An aerial photograph of a tropical coastline. On the left, a steep, green cliff covered in dense vegetation meets a small, sandy beach. The water is a clear, light blue-green color, revealing a rocky seabed with coral reefs. The ocean extends to the horizon under a bright blue sky with scattered white clouds.

The First International Workshop on Open Energy Systems
(14-15 January 2014, OIST)

Practical and Advanced Renewable Energy in Okinawa

Dr. Jun-ichiro Giorgos TSUTSUMI

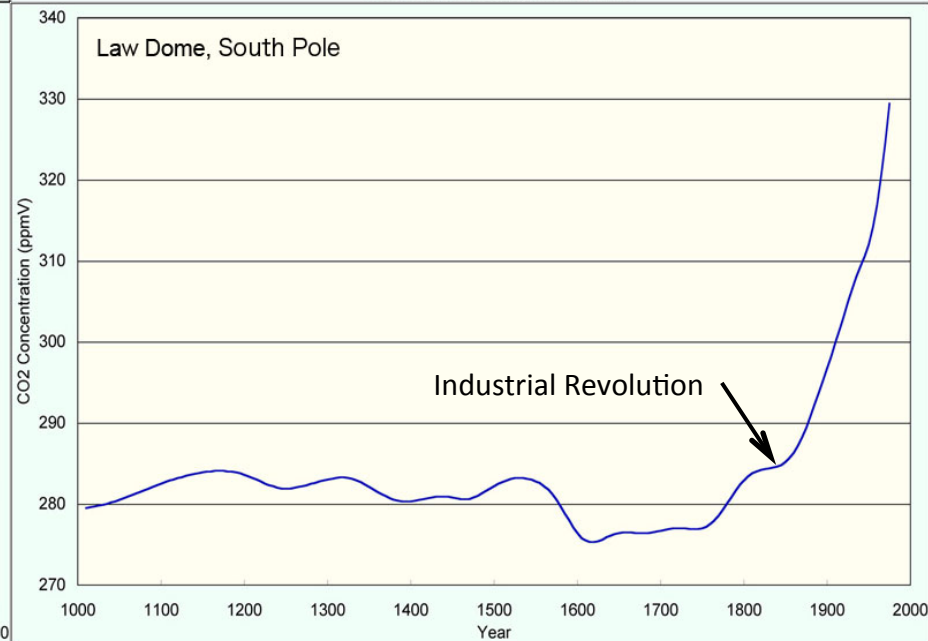
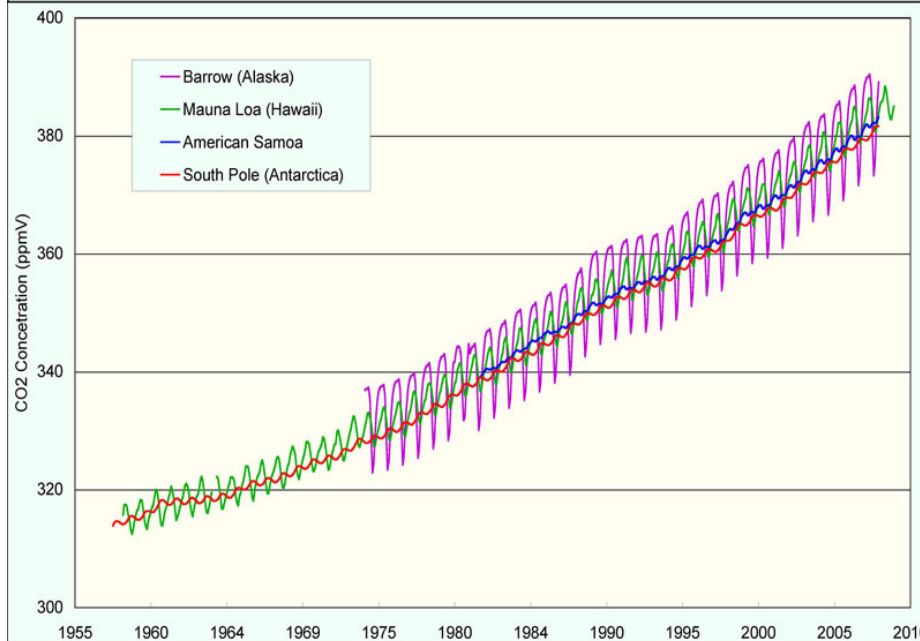
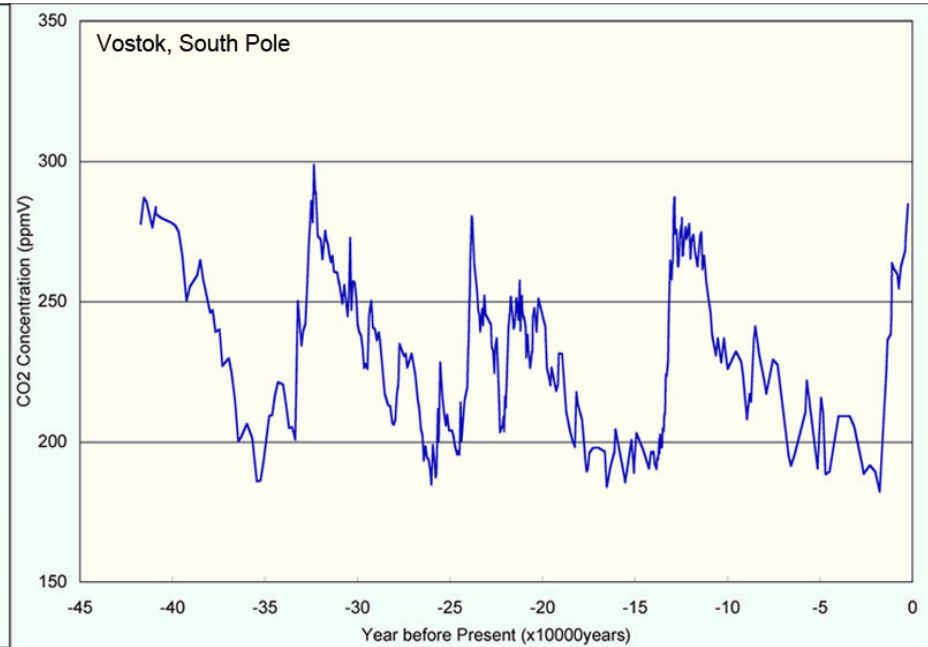
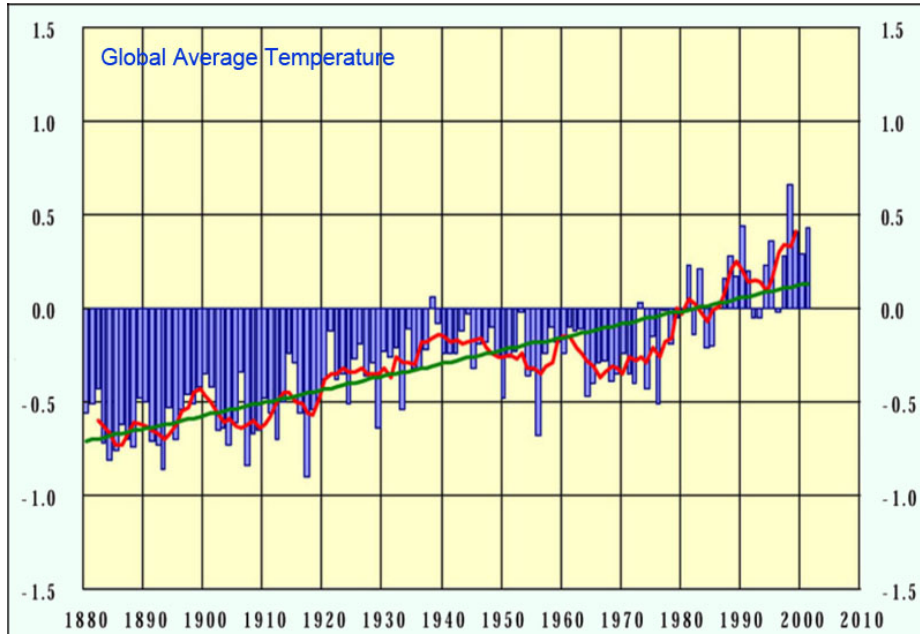
Professor, Faculty of Engineering

