Energy Management Action Network (EMAK)
Workshop 8
Energy Management Best Practice

Realization of Sustainable Energy by Smart Campus

3rd February 2017

Masaaki Bannai
Mie University

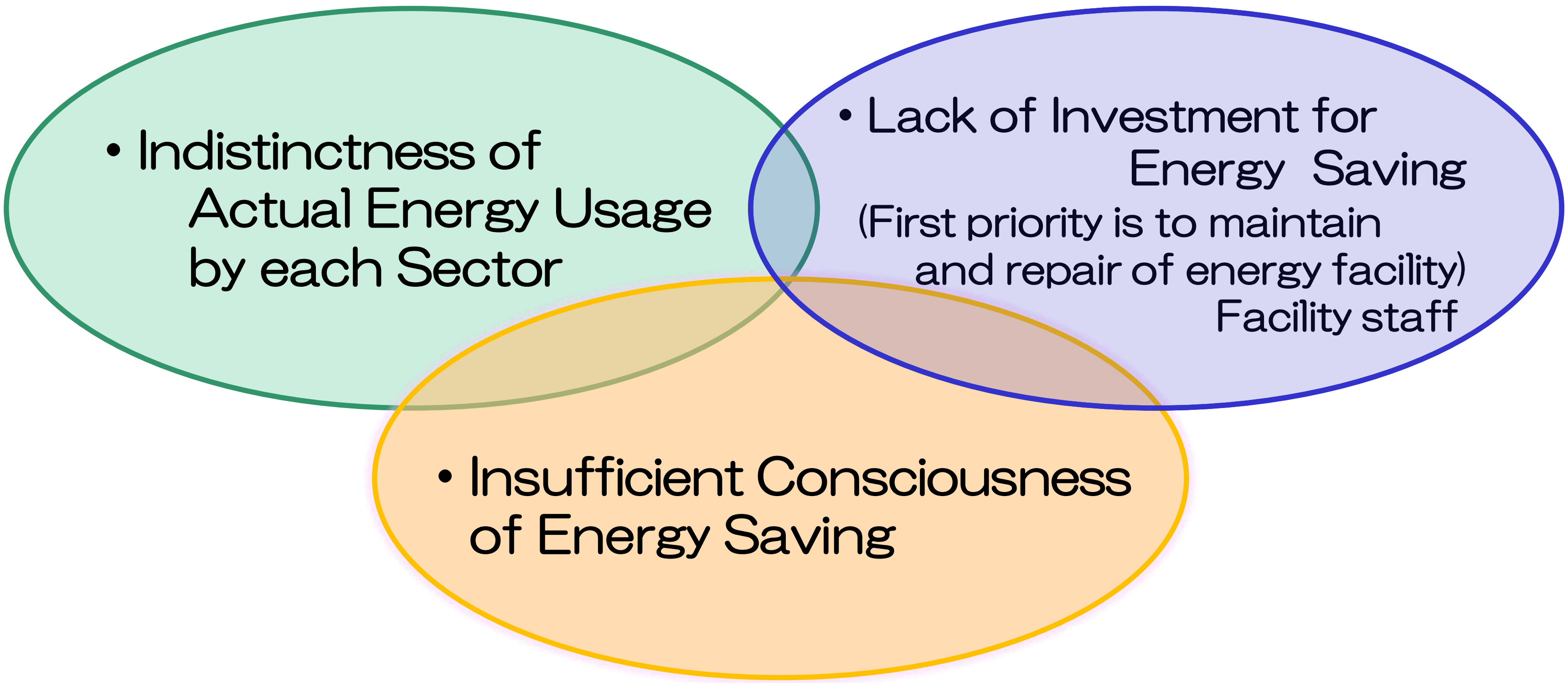
Contents

Toward Smart Energy in Campus

Regional Warming Suppression by Smart Campus

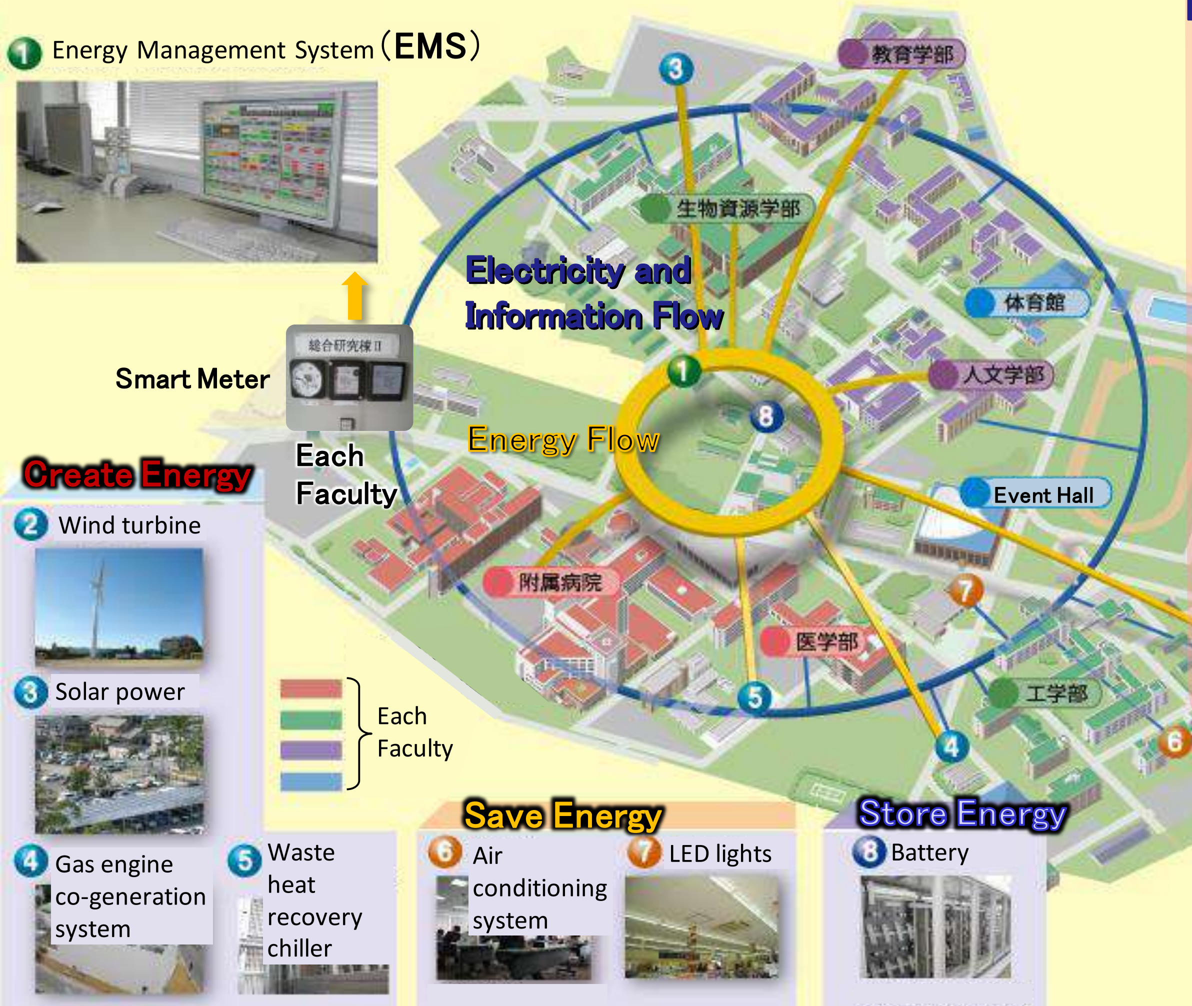
Theses on Promoting Energy Saving at University

Goal： Be Proud of Environmentally Advanced University to the World



Aiming at an Environment ally Advanced University

Systems Configuration of MIESC



【Target】

1. CO_2 Reduction Rate 24%
2. Expand Smart System to Others

Overview of Mie University (2015)

