lines.
  - Less moving part effectuate less maintenance time and effort.

- Disadvantage**
- Unstable output as easily affected by the weather change.
  - Requirement of the power output compensation at the small sized grid as its unstable output character.

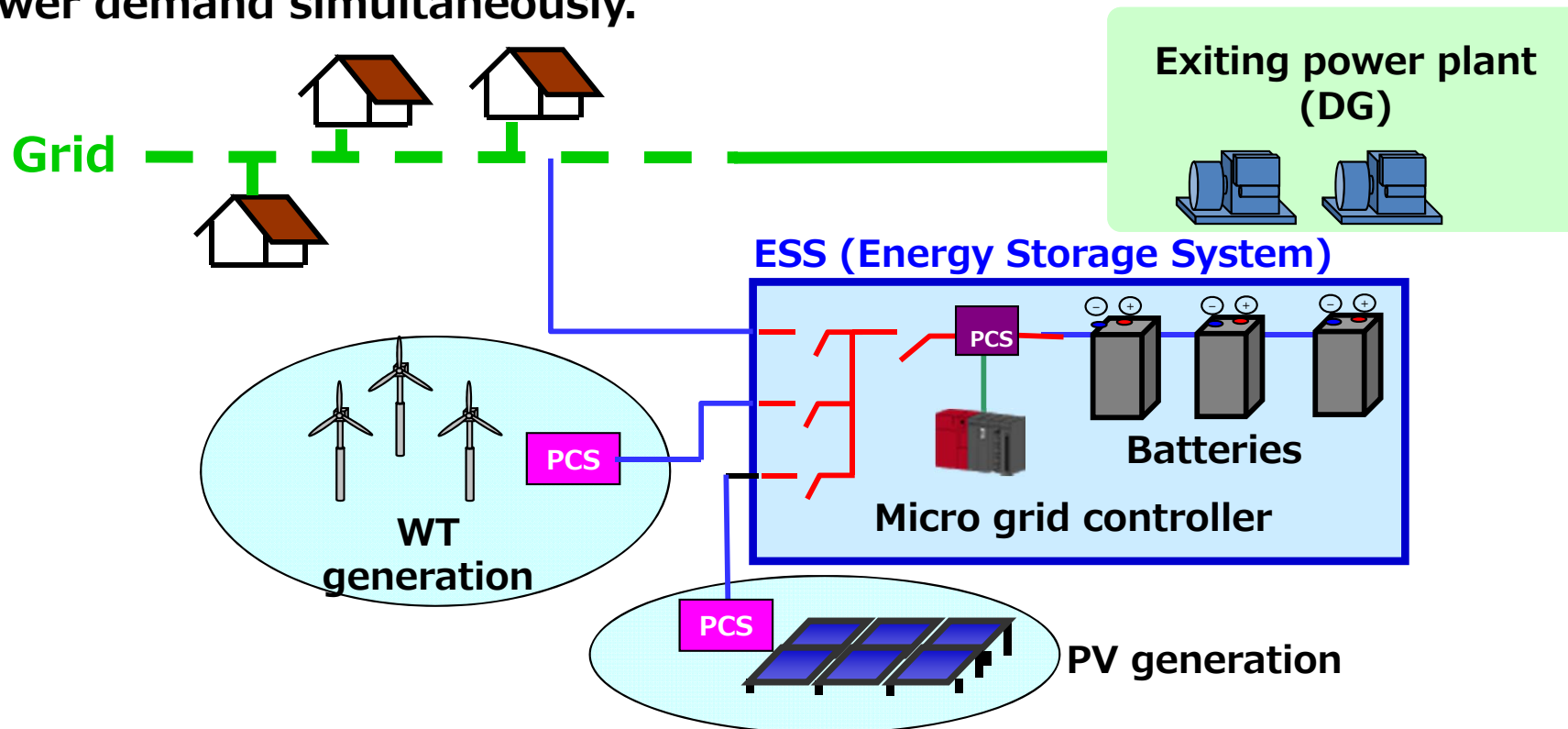
- Our strength**
- Accomplished state-of-the-art ESS technology with Fuji Electric PCS and charge/discharge control system.
  - A number of EPC record of PV generating system with the specific ESS for the remote islands over the world.