E-mail: jzutsumi@tec.u-ryukyu.ac.jp

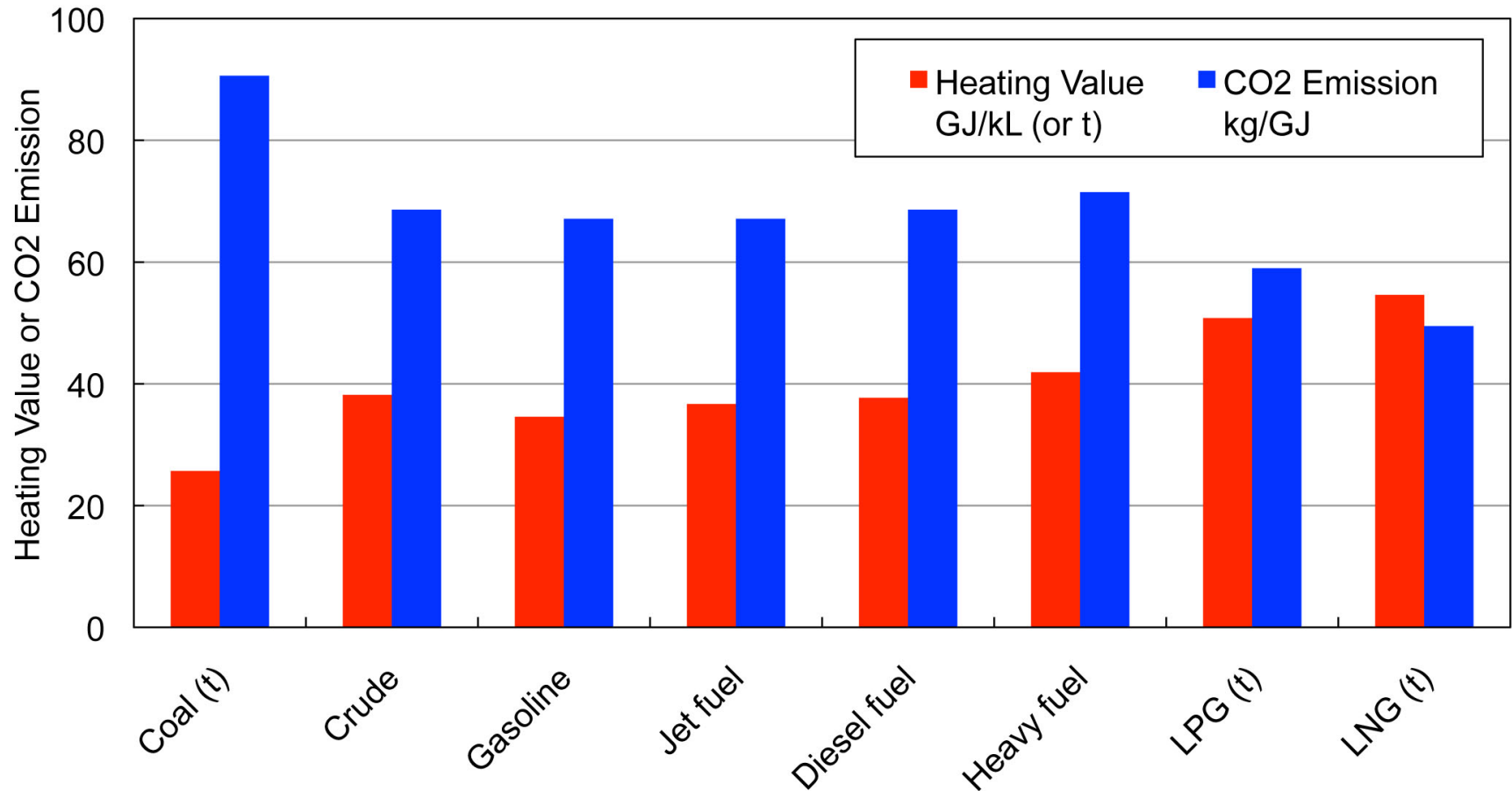
Contents of Presentation

- Emission of Green House Gas from Energy
- Ordinary Popular Natural Energy in Okinawa
 - Natural Energy (Photovoltaic System, Wind Turbine)
 - Recycle Energy (Waste Heat, Digested Gas, BDF)
- Hawaii-Okinawa Clean Energy Partnership
 - Smart Grid System, OTEC, Energy Saving, People Exchange
- Energy Research in University of the Ryukyus
 - Remote Control, Ocean Biomass, Solar Heater, Power Stabilizer
- Smart Energy Projects by Okinawa Prefecture
 - Smart Energy Houses, Leveling System, Miyako Projects, etc.
- Energy Projects in Miyako Island
 - Whole Island EMS, PV on Rented Roofs, Small EV
- Remarks in Development of Renewable Energy