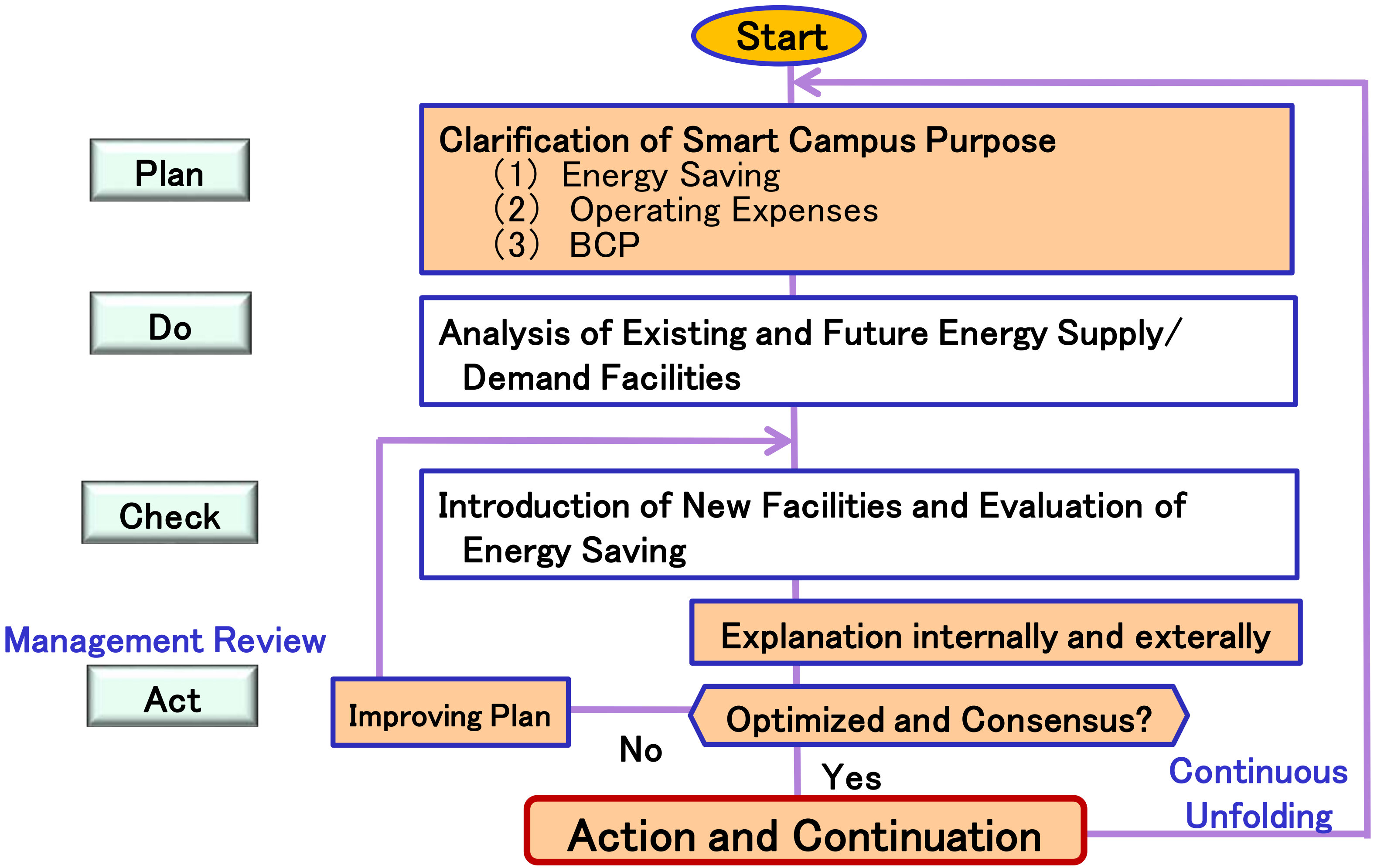
Site Area	:	528,040	m^2
Total Floor Area	:	314,539	m^2
No.of Students	:	7,297	persons
No.of Faculty and staff	:	1,877	persons
Total members	:	9,174	persons

Annual Energy Consumption (2014)

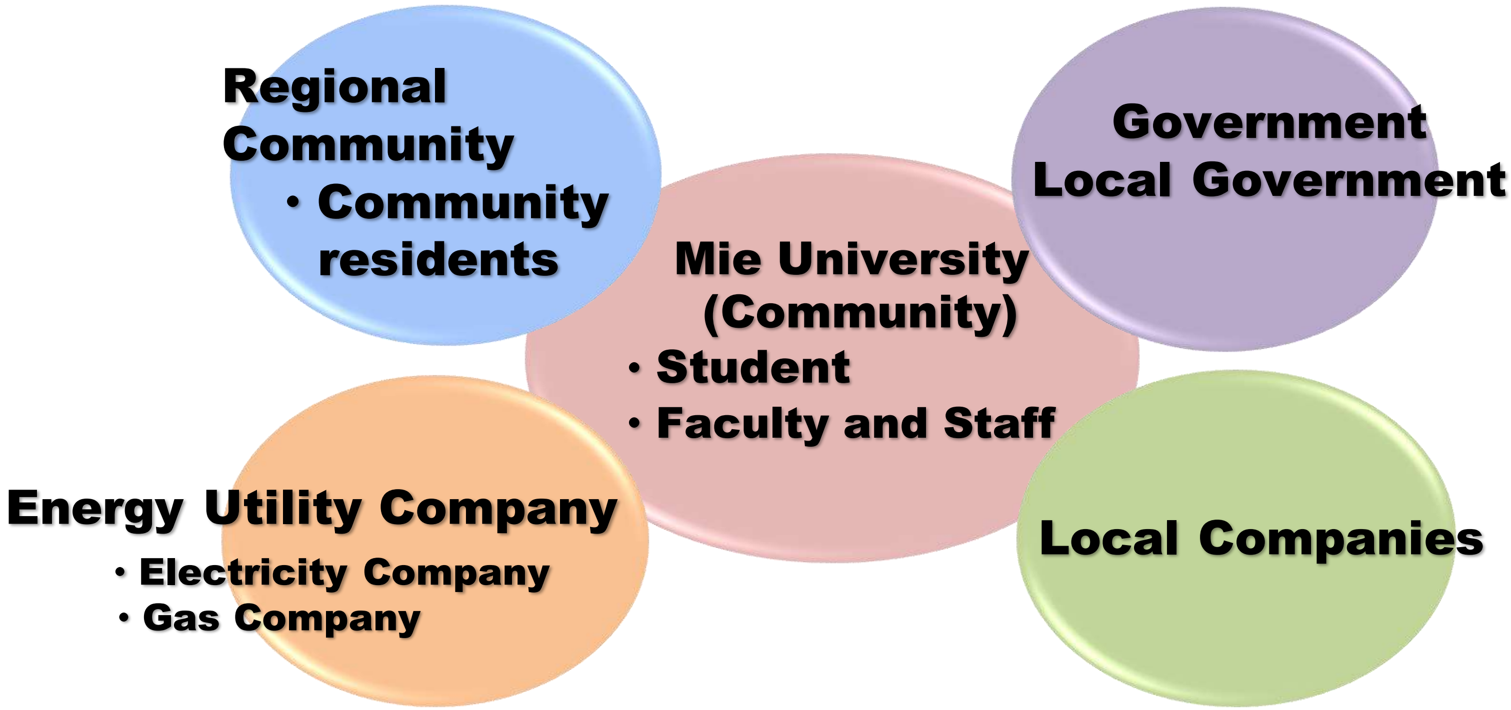
Electricity	41 .0	GWh
City Gas	4,635	km^3
Heavy Oil-A	424	kℓ
CO_2 Emission	23,458	t-CO_2

PDCA Cycle Execution toward Smart Campus

Execution of CO_2 Reduction Plan by Means of PDCA Cycle



Aim for Realization of Smart Campus and Related Stakeholder



1. A Feasibility Study with Renewable Energy / Energy Saving Facilities
   - ◆ Energy Saving Ratio
   - ◆ Allotment of large/small independent power

