



Status of Microgrid R&D in Thailand

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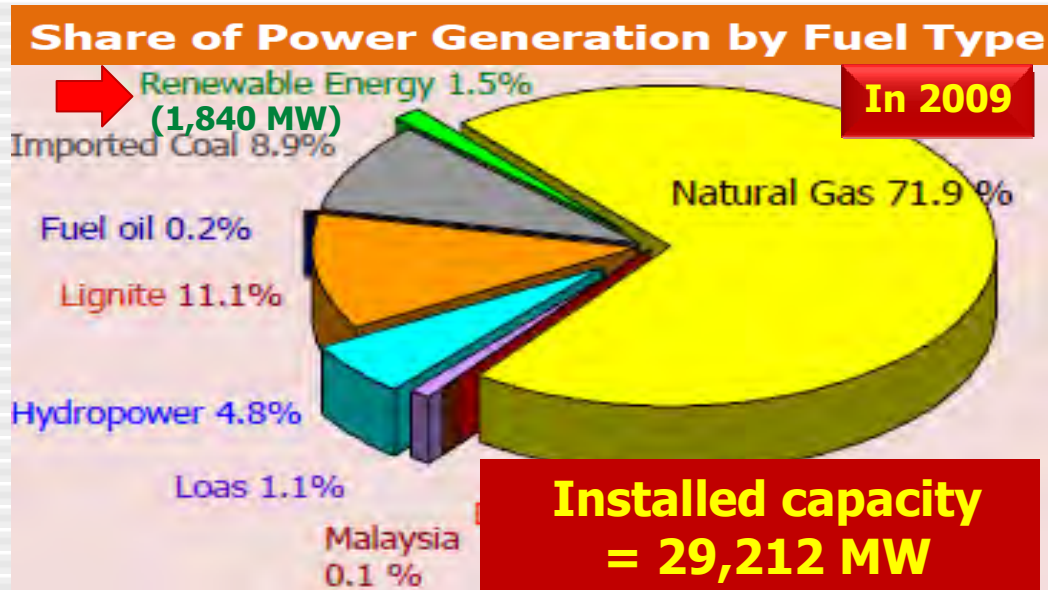
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**Vancouver 2010 Microgrid Symposium on Microgrid
Vancouver, BC, Canada
July 21-22, 2010**

Outline

- ✓ Overview of renewable energy situation and plan
 - High potential renewable energy resources
 - 15 years renewable energy development plan
- ✓ Microgrid R&D projects
 - Thailand & Japan cooperative projects
 - Thai government projects
 - University research
- ✓ Summary

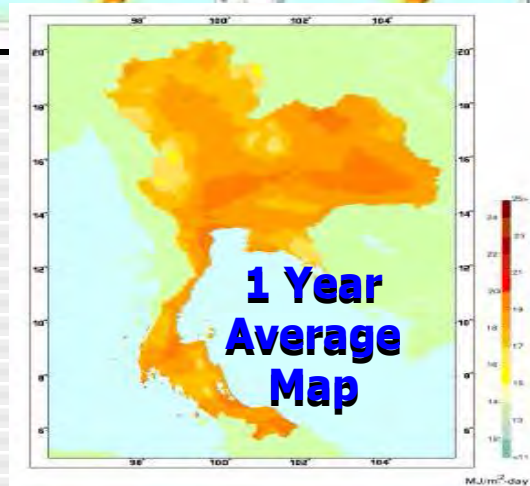
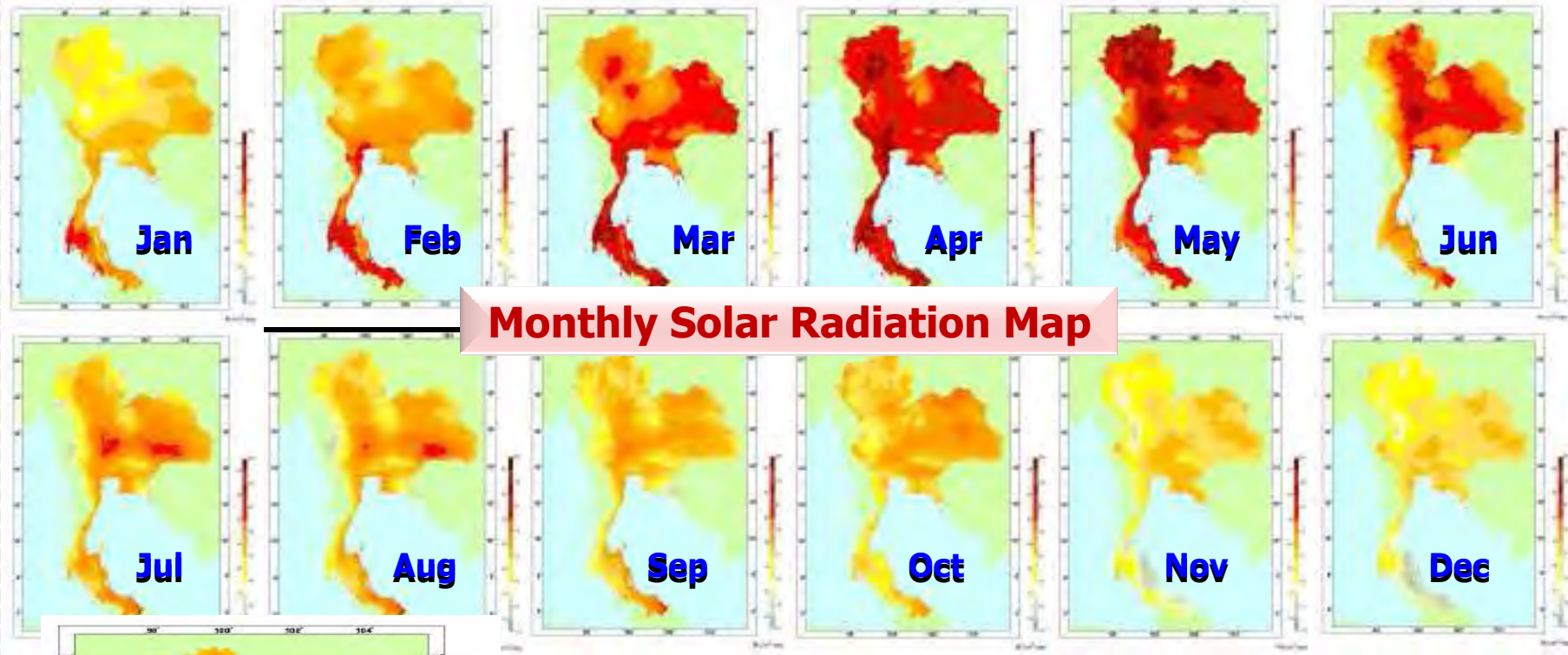
Thailand & Power Generation from Renewable Energy