Global Air Temperature and CO₂ Concentration

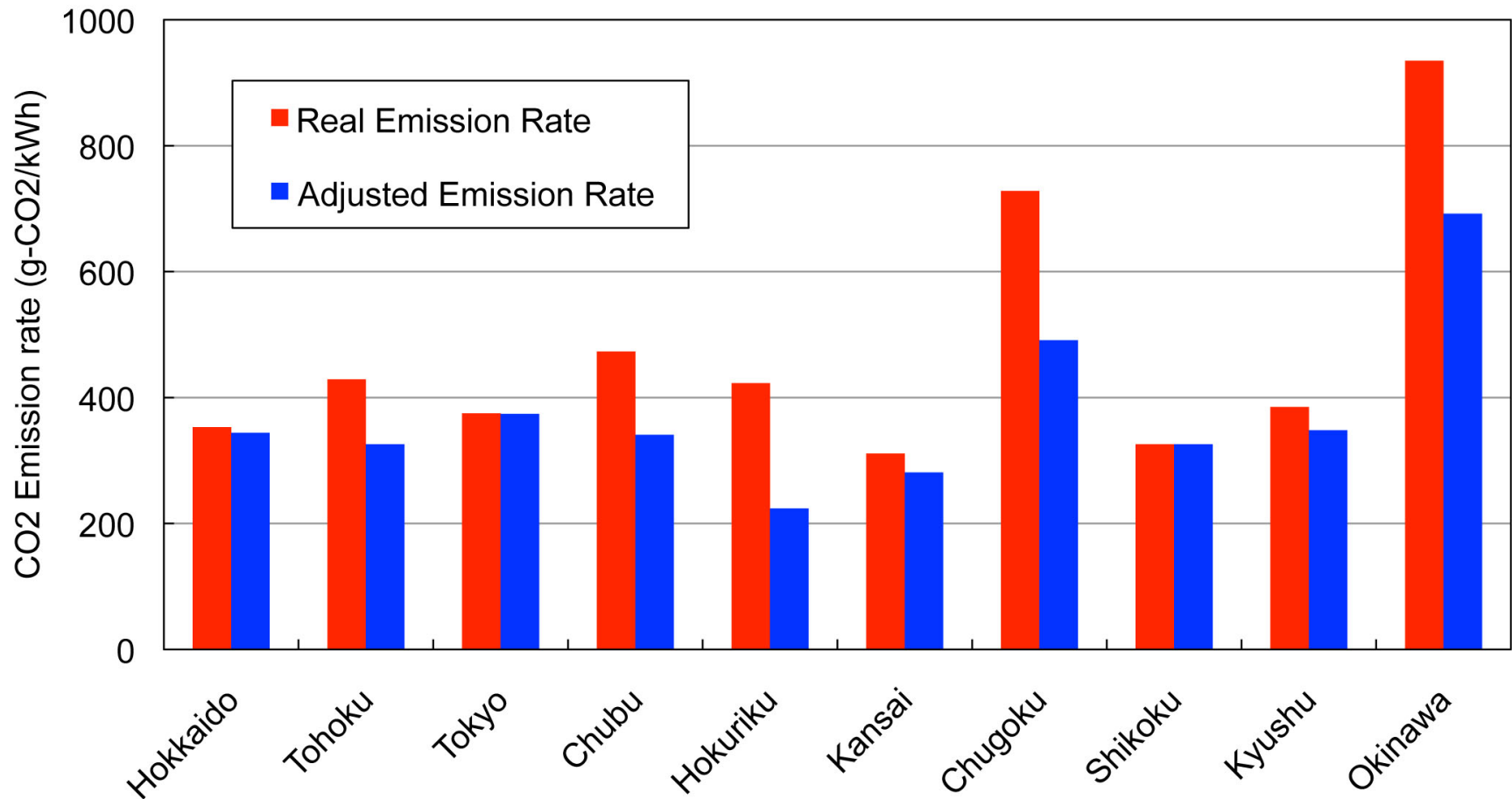


CO₂ Emission Rate from Fossil Fuels



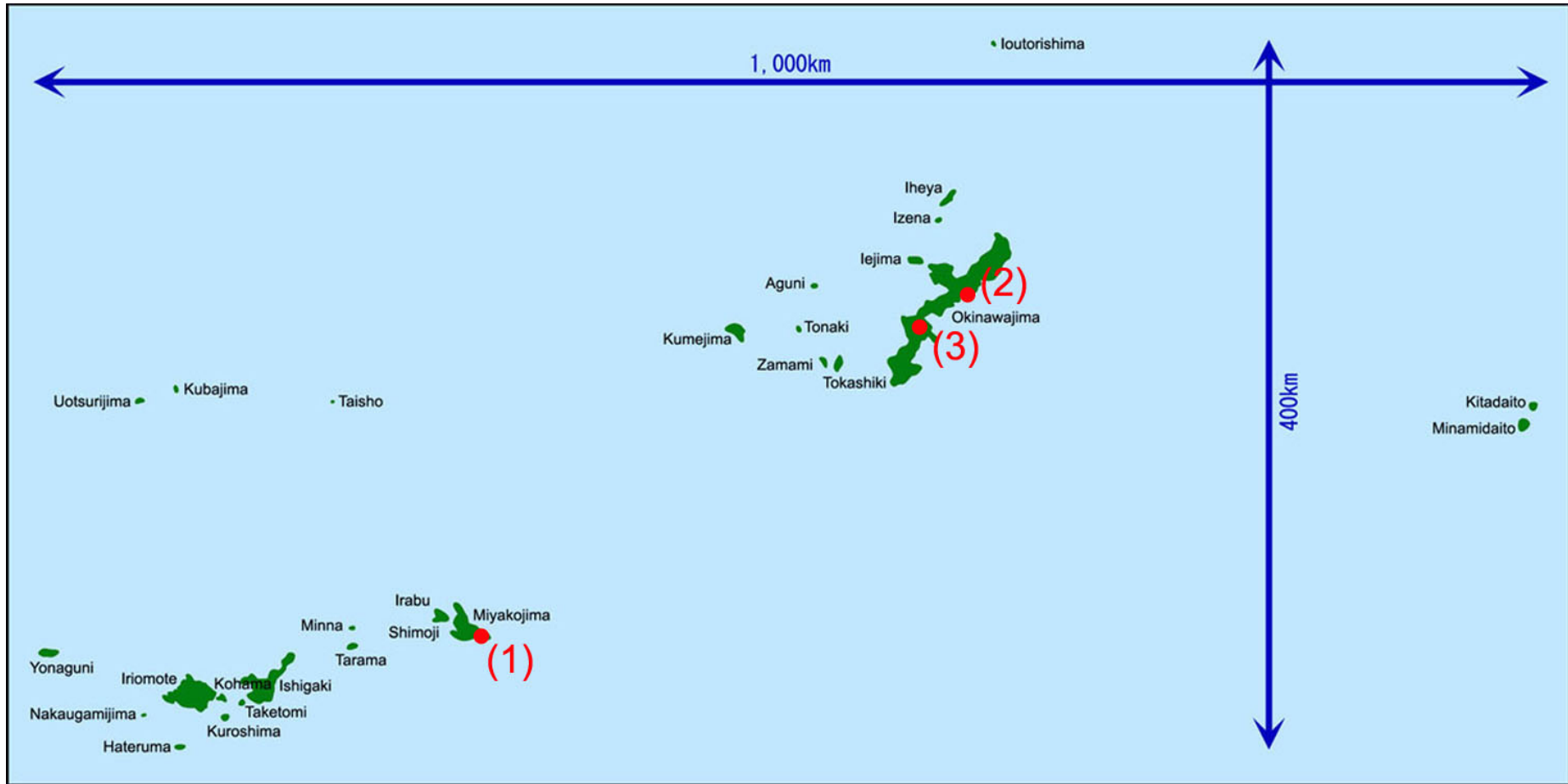
Heating values and CO₂ emission rates by combustion of various fossil fuels. CO₂ emission: Coal > Oil > Gas.