2. Collaboration with Demand and Supply Side
   - ◆ Abrupt Fluctuation of Renewable Energy
   - ◆ Leveling of Electricity

Proposal of Smart Community

Purposes

1. Utilization of
   - Sustainable Energy (Solar and/or Wind Power)
   - high efficient co-generation
2. CO_2 Reduction emitted from Institute/University
3. Stable Energy Supply
   under Normal Condition and
   Independent Power Supply in case of a natural disaster

Energy Creation with less CO_2 emission

- Solar Power
  Photovoltaic (PV)
- Co-Generation

Energy Management System (EMS)

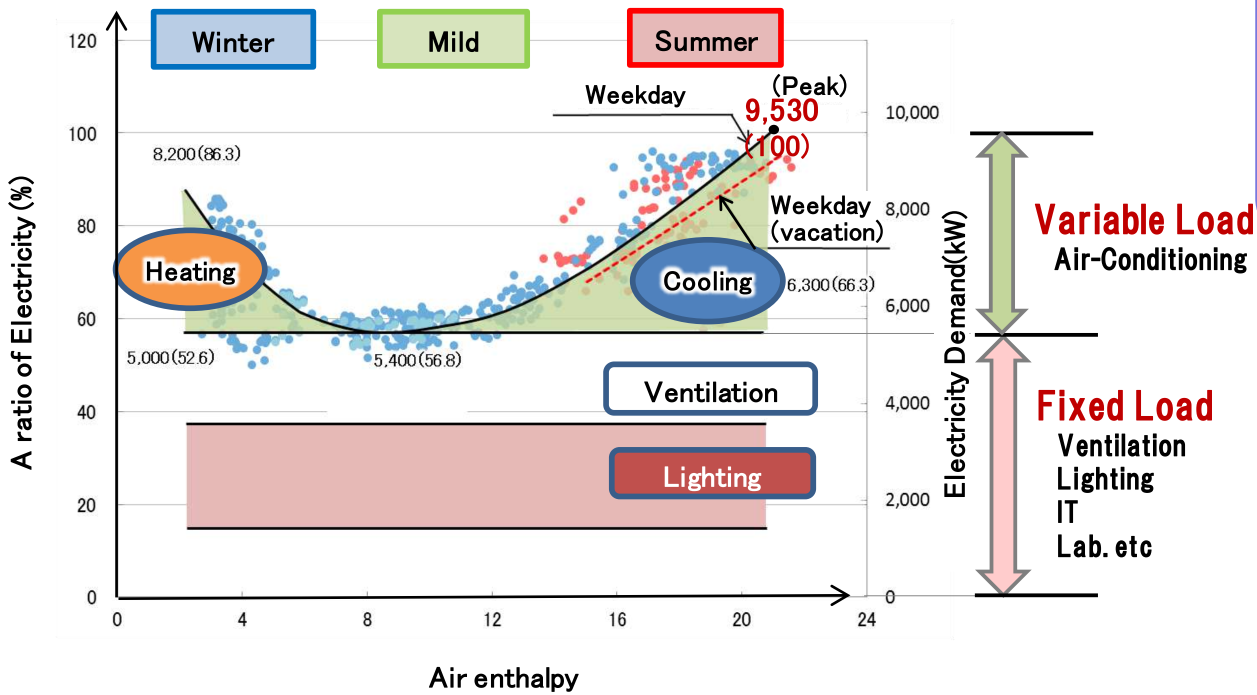
- Peak Shaving
- Stable Supply
  - Demand Forecast
  - Optimum Operation
  - Storage of Electricity

Energy Saving

- Air-Conditioning System
- LED Lighting
- Waste Heat Recovery Equipment

Decision of Various Measures

Application	Energy	Method
Air-Conditioning	Demand Large (in Summer)	Desiccant
Lighting	Fixed Load, **Operating Hour Long**	Directly use DC



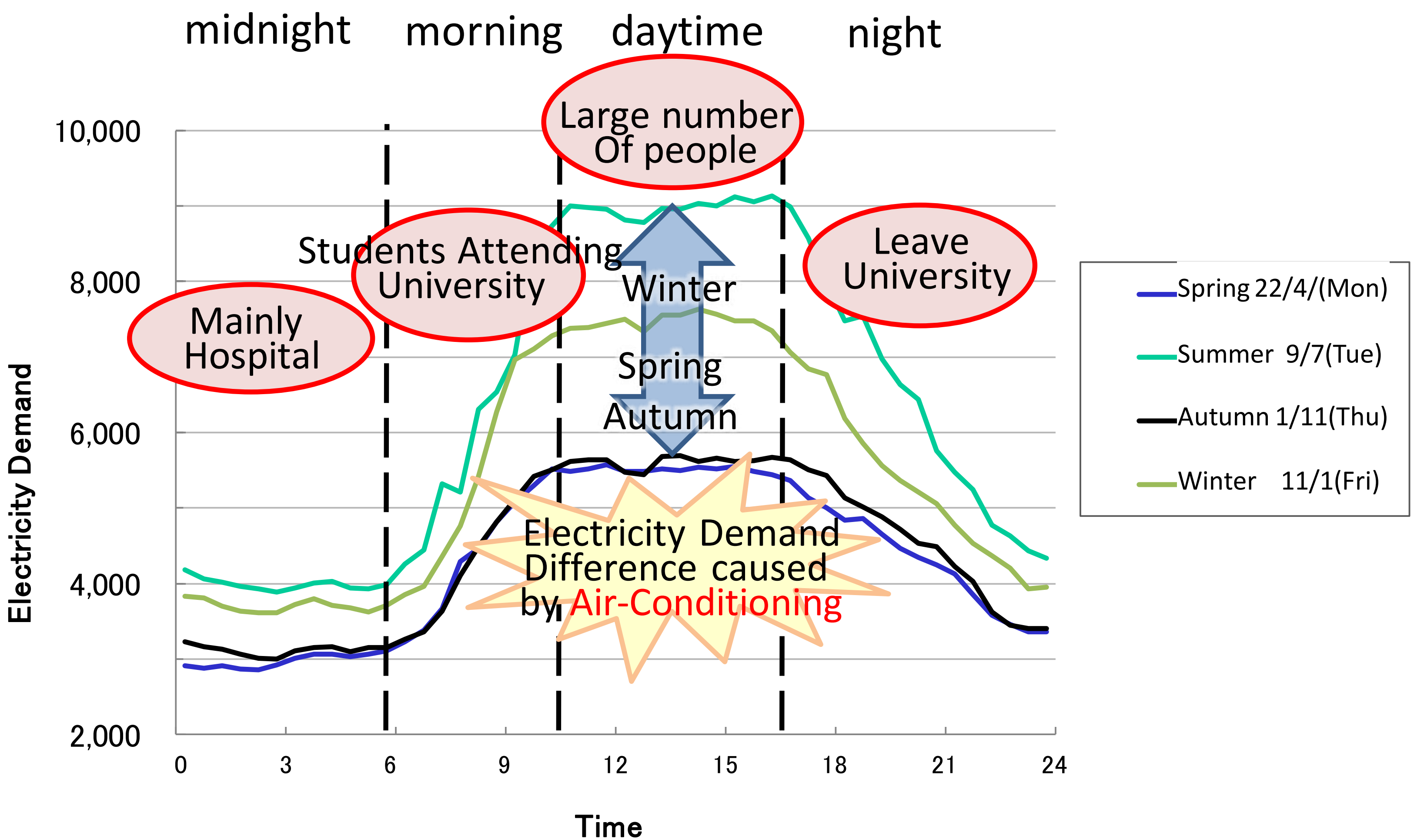
Leading Measure

Energy Saving Air-Conditioning (Desiccant type)

LED Lighting with low energy loss (connected with DC of PV)

Lighting in CVS

Seasonal Electricity Demand



Electricity demand is affected by each season respectively.

Electricity Demand Forecast

daytime（10：30～17：00）

Electricity Demand is affected by ambient air enthalpy and solar radiation.