GOAL

"To increase a share of power generation capacity from renewable energy to be 5,608 MW of total fuels in 2022"

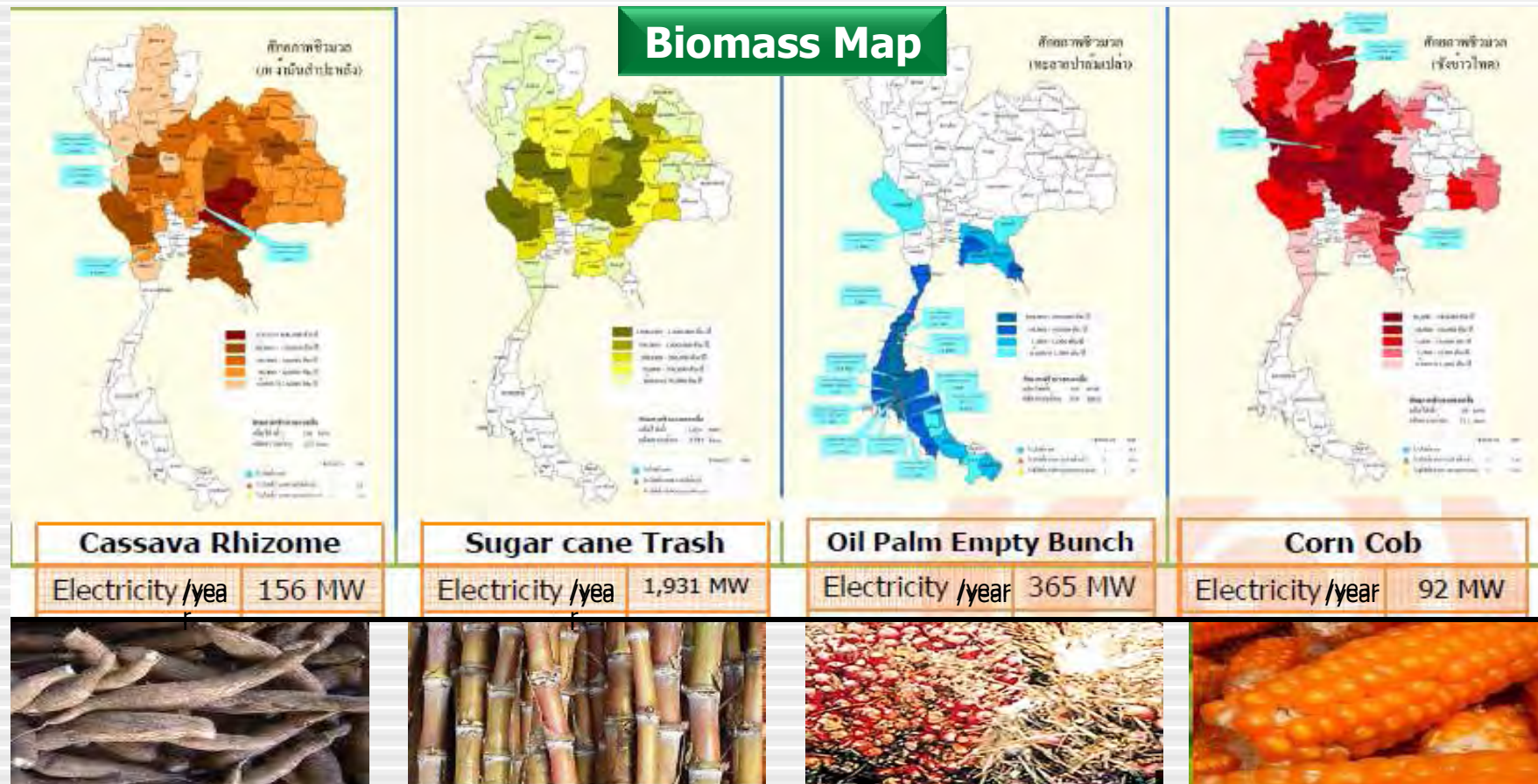
High Potential Renewable Energy ~ Solar Energy ~



- ✓ Thailand has a good condition of irradiation all over the country.
- ✓ The yearly average daily solar radiation is 18.2 MJ/m²/day or 5.05 kWh/m²/day.

➔ *High potential of solar energy.
In 2009, power generation capacity from
photovoltaic system ~ 39 MW.*