CO₂ Emission Rate by Electric Power Companies before *Fukushima*



“Adjusted rate” means the emission rates adjusted by the carbon credits of Kyoto mechanism.

Mega Solar Fields in Okinawa



- (1) Fukuzato, Miyakojima (4,000kW) Okinawa Electric Power Co.
- (2) Abu, Nago (1,000kW) Okinawa Electric Co.
- (3) Ikehara, Okinawa (2,000kW) EcoLumiere LLC.

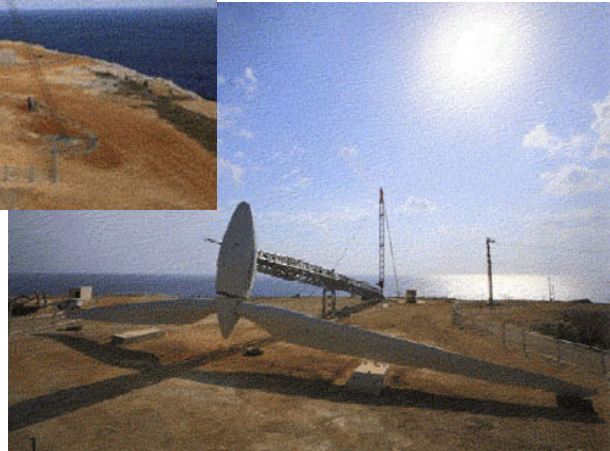
Mega Solar Energy Field in Miyako Island



Damages on wind turbines By typhoon 0314 (Maemi)



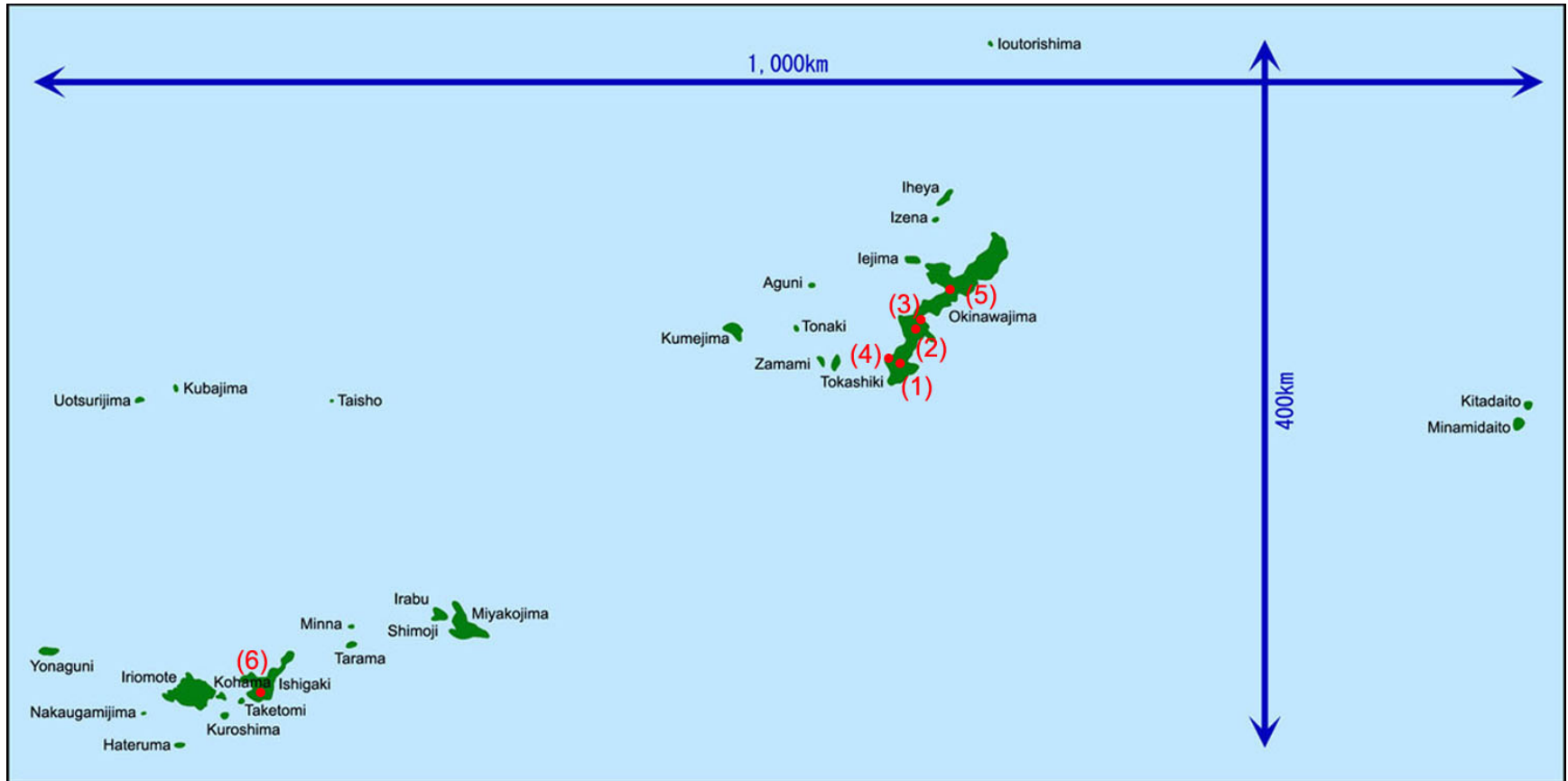
New Type of Tilttable Wind Turbines tested in two islands