- Current aspect in Indonesia**
- Rich solar power resource by the geographic advantage striding equatorial line.
  - Huge demand of independent distributed power generation system at plenty of remote islands around 13, 000.

- Our solution**
- Micro-grid system and output power stabilization system for the remote island.

# Outline of the micro-grid system

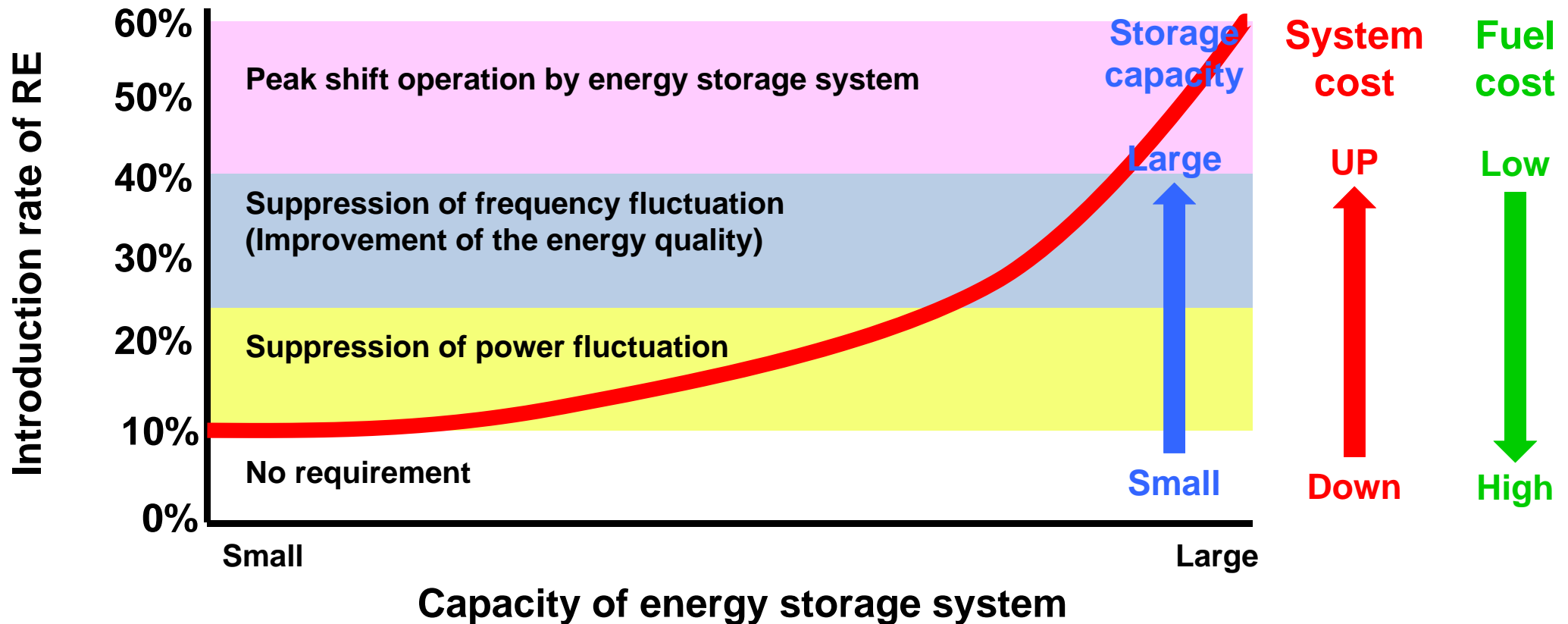
- ❑ Independent grid consist of the multiple distributed power supply, such as solar power and wind turbine as well as conventional diesel generator, plus storage battery and micro-grid controller.
- ❑ Micro-grid controller will direct electric power supply in respond to the movement of power demand simultaneously.