Electricity Demand [kW]

= **Load by ambient air + Load by solar radiation + Fixed Value + Compensation**

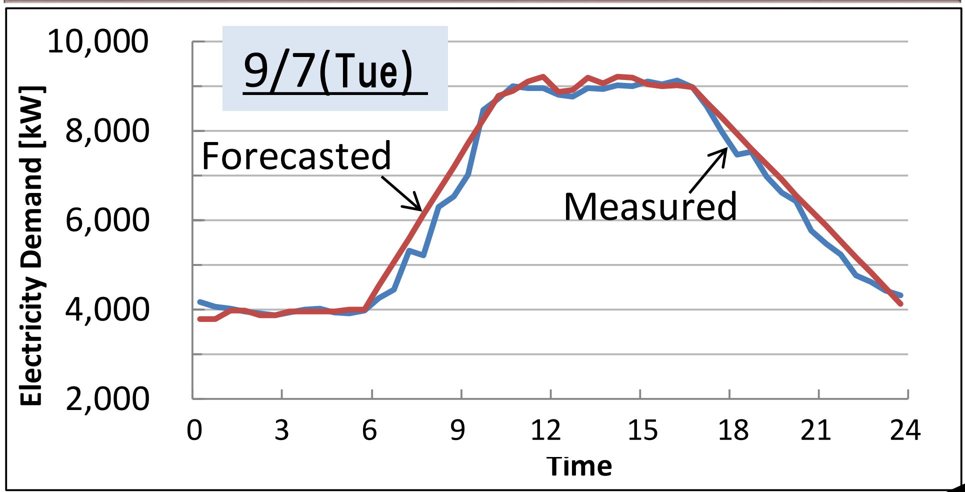
$$= \alpha \cdot h \quad + \quad \beta \cdot SR \quad + \quad \gamma \quad + \quad \sigma$$

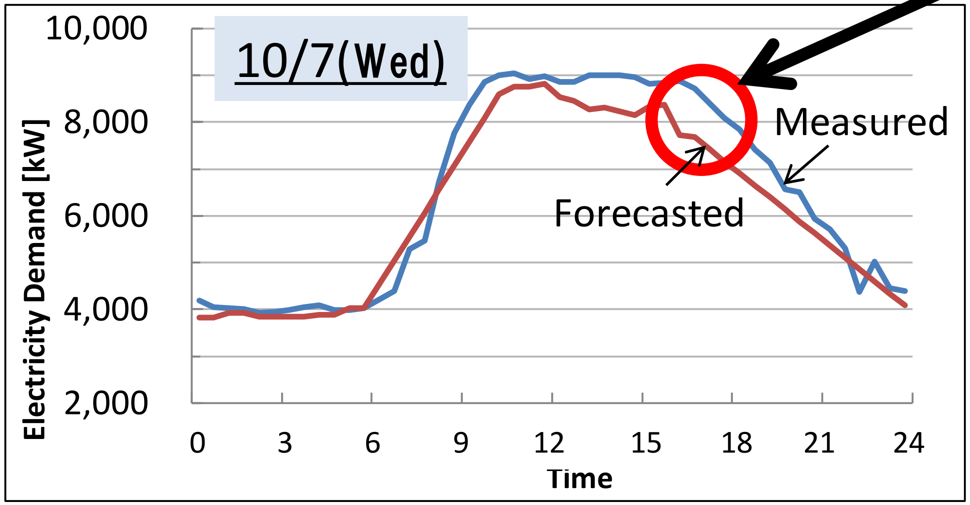
α	:	Air enthalpy coefficient	[kW･kg/kcal]
h	:	Air enthalpy	[kcal/kg']
β	:	Solar radiation coefficient	[m^2]
SR	:	Solar radiation	[kW/m^2]
γ	:	Fixed value	[kW]
σ	:	Compensation (by saving activity)	[kW]

Patent applicated on'13

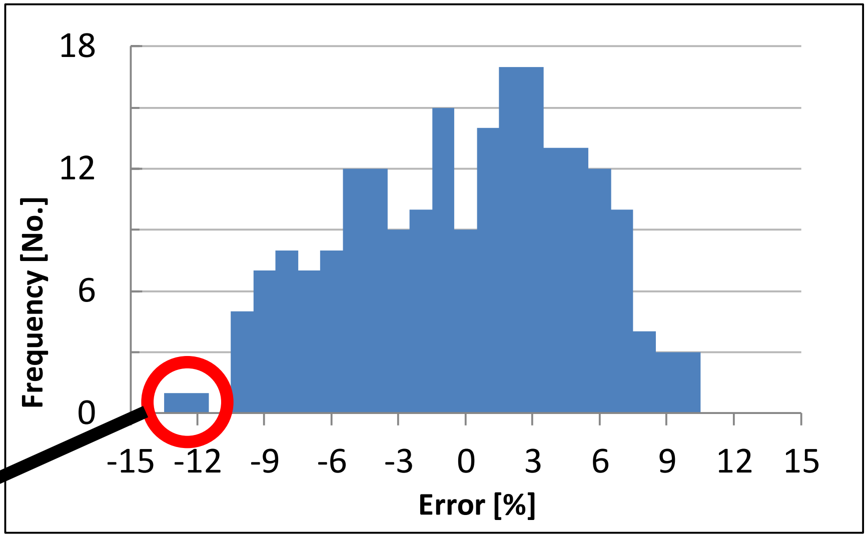
Demand Comparison (Measured and Forecasted)

Comparison between measurement and prediction





Errors



Average RMS Error: Daytime 4.6 %
Nighttime 3.7 %

Preservation of Environment

Countermeasure of Shadow-Flicker and Noise Caused by Wind Turbine (WT)

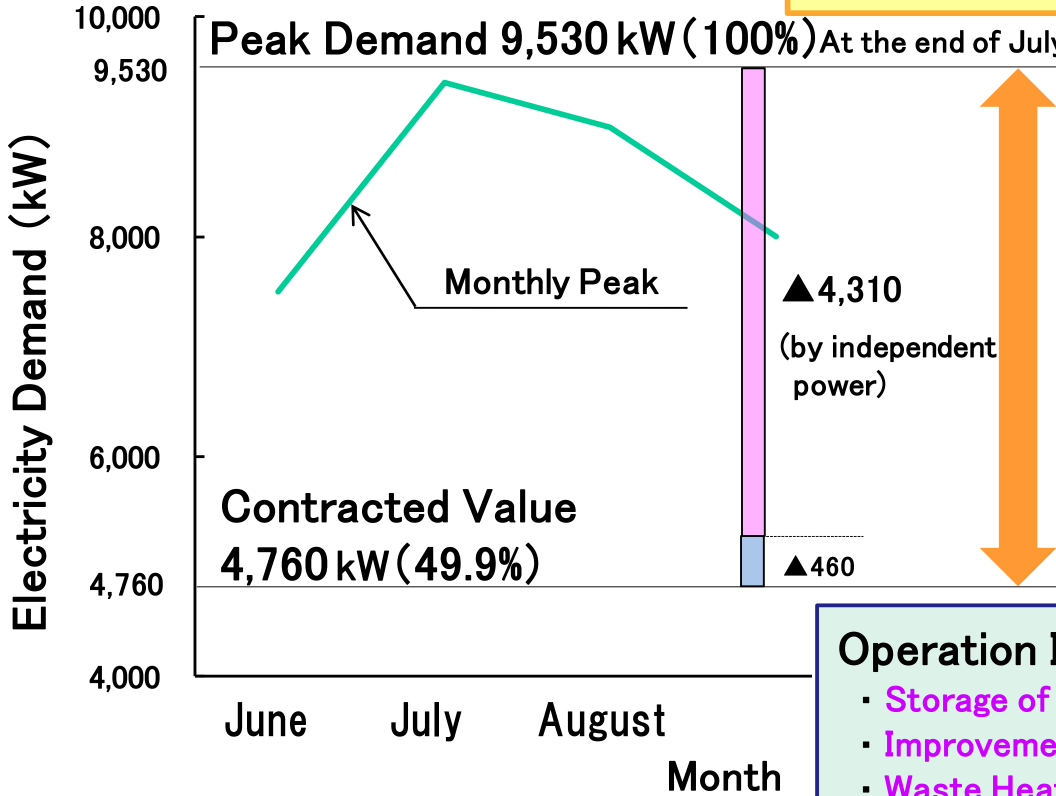
The shadow-flicker occurs when the wind-turbine blades move across the sun shining. The influence of shadow-flicker is predicted and its result occurs influence to residents. An operation is arranged to shutdown the wind-turbine beforehand when the shadow-flicker is expected in a fine morning.