High Potential Renewable Energy ~ Biomass Energy ~

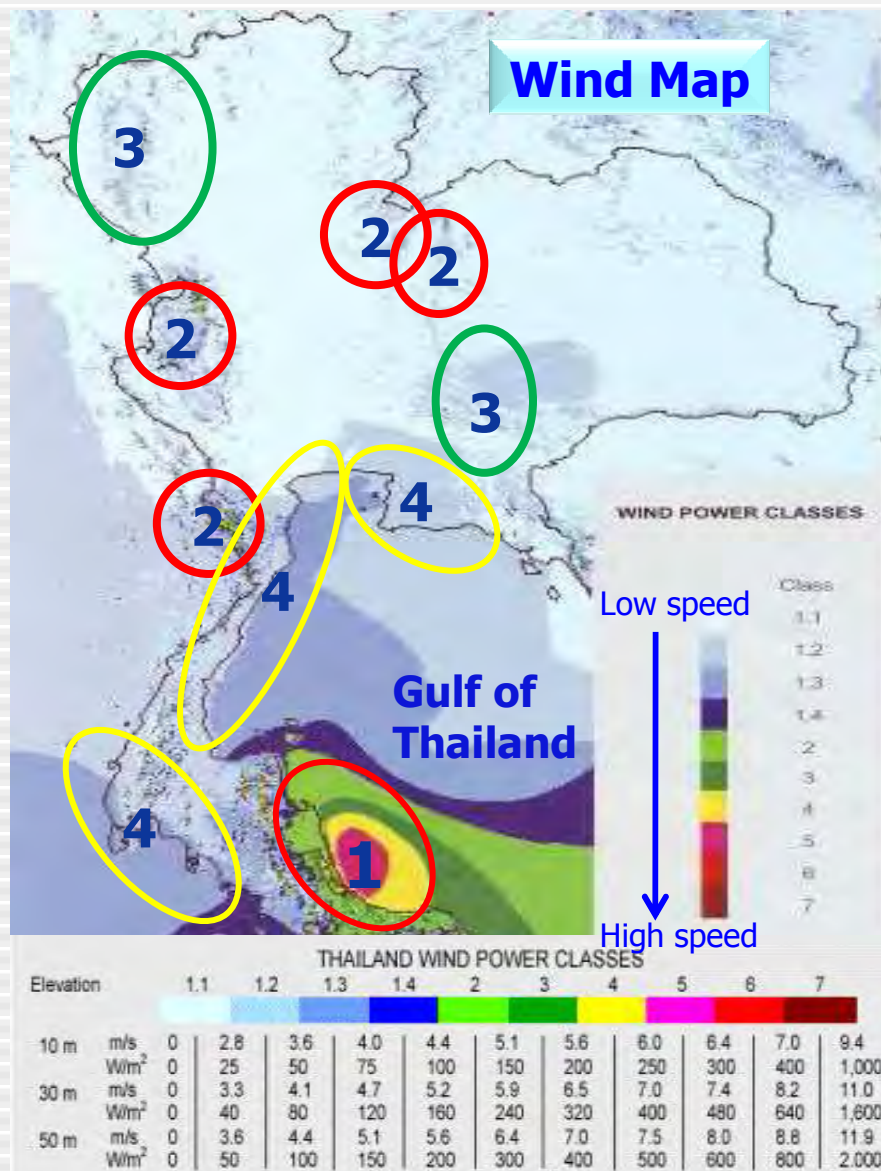


- ✓ Since Thailand is an agricultural-based economy, there are various resources of agricultural wastes and by-products that can recycle into energy.

➔ **High potential of biomass energy**
In 2009, power generation capacity from biomass ≈ 1,644 MW.

High Potential Renewable Energy

~ Wind Energy ~



Wind Speed at 50 m height

- No. 1 The eastern coastline of the southern part of the gulf of Thailand ,
Wind Speed = 6.4 m/s
- No. 2 Hill and Mountain
Wind Speed = 5.6 m/s
- No. 3 Top of Mountain
Wind Speed = 5.1 m/s
- No. 4 Coastal area
Wind Speed = 4.4 m/s

➡ ***Highest potential in area No. 1.***
In 2009, wind power generation capacity ≈ 5 MW.

15 Years Renewable Energy Development Plan for Power Generation (2008-2022)

Type	Potential	Existing 2009	Target 2022
Power Generation	MW	MW	MW
Solar Energy	MAX > 50000	39	500
Wind Energy	1,600	5	800
Hydro Power	700	67	324
Biomass	4,400	MAX 1,644	MAX 3,700
Biogas	190	80	120
Solid Waste	400	6	160
Hydrogen			3.5
Total		1,840	5,608

- Notes
1. The maximum potential of renewable energy is *Solar Energy*.
 2. In 2009, the maximum capacity of renewable energy is *Biomass*.
 3. In 2022, the maximum target of installation is *Biomass*.

National Policy To encourage electricity production from renewable energy, particularly from small scale electricity generating projects.

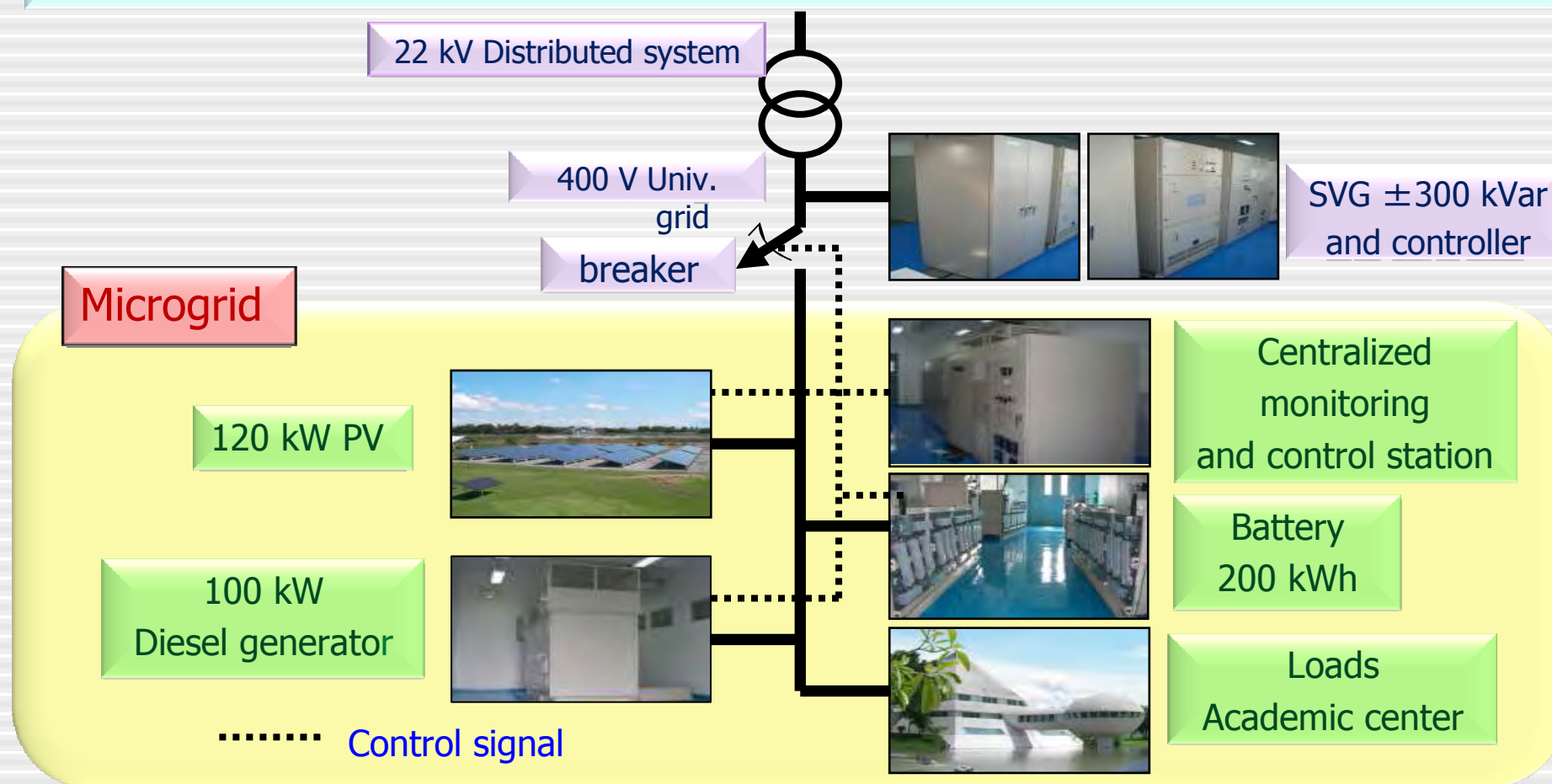
➡ High opportunity for MICROGRID Projects