## Benefit:

- ❑ Reduction of fuel cost including transportation cost of fuel
- ❑ Independent energy security
- ❑ CO<sub>2</sub> reduction through installing of renewable energy generations

# Optimal introduction of RE and ESS

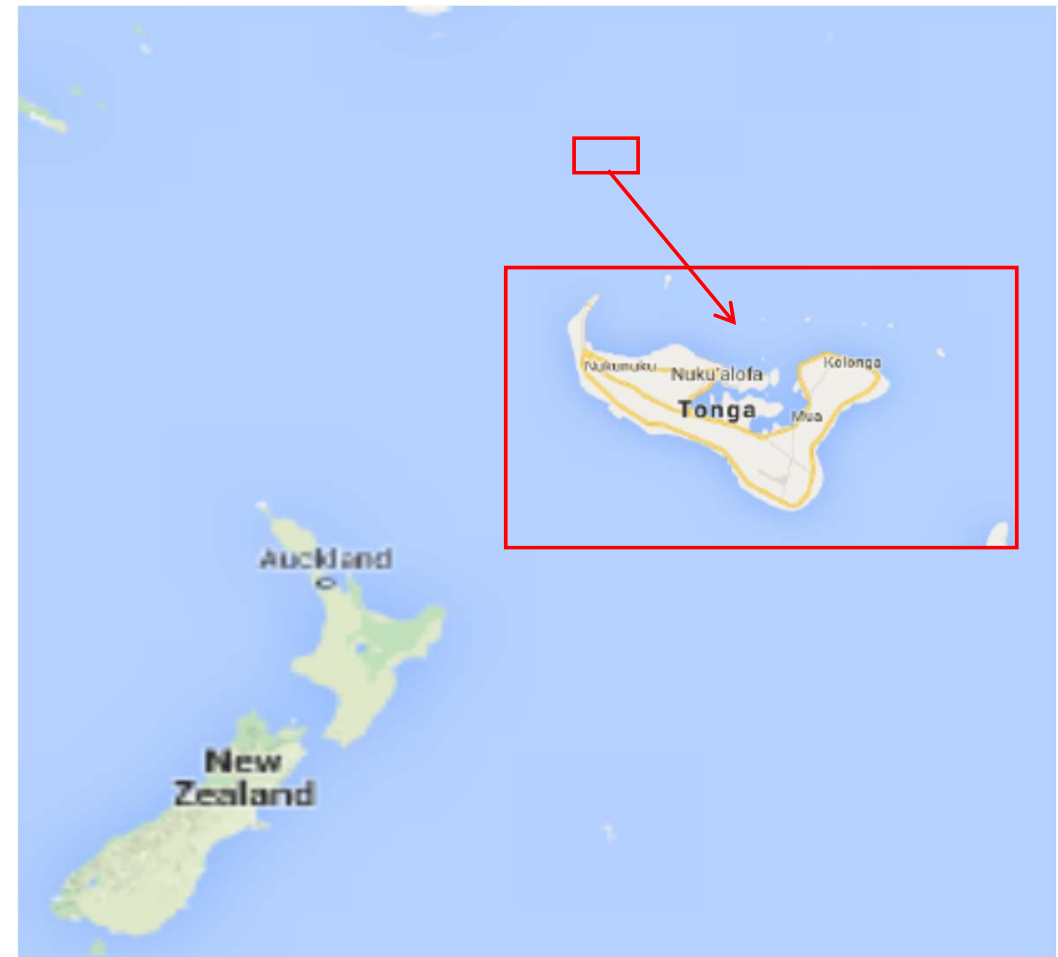


**Requirement of the optimal balance between introduction rate of RE and installment capacity of ESS**

# Job reference of micro-grid system

- Demonstration projects in Kyushu region (2013)
- Demonstration projects in Okinawa (2014)

- JICA grant aid project in the Kingdom of Tonga (2015)