Sound Level dB(A)	Sound similar to :
60	Normal conversation
50	Quiet office
40	Library or midnight in city
30	Chirp, midnight in suburbs

(i) Electricity Peak Restraint

Effect of Electricity Demand Restraint

4,770kW（50.1% of Electricity Peak Value）



Peak Restraint
▲4,770kW
(▲50.1%)

Operation Improvements

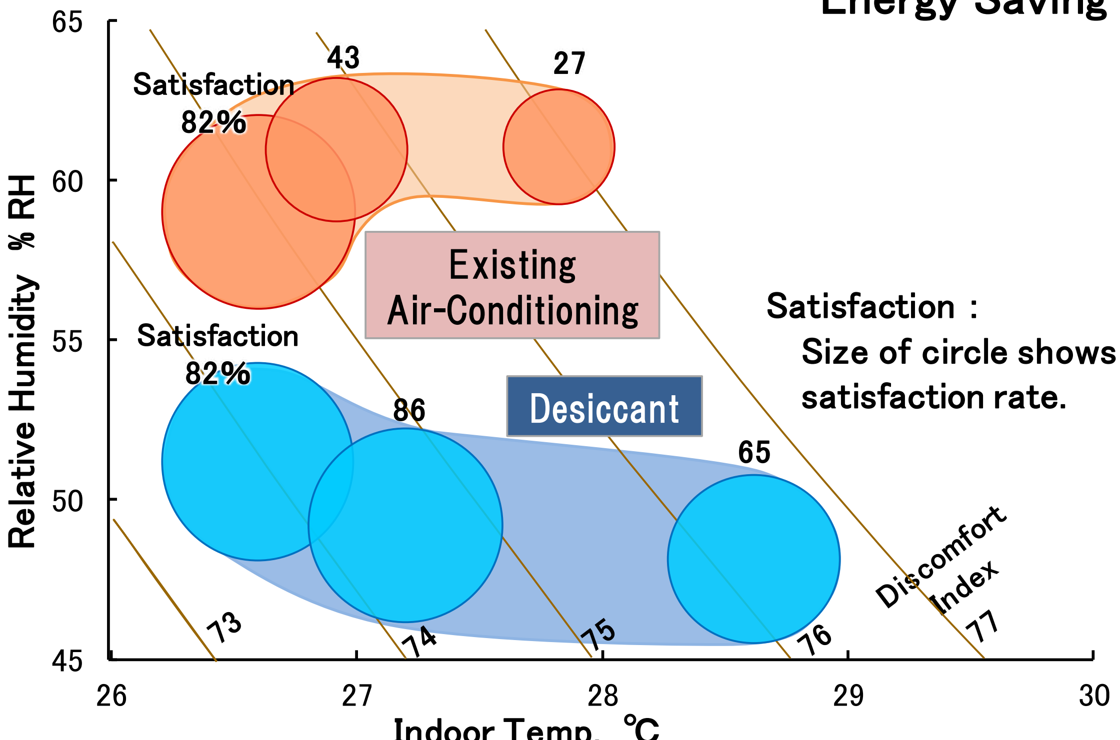
- Storage of Electricity (▲ 60)
- Improvement of Facilities' Operation (▲ 310)
- Waste Heat Use (▲ 60)
- Improvement of chilled water transportation (▲ 30)

Methods of Demand Restraint

(ii) Desiccant Air Conditioning (New Energy Saving Method)

Evaluation by Discomfort Index

Discomfort Index	Feeling	Goal
65－70	Comfort	
70－75	Feel not hot	Our Target
75－80	Slightly hot	
80－85	Hot and Sweat	