Project 1 Thailand & Japan Cooperative Demonstration Project for Microgrid Stabilization, Energy Park, Northern Thailand



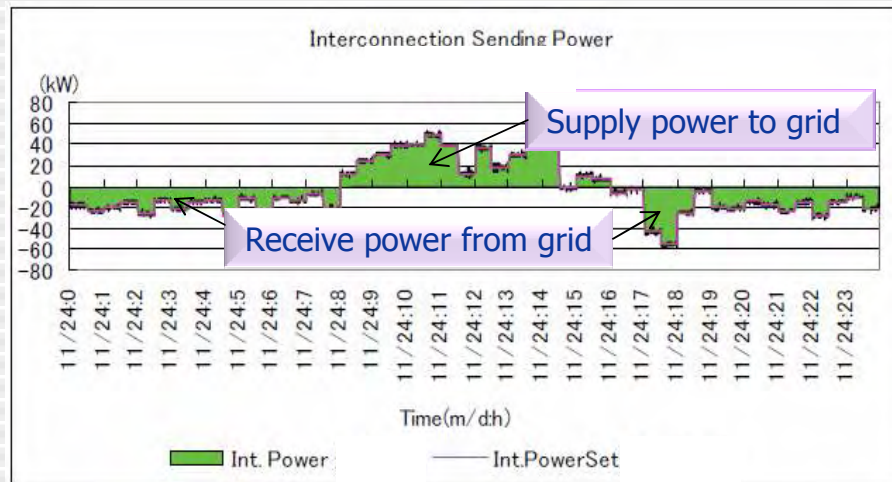
Objective

To stabilize power fluctuations in microgrid due to photovoltaic and loads in both grid-connected and stand-alone operations.