# Impact of the Tonga micro-grid project

Rated generating capacity

**1.0 MWp**

Annual generating volume

**1,308 MWh/year**

Diesel fuel saving

**327 kL/year**

Carbon dioxide reduction

**886 t-CO<sub>2</sub>/year**

[ Source:2013 JICA, Yachiyo Engineering Co., Ltd. West Japan Engineering Consultants, Inc. "Preparatory survey report on the project for introduction of a micro-grid system with renewable energy for the Tonga Energy Roadmap in the Kingdom of Tonga" ]

- Advantage**
- Wind power energy can be transformed to electricity at higher efficiency.
  - 24 hours operation even in the night unlike PV power generation.
  - Wider installation possibilities at both on-shore and off-shore.

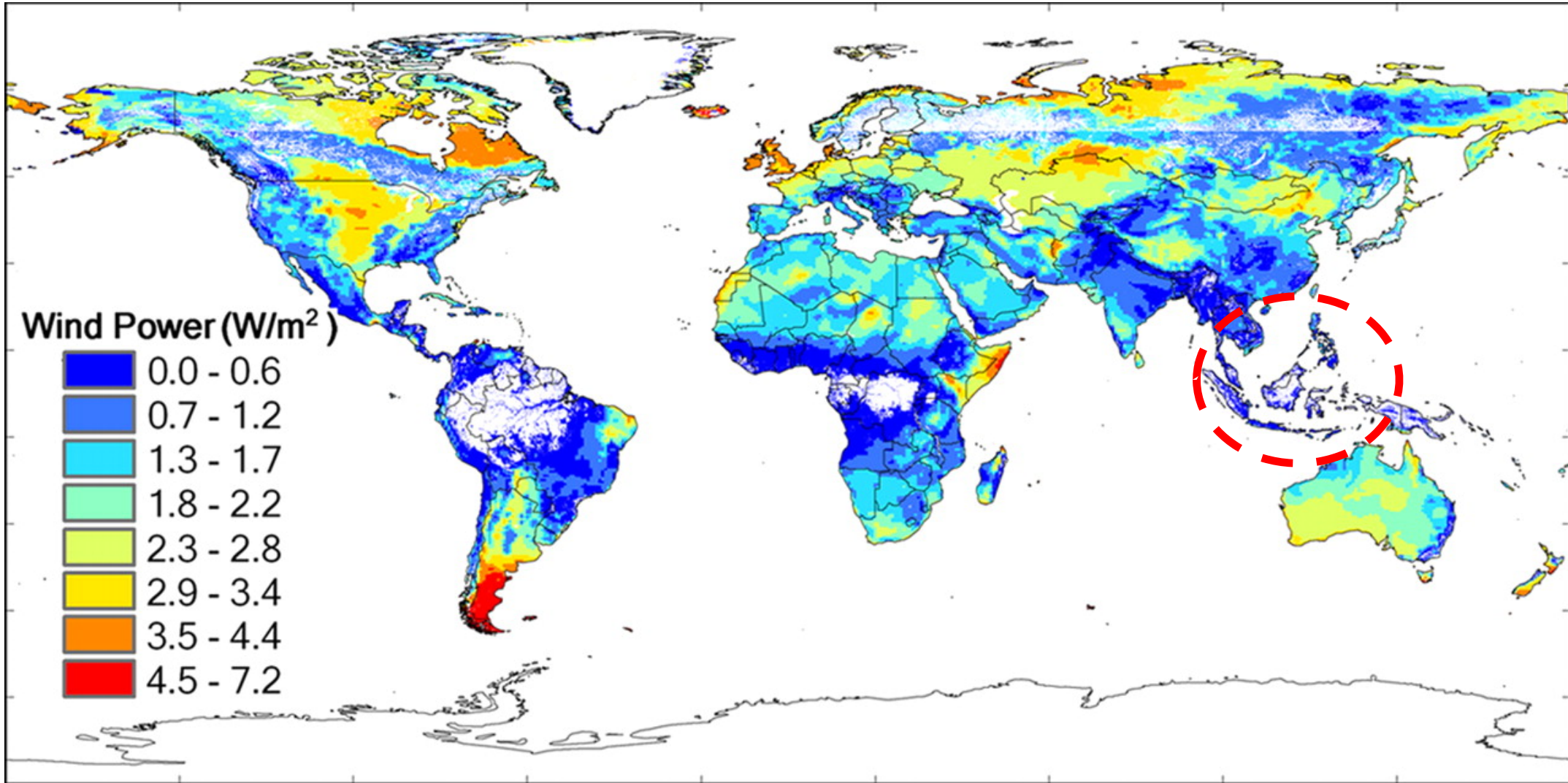
- Disadvantage**
- Frequent maintenance requirement on the moving parts.
  - Adverse effect of noise generated by wind turbine rotation.
  - Requirement of the power output compensation at the small sized grid as its unstable output character.