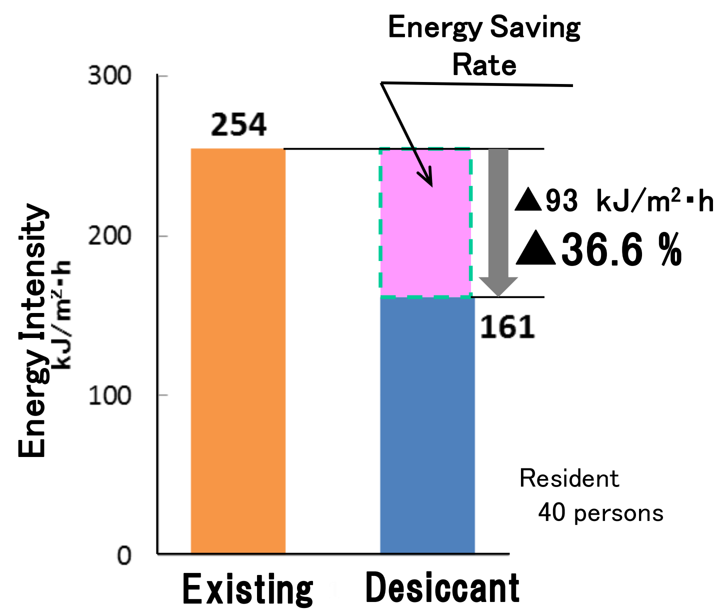


【Comfortness feld by inhabitant】

Evaluation

- As ever : Indoor temperature
- New Idea : Indoor temp. and Humidity

Energy Saving Effect : 36.6% reduced

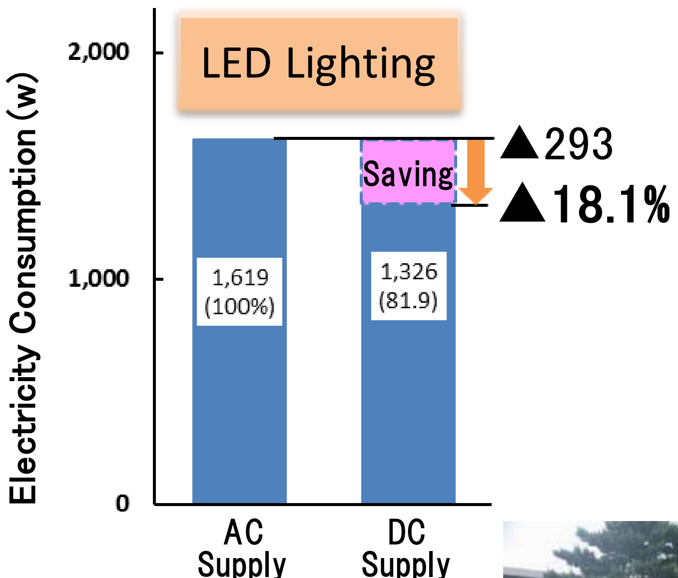


【Energy Consumption】

(iii) DC (Direct Current) Power Supply to LED Lighting

DC (Direct Current) Power is directly supplied
from PV to LED Lighting

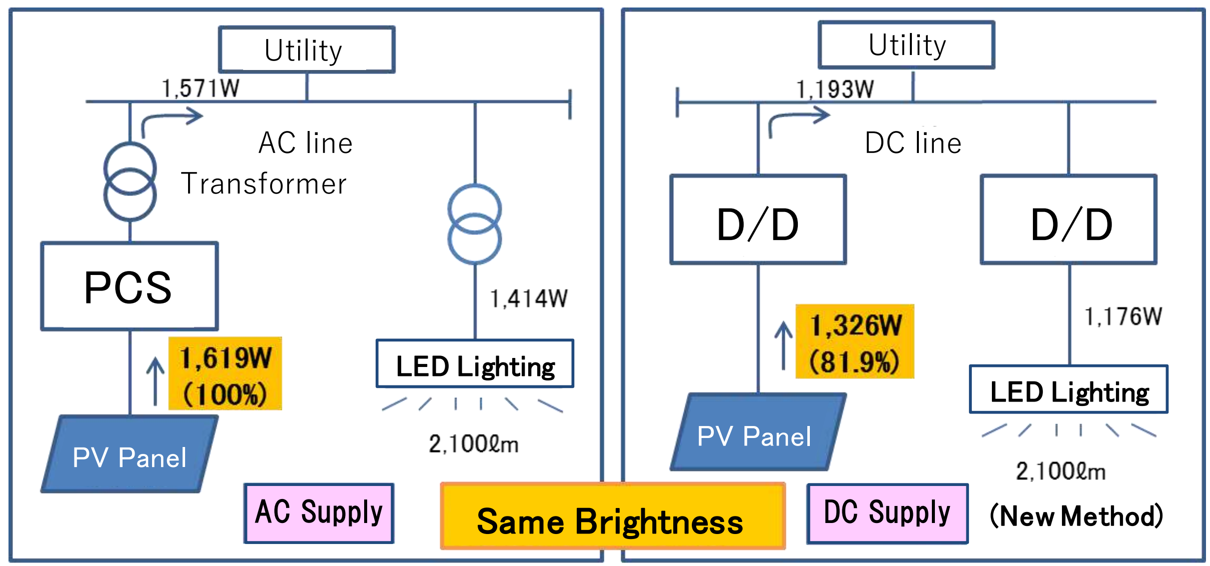
【Energy Saving Effect :18%】



【Comparison between DC vs AC】

Conventional

New supply method



AC : Alternating Current
DC : Direct Current

CVS in Campus

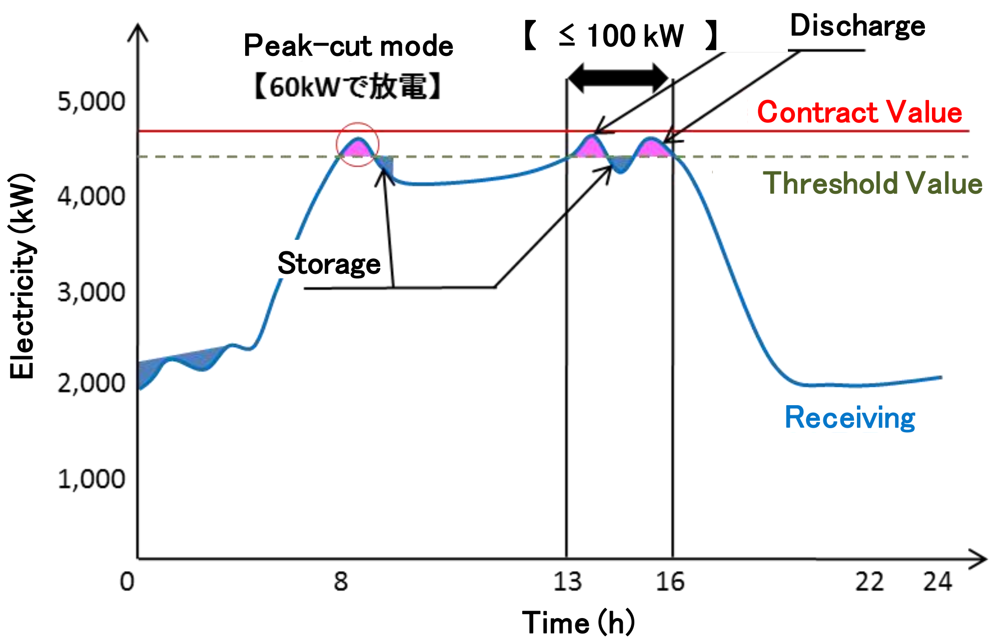
LED lighting in the CVS

(ⅳ) Effective Usage of Small size Battery

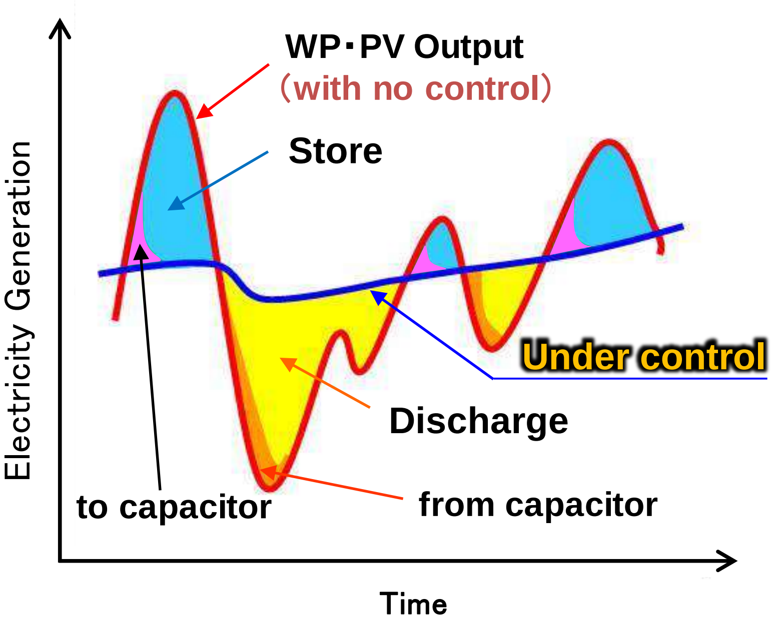
Hybrid Storage (Fast Capacitor and Lead Battery)

- Electricity demand restraint at Power Peak Period
- Mitigation of Abrupt Fluctuation for WP and PV

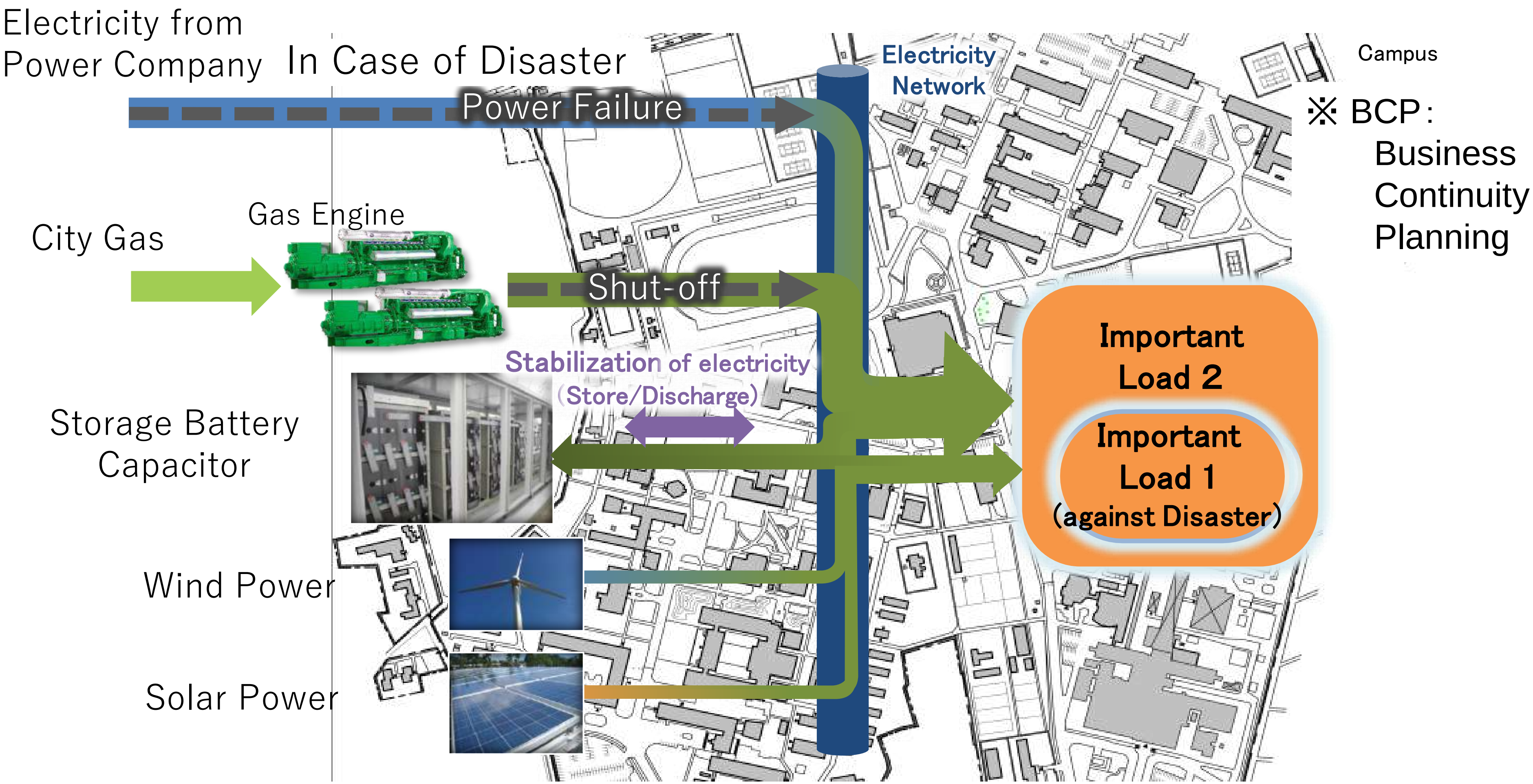
Improvement of Battery Operation
【Electricity Demand Peak-cut】