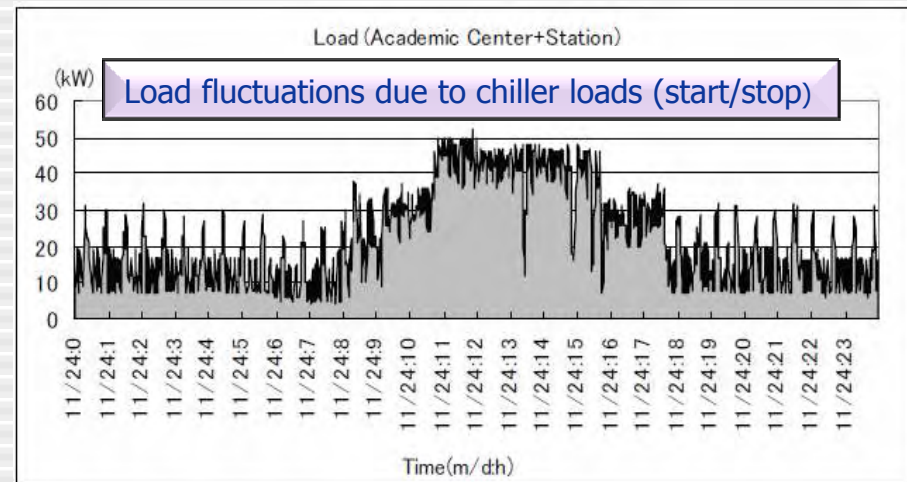


One Day Monitoring Results

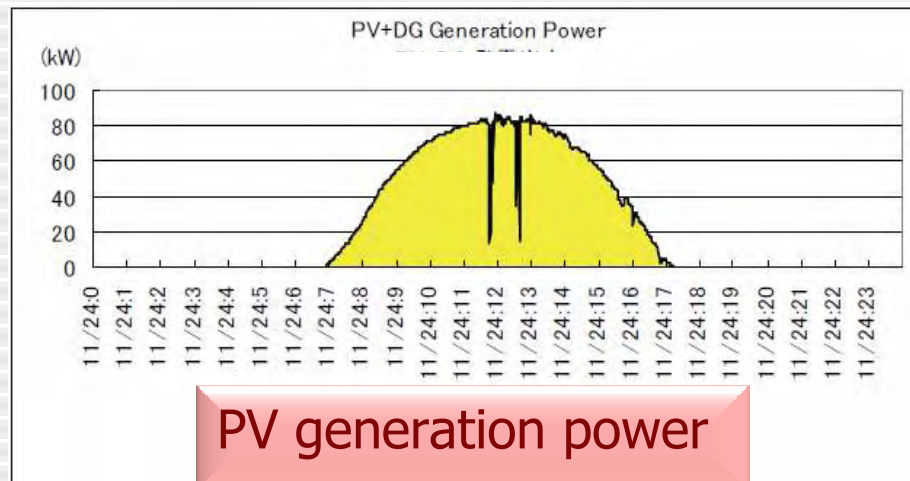
Normal operation of grid-connection



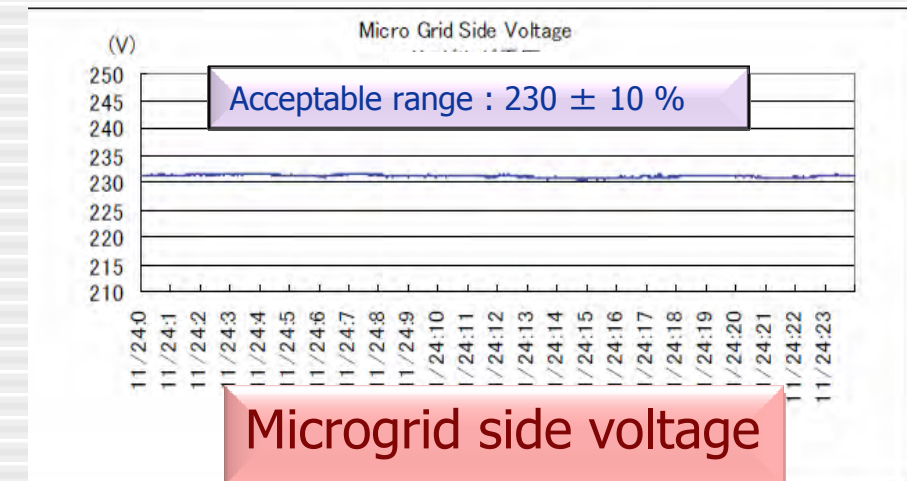
Interconnection sending power



Load demand power



PV generation power

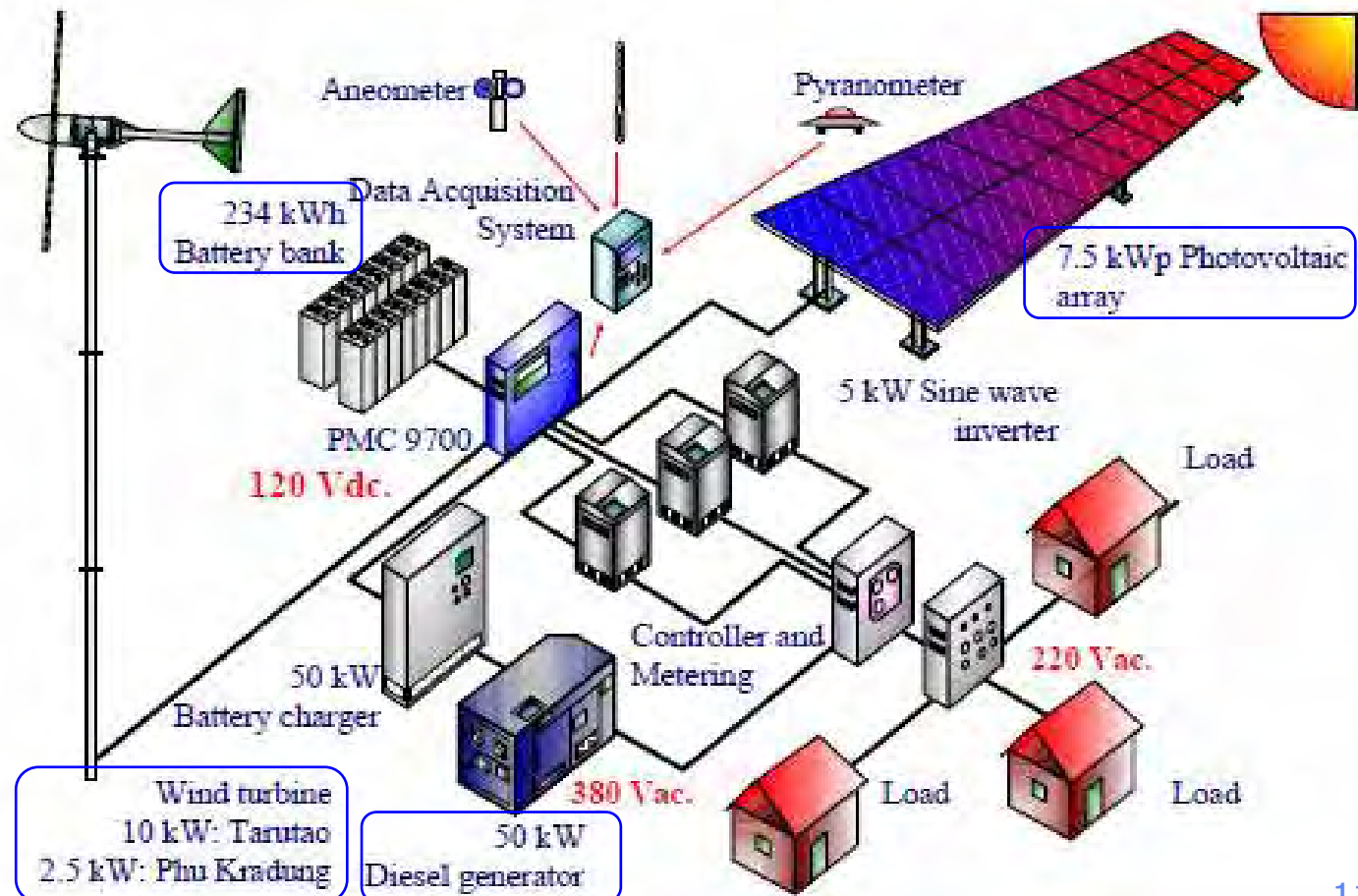


Microgrid side voltage

Project 3 Isolated PV/Wind/Diesel Hybrid Microgrid ~ Three National Parks ~

Objective

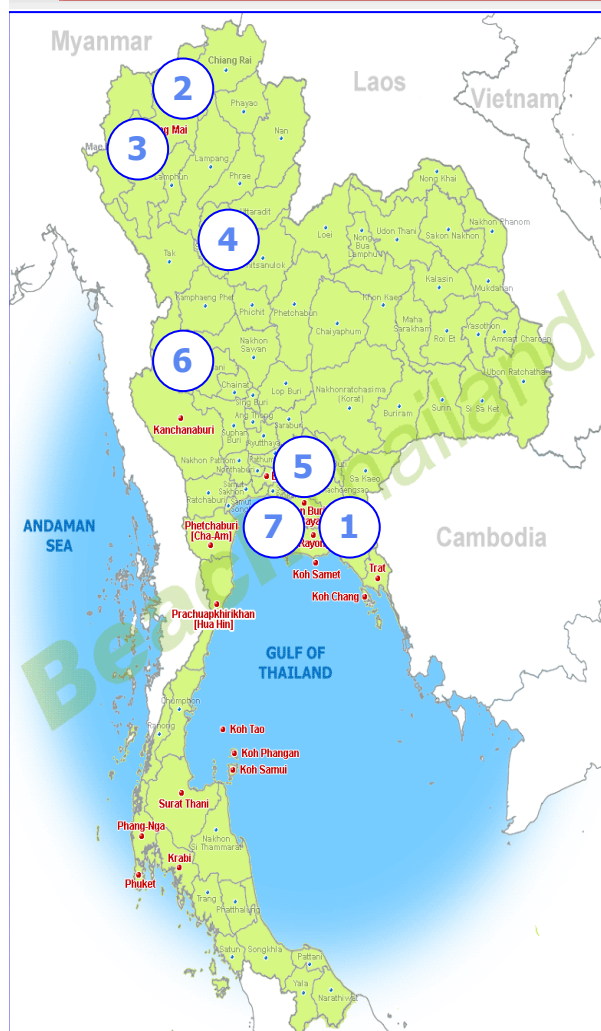
1. To supply electricity in the remote areas without power grid access.
2. To design, install, test and evaluate an isolated microgrid with hybrid power generations.



Other Microgrid Projects by Thai Government

Common Point

1. To supply electricity to rural areas without power grid access.
2. Each project is an isolated microgrid with PV-diesel based hybrid system.



Location of sites

Description/Capacity

- | | |
|--|---|
| 1. Kohjig project,
Chataburi Province | PV/wind/diesel hybrid system
7.5 kW PV, 10 kW wind, 65 kVA gen. |