- Our strength**
- Accomplished state-of-the-art ESS technology with Fuji Electric PCS and charge/discharge control system.
  - A number of EPC record of WT generating system with the specific ESS for the remote islands over the world.

- Current aspect in Indonesia**
- Ordinary wind condition at 3 - 6m/s.  
Need high efficient system to meet with the minimum ideal wind speed 7m/s.

- Our solution**
- Combination of hybrid generating system and hybrid ESS.  
Hybrid generation by WT + PV  
Hybrid ESS by peak-shifting + power output stabilizer

# Geographic features in Indonesia



**Strong wind power resource have a tendency to eccentrically-located at North-South region.**

**Need to maximize the efficiency with hybrid generation system.**



# Challenge in Galapagos

- Japanese Grant Aid Project for Galapagos, Ecuador  
Project period from October 2014 (on-going)



# Double hybrid system in Galapagos

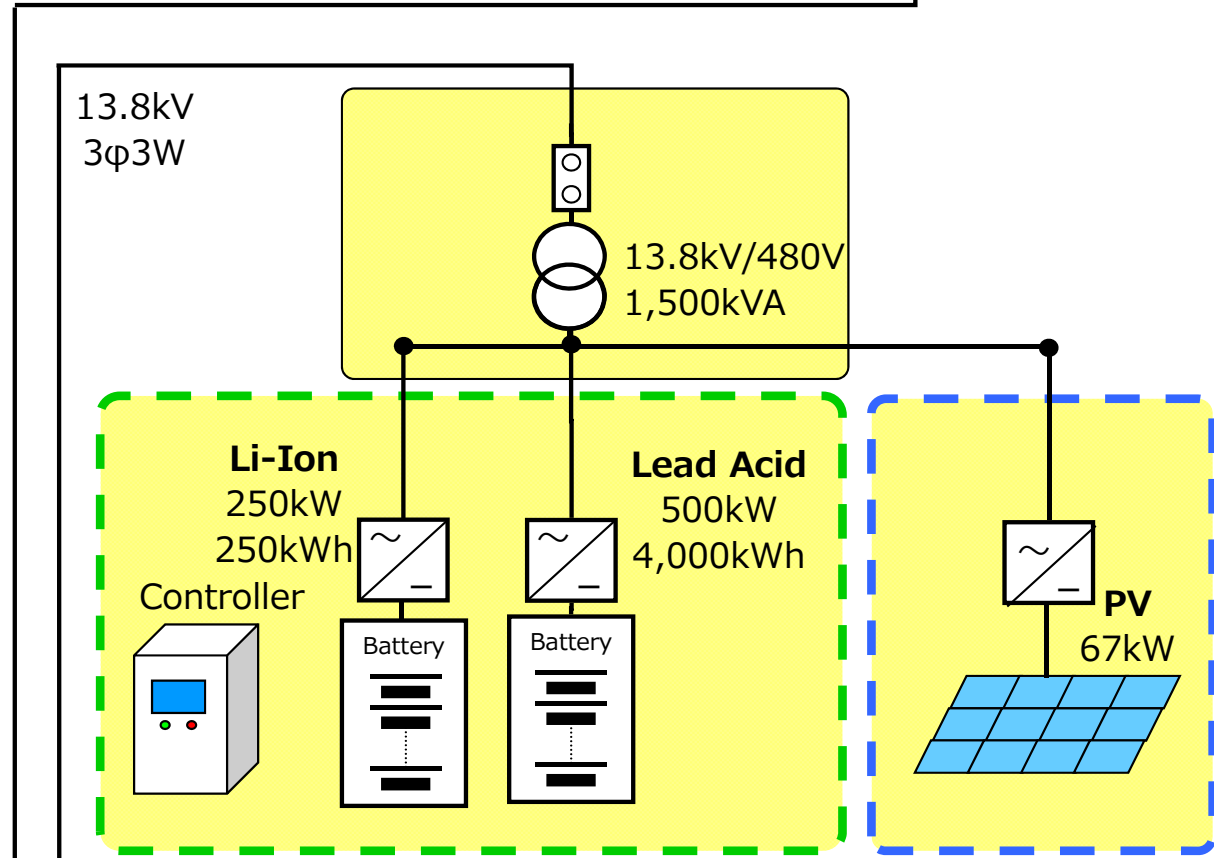
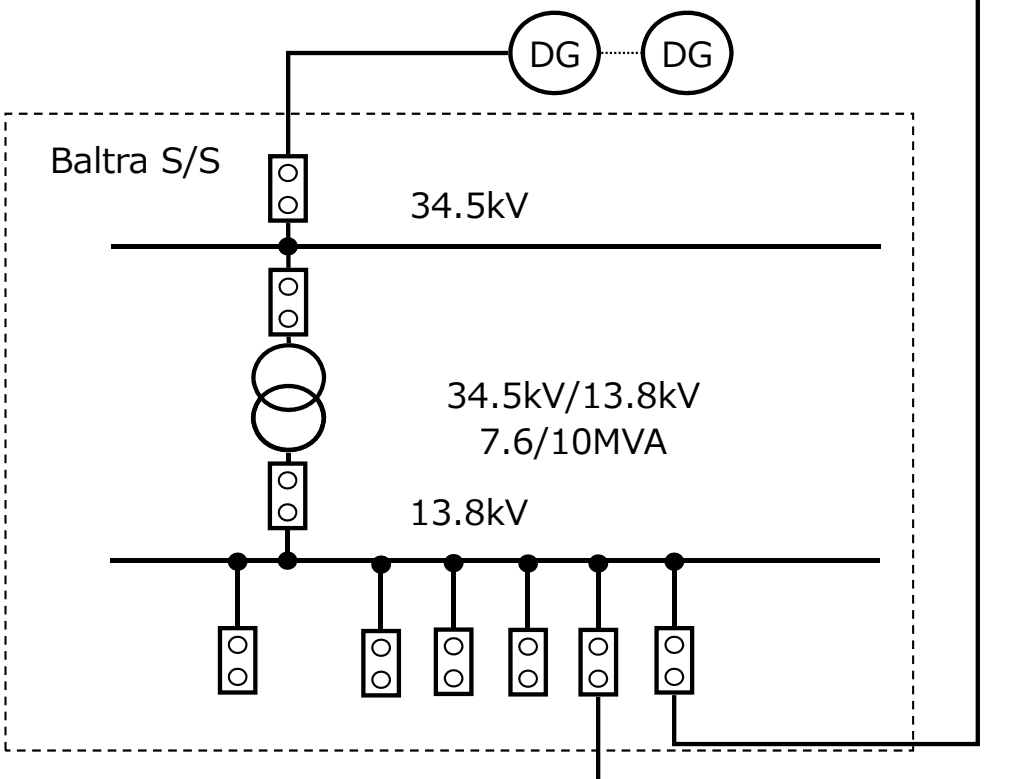
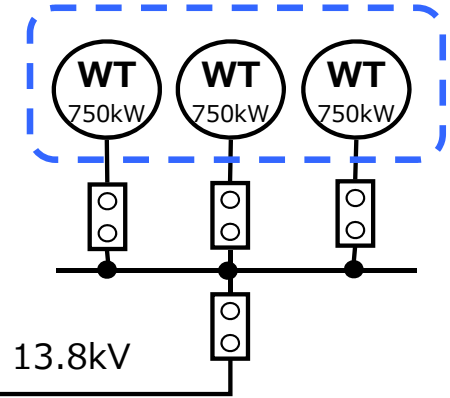
## 1. Multiple number of renewable energy generators