Minami-Daito

Hateruma

Waste Heat, Digested Gas in Okinawa



- (1) Naha-Haeburu Clean Center (8,000kW, Stoker + Melting Furnace)
- (2) Ecotopia Ikehara (6,000kW, Fluidized-bed Gasification Melting Furnace)
- (3) Mishima Clean Center (3,000kW, Direct Gasification Melting Furnace)
- (4) Naha Sewage Purification Center (1,210kW, Digested Gas from Sludge)
- (5) Nago Sewage Purification Center (50kW, Digested Gas from Sludge)
- (6) Ishigaki Cogeneration System (300kW, Waste Lumber Pellet + BDF)

Power Generators by Waste Heat from Incinerators and Digested Gas from Sludge

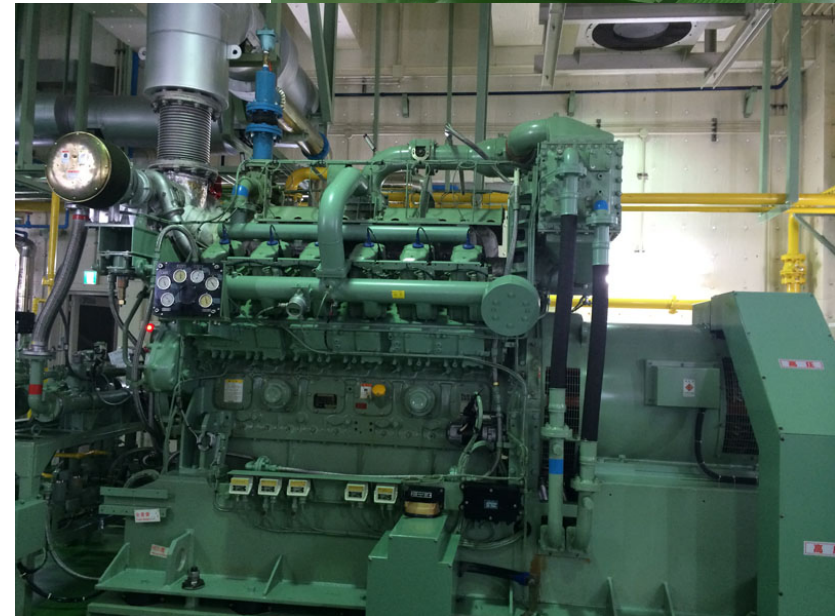


Naha-Haebaru
Clean Center

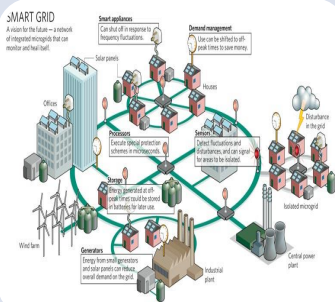
Naha Sewage
Purification Center



Ecotopia Ikehara



Hawaii-Okinawa New Energy Partnership from 2010



Smart Grid:

Collaborate on
pilot projects
on Miyako,
Maui, and Oahu

Energy Efficiency in Buildings:

Work together to
identify best
practices for
subtropical
climates

OTEC:

New ocean
energy
technology ,Oce
an Thermal
Energy
Conversion

People-to-People Exchange:

Among students,
researchers,
government, and
industry

Relations between Hawaii and Okinawa

- **Government-to-Government**
 - Department of Energy (DOE), USA - Ministry of Economy, Trade and Industry (METI) and Japan
- **National Organizations**
 - National Renewable Energy Laboratory (NREL) , USA - New Energy and Industrial Technology Development Organization (NEDO), Japan
- **State-to-Prefecture**
 - State of Hawaii and Okinawa Prefecture
- **University-to-University**
 - University of Hawaii and University of the Ryukyus
- **Private Companies (Electric Power Co.)**
 - Hawaiian Electric Company (HECO) and Okinawa Electric Power Company (Okiden) and their group companies
- **Existing Collaborative Project**
 - Private companies (Maui smart grid, etc.) and people exchanges
 - NOT clear in universities without any special budget