| 2. Doi Intanon Royal Project,
Chiang Mai Province | PV/diesel hybrid system
0.6 kW PV, 5.25 kVA gen. |
| 3. Wat Chan Royal Project,
Chiang Mai Province | PV/diesel hybrid system
0.6 kW PV, 5.25 kVA gen. |
| 4. Kirimas Project,
Sukothai Province | PV/diesel hybrid system
2 kW PV, 5 kVA gen. |
| 5. Tha Takiab Project,
Cha-choeng Sau Province | PV/wind/diesel hybrid system
1.1 kW PV, 0.8 kW wind, 3kVA gen. |
| 6. Huai Kha Khaeng Project,
Uthai Thani | PV/diesel hybrid system
10.5 kW, 42 kVA gen. |
| 7. Lan Island Project,
Chonburi | PV/wind/diesel hybrid system
60 kW PV, 200 kW wind, 500 kVA gen. |

University Research 1

~ Energy Park, Naresuan Univ., Northern Thailand ~



Demonstration of Photovoltaic



PV Microgrid

Solar thermal applications

- / Flat plate solar hot water heater
- / Evacuate tube solar hot water heater
- / Solar herbicide extracting system
- / Solar dyer system
- / Solar cooling air condition for office
- / Solar cooling for agriculture product