- Secure stable clean energy generation

## 2. Peak-shifting & Power stabilizer by hybrid ESS

- Stem to stern use of clean energy

## Maximize the use of clean energy in Galapagos



## Small / Micro Hydro power generation

- Advantage**
- Completely non-polluting source of energy.
  - Lower operational cost compared to fossil fuel-based generation plants.
  - Stable and foreseeable power can be achieved. (High equipment utilization)
  - Long life time more than 40 years with suitable maintenance.

- Disadvantage**
- Building a dam affects the environment and wildlife and causes a lot of pollution.
  - Relatively high civil cost.
  - Long term installation period from planning to commercial operation.

- Our strength**
- Established technology from small and micro to large hydraulic plant.

- Current aspect**
- Higher installation ratio with 30% to potential.

- Our solution**
- Small and Micro hydraulic generating system (around 10kW -20MW).

## Biomass generation

- Advantage**
- Significant contribution to the environment conservation by the use of waste.

- Disadvantage**
- Difficulty in stable procurement of bio-fuel.
  - Higher total system cost inclusive of total fuel management consist of procurement, distribution, management.

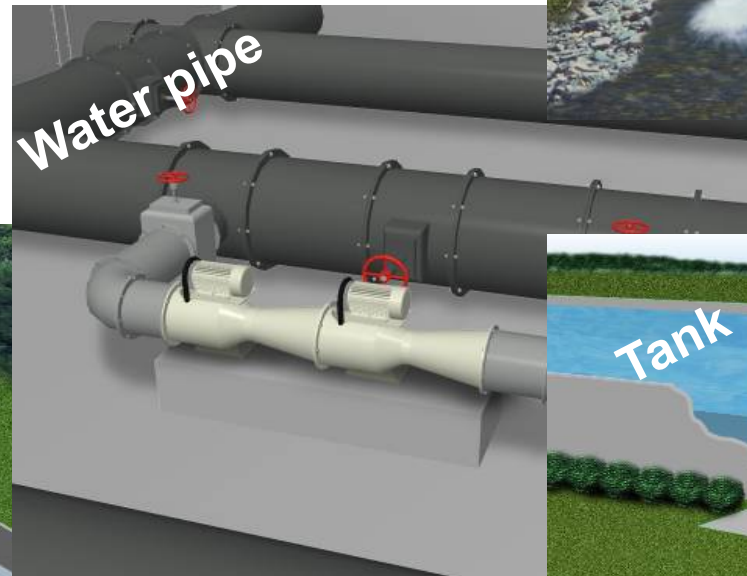
- Our strength**
- A few order receiving record in both Japan and world.

- Current aspect**
- Rich biomass fuel resource such as palm oil, natural rubber, coconuts.