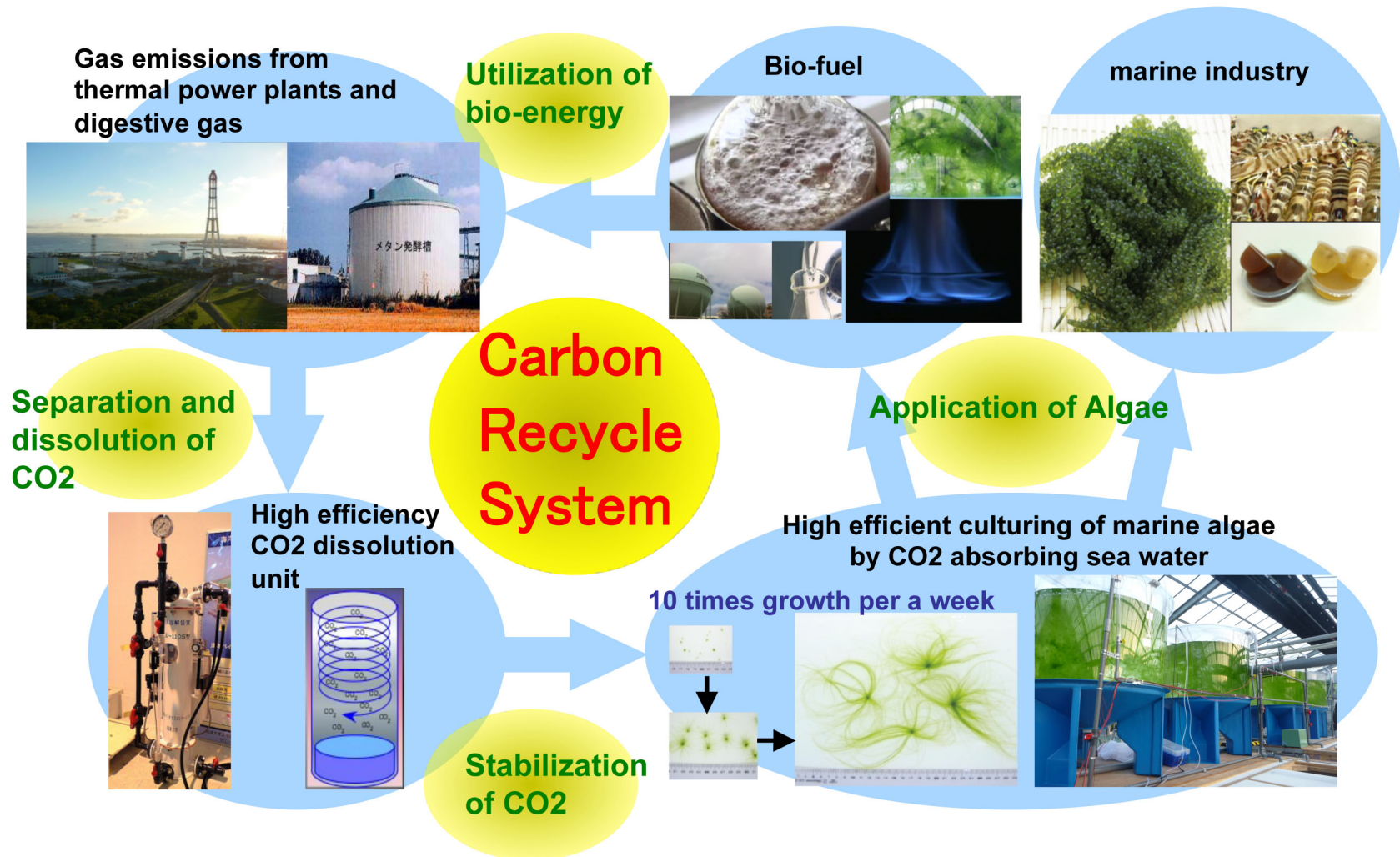
Hawaii-Okinawa Energy Project Team in University of the Ryukyus