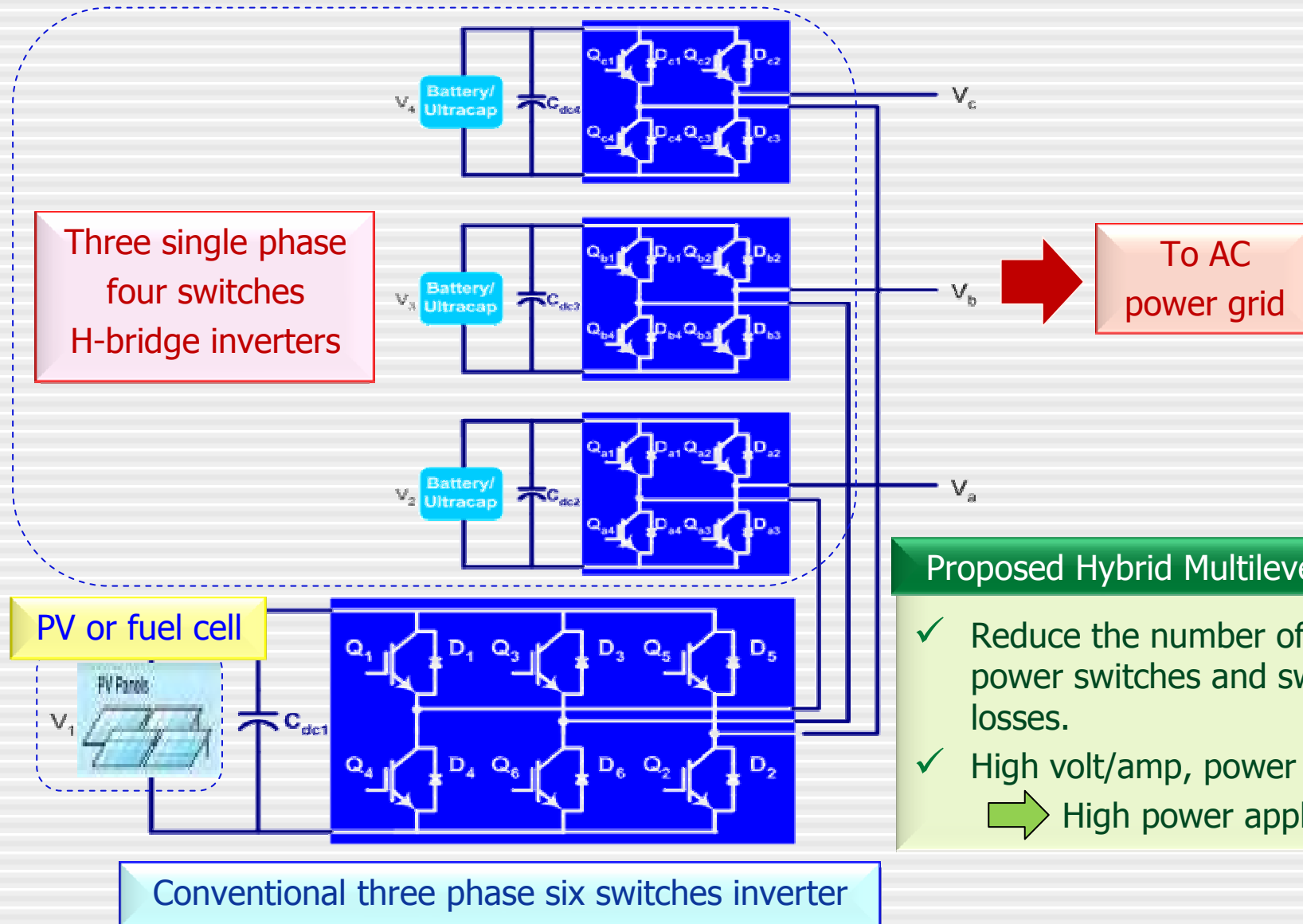
Testing systems

- / Outdoor PV module testing system
- / Outdoor collector testing system

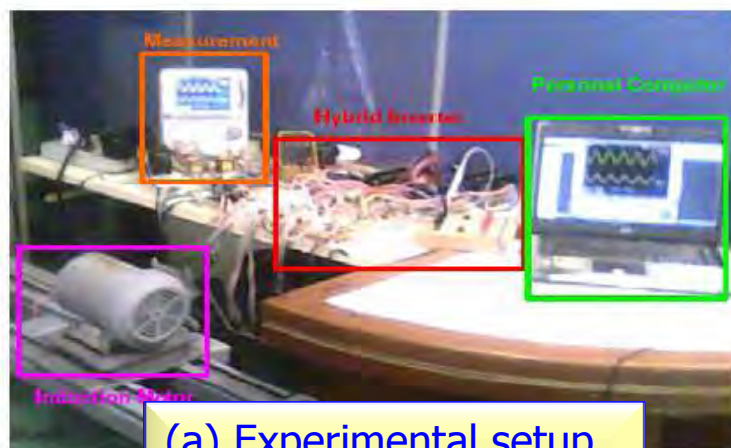
From
<http://www.sert.nu.ac.th/>

Solar electricity applications

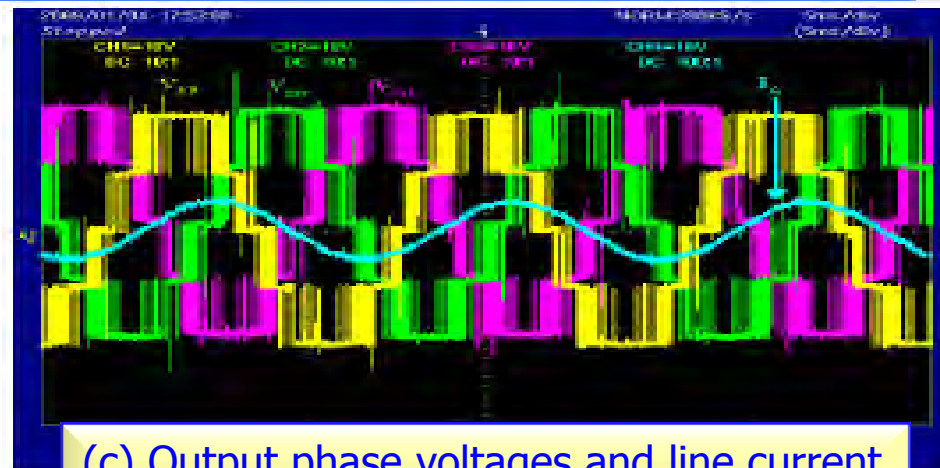
- / 600 W PV water pumping for the necessities of life
- / 600 W drip irrigation PV water pumping
- / 1.3 kW PV water pumping
- / 7.2 kW PV solar water aerator
- / 150 W PV water pumping for fog nozzles system
- / 75 W solar home system
- / 150 W solar home system
- / PV-diesel hybrid system
- / PV fountain system
- / PV public lighting
- / PV communications
- / 10 kW PV stand alone system
- / 2 kW PV battery charging
- / 3 kW PV grid connected
- / PV electric fence system for cattle
- / PV insect trap system



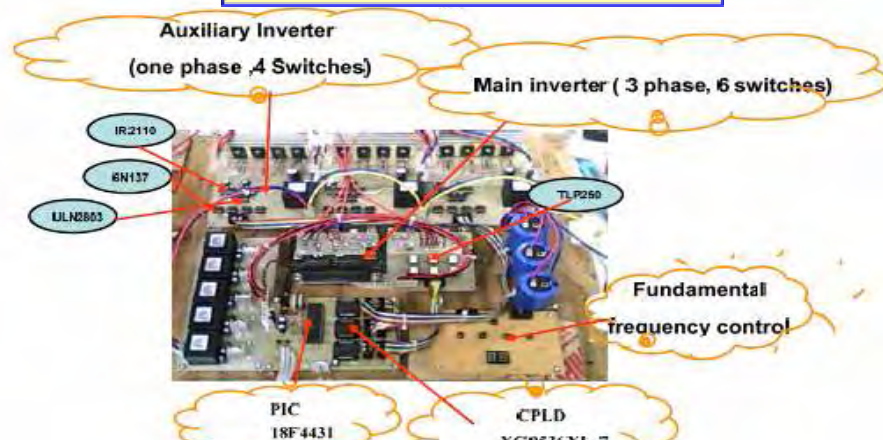
3-kW Prototype Hybrid Cascaded Multilevel Inverter