【Abrupt Fluctuation Mitigation】



Electricity Supply to Campus in Case of Disaster (BCP※)



Electricity, Gas : Shut down
Wind Power, Solar Power : Normal Condition

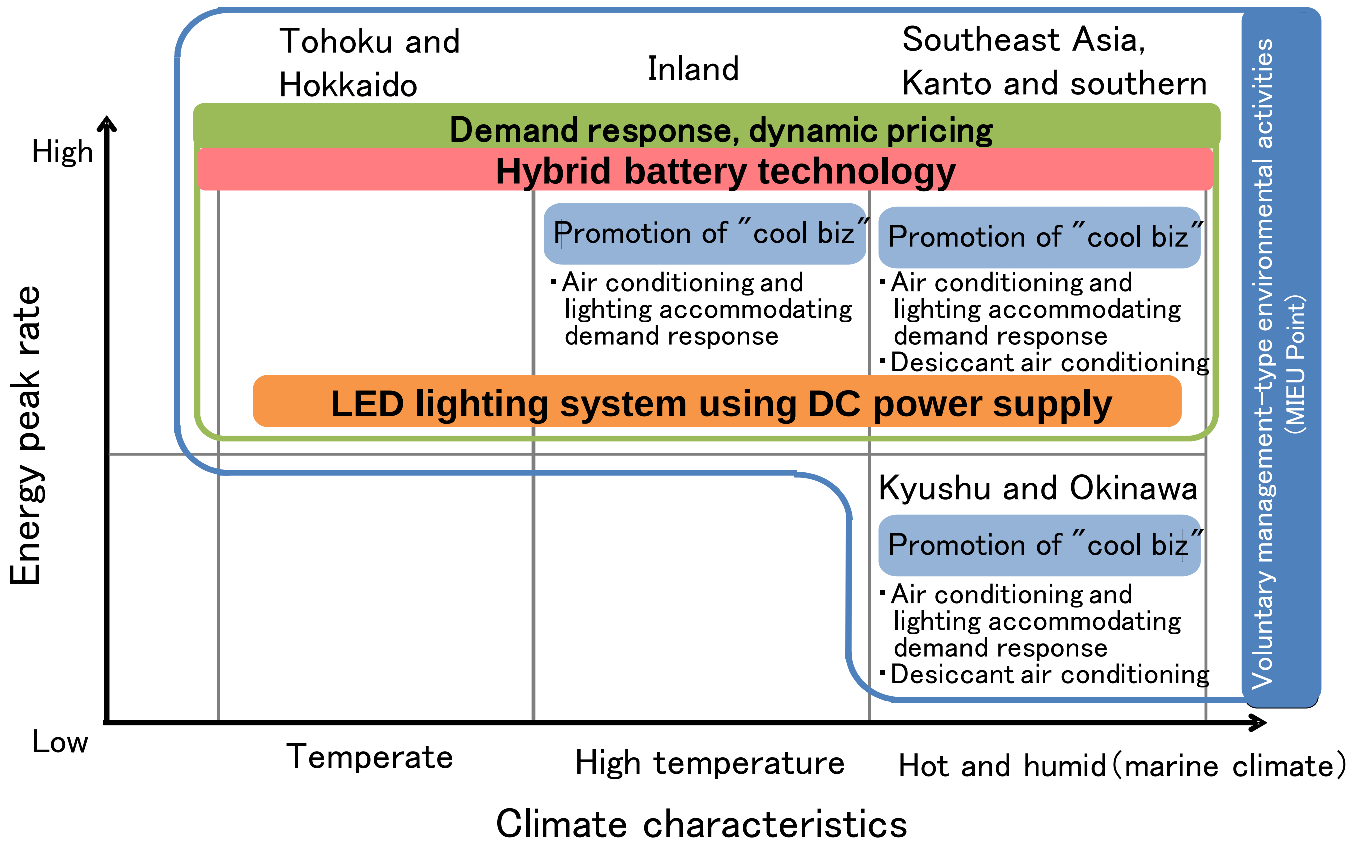
Electricity Supplied by Renewable Energy

Generalization of the methods implemented in the Smart Campus Program and future expansion

Apply versatile technologies and actions for energy saving and power saving to other universities in and outside Japan

Promotion of PR and expansion

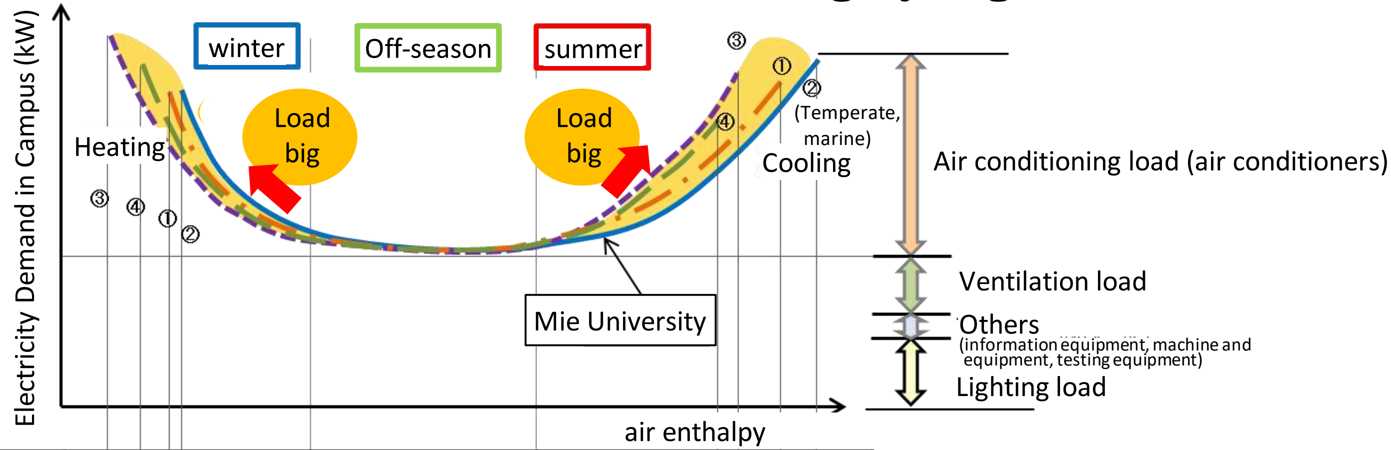
【Common technologies】
- Power demand forecast
- Evaluation of environmental impact to the community
- Autonomous power supply in case of a disaster