Hawaii-Okinawa Project Team for Environmental Energy
HOPEE

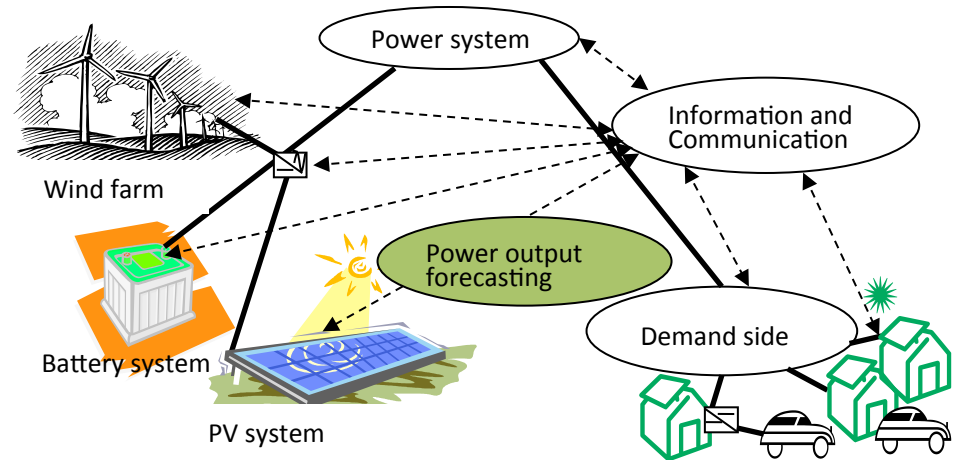
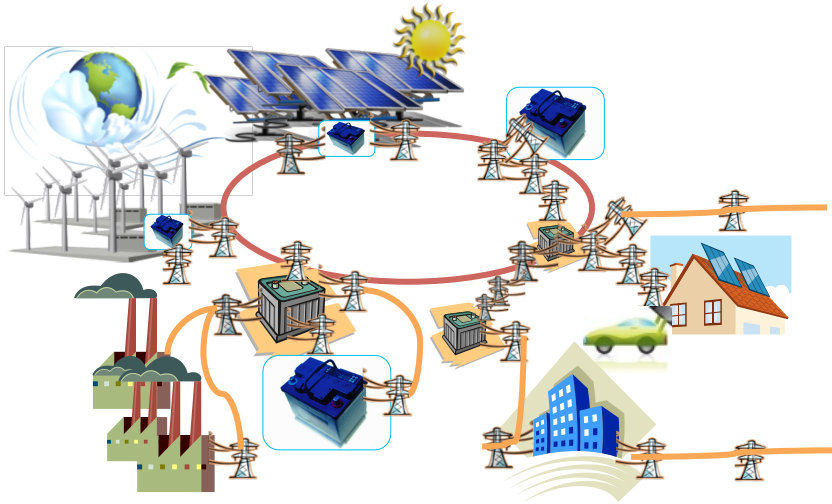
- Marine Biomass (Assoc. Prof. Senaha)
 - Energy from algae rapidly grown by artificial CO₂ supply
- Remote Control System (Prof. Tamaki)
 - Remote control of natural energy in small islands
- Stable Smart Grid (Prof. Senju, A. Prof. Yona)
 - Stabilizer system of micro grid with natural energy
- Solar Heat Collector (Prof. Tsutsumi, Prof. Kondo)
 - High efficient solar water heater by bagasse charcoal

Development of the carbon recycle system by use of marine biomass

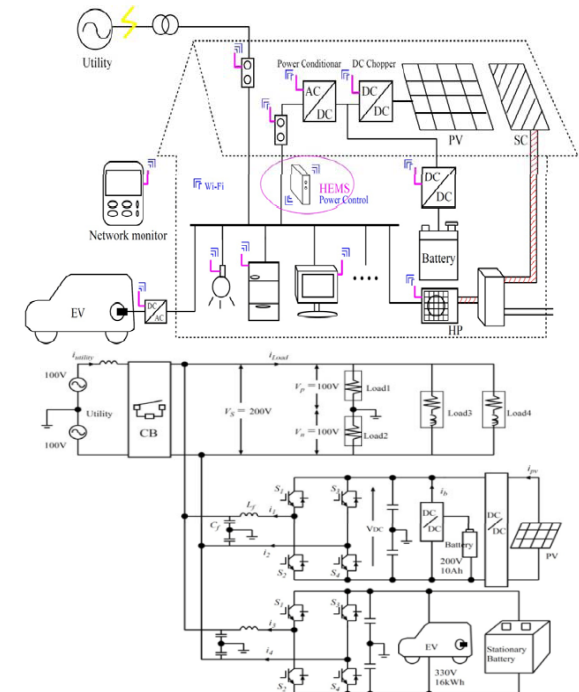
Izuru Senaha, University of the Ryukyus



Leveling and Stabilizing Smart Grid

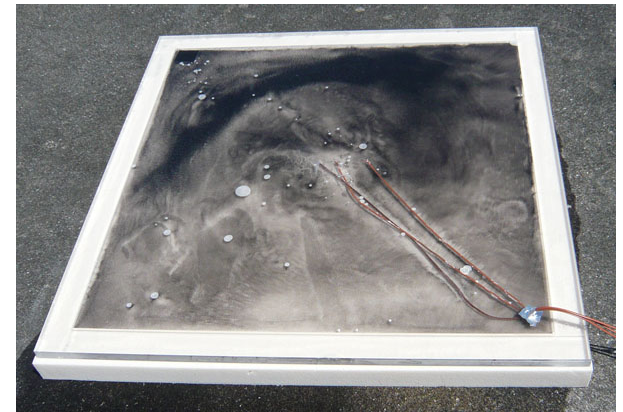
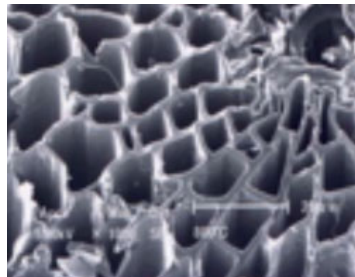


- Optimal Operation for Smart Grid
- Advanced Power