(a) Experimental setup



(c) Output phase voltages and line current



(b) Proposed hybrid multilevel inverter



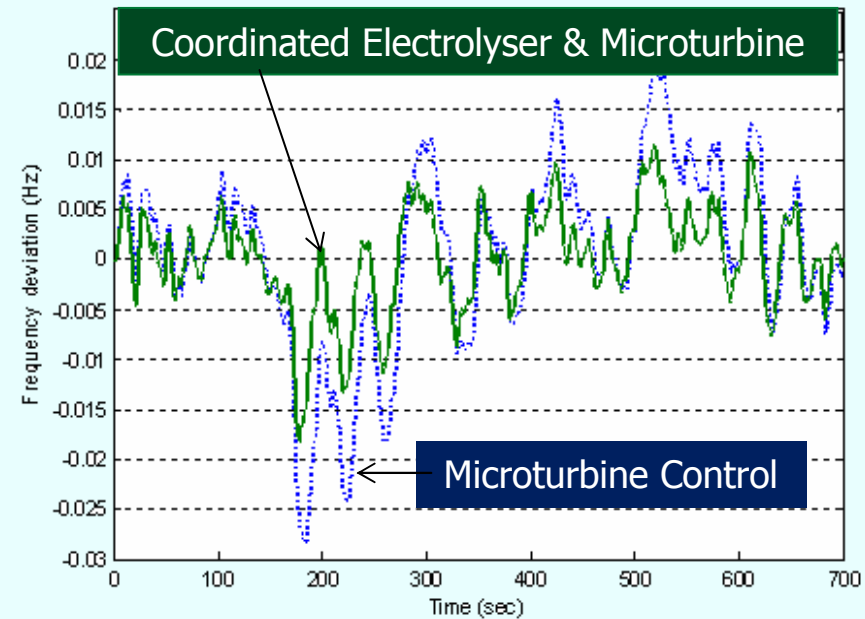
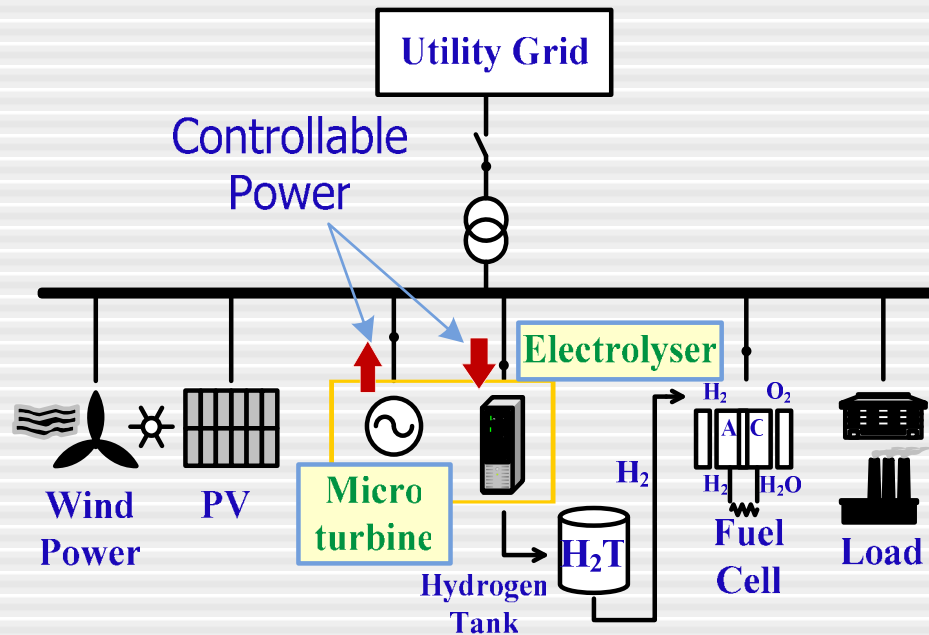
(d) Output voltage of inverters, line current

Reference S. Khomfoi and N. Praisuwanna, " A Hybrid Cascaded Multilevel Inverter for Interfacing with Renewable Energy Resources ", International Power Electronics Conference (IPEC2010), June 21-24, 2010, Sapporo, Japan



University Research 3

Alleviation of Frequency Fluctuation in a Microgrid by Coordinated Control of Electrolyser and Microturbine



Control Concept

- ✓ The intermittent power generation from wind and PV causes frequency fluctuation.
- ✓ The electrolyser absorbs power from the system to produce the hydrogen input for fuel cell.
- ✓ Based on the coordinated control of the power absorbed by electrolyser and the power supplied by microturbine, the frequency fluctuation can be alleviated.

Reference S. Vachirasricirikul, I. Ngamroo and S. Kaitwanidvilai , "Application of electrolyzer system to enhance frequency stabilization effect of microturbine in a microgrid system. *International Journal of Hydrogen Energy*, Vol. 34, Issue 17, September 2009, pp. 7131-7142.

Summary

- ✓ Thailand renewable energy situation and plan
 - Abundant supply of resources, especially solar & biomass
 - 2022 target of renewable energy capacity for electricity generation is 5,608 MW (In 2009 = 1,840 MW)
 - High opportunity for future microgrid projects
- ✓ Microgrid R&D projects
 - Thai-Japan cooperative projects
 - Advanced technology from Japan
 - Thai government projects
 - Isolated microgrid for rural areas without power grid access
 - Hybrid PV-diesel generation system
 - University projects
 - Ongoing



Thank you for your attention