Considering a feasibility study with an Indian University and graduate school

Guideline of Air–Conditioning Schema

【Selection of optimum heat source for air conditioning by region】



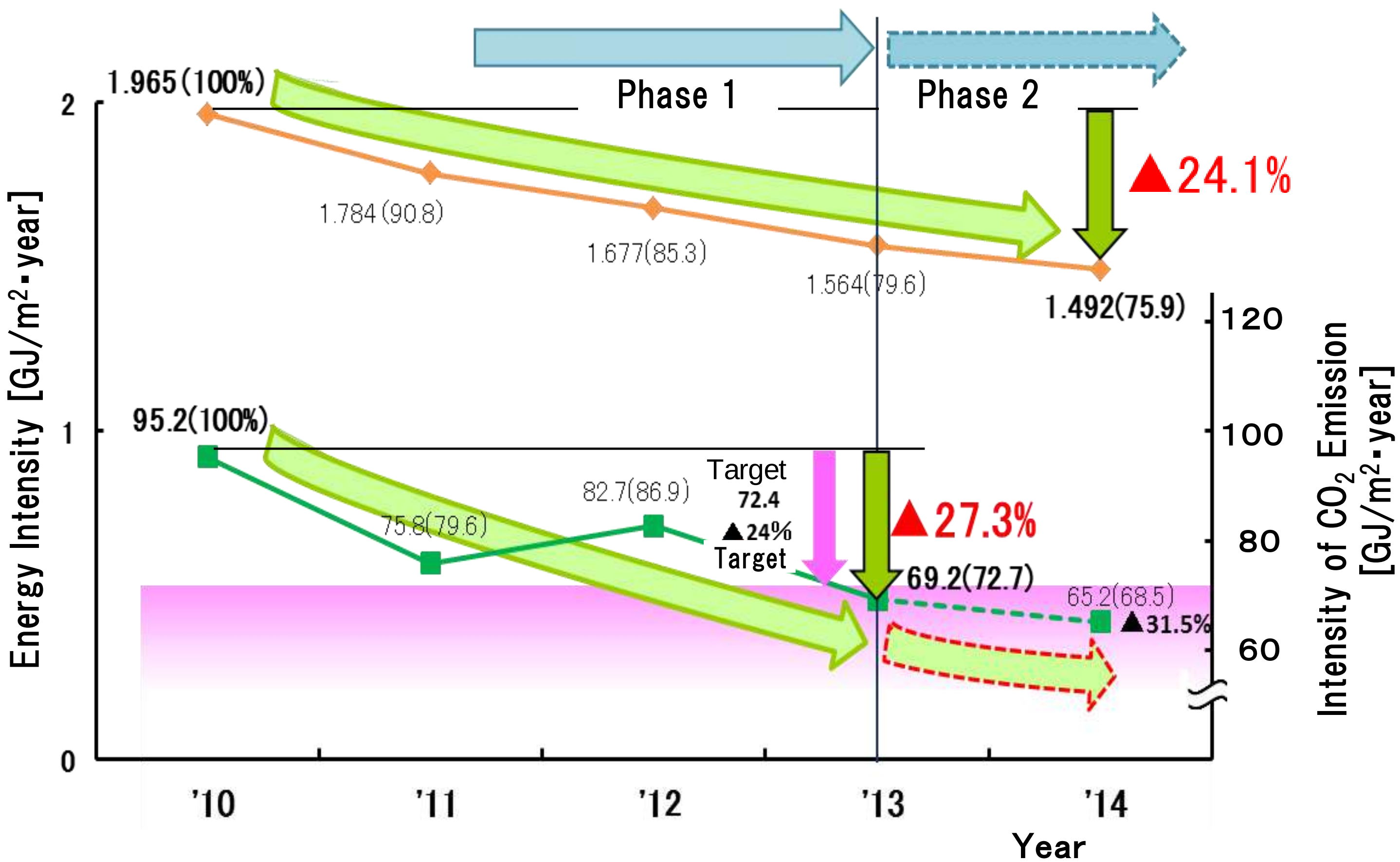
Air Conditioning			Heating		None	None	
Climate conditions	Temperate	①Inland					
		②Close to the sea					
	Cold	③Inland					
		④Close to the sea					
Heat source for cooling and heating	Use exhaust heat	Absorption	○		—	◎	
		Steam/hot water	◎		—	○	
	Electricity	Turbo	—			◎	
		Desiccant	△ (Low COP)	◎	—	◎	
		Heat pump	△ (Low COP)	○	—	◎	◎
	Gas	Absorption	◎	○	—	○	
		Gas heat pump	△	○	—	○	
	Gas/oil	Boiler	○		—		

Evaluation of energy efficiency

◎ > ○ > △

Results and Future

【Progress of Energy and CO_2 Emission】



We will continue our smart activity to prevent global environment.

Our Future Activity

- **Establishment of Vision and Goal**

  Aim at『**One of the Advanced Environmental University in the World**』

- **Encourage the Energy Saving Activity**

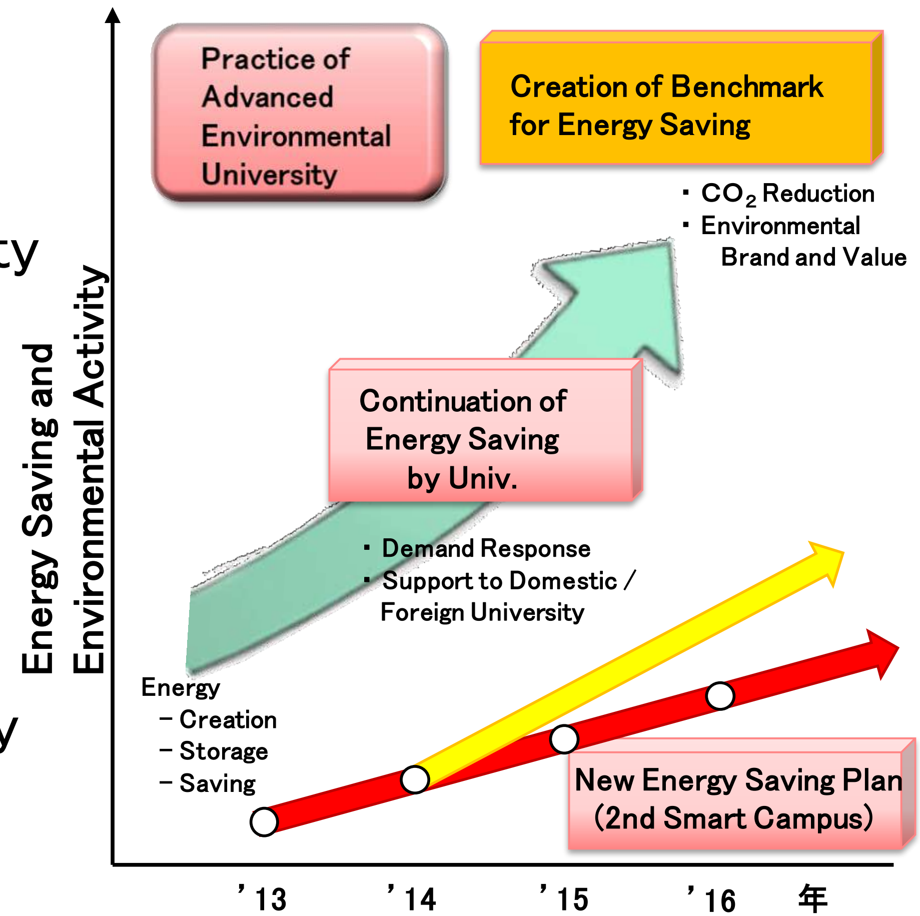
  Visualization of energy usage conditions and Guide to all the member

- **Optimization by Removal of Uselessness**

  High accurate demand forecast
  High priority operation of efficient equipment

- **Continuous Practice of ECO Activity**

  Continuity of energy saving activity in a body
  Demand response, Incentive Activity



What is Smart?:

Everyone continues to respect "Nature, Object and Region".

Thank for your Attention!