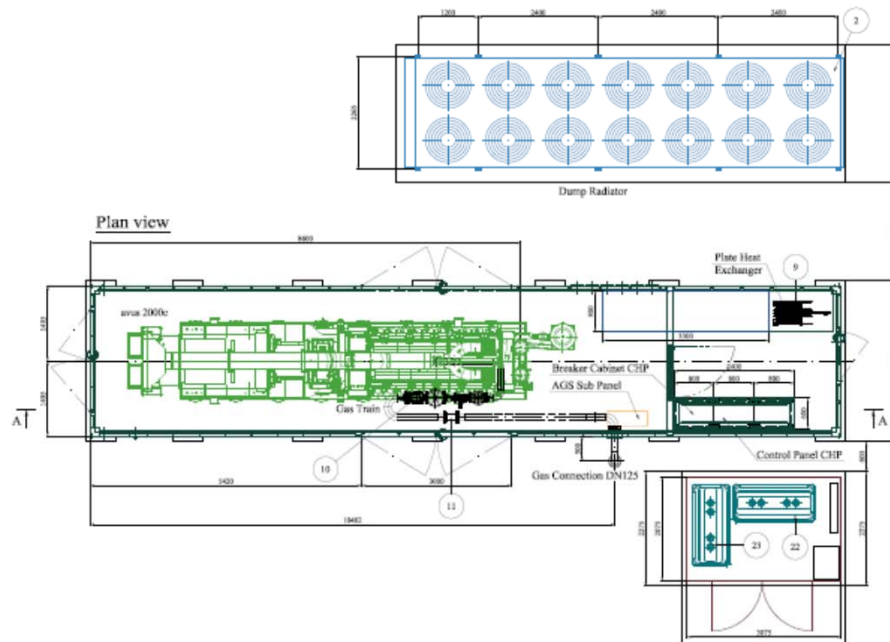
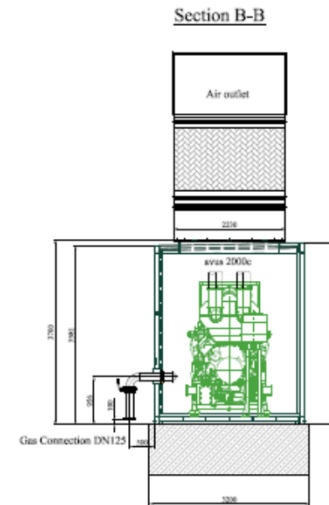
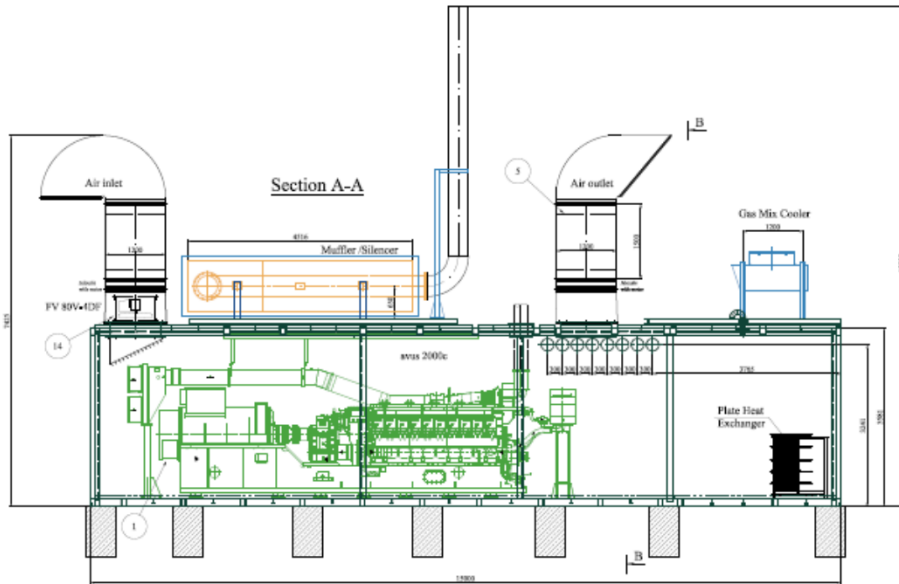
- Our solution**
- Gas engine co-generation system using biogas.

# Fuji Electric micro tubular turbine

1. High performance waterwheel
2. Wider application range
3. High efficiency timing belt
4. Easy maintenance



# Fuji Electric Co-generation gas engine





**FE** Fuji Electric  
*Innovating Energy Technology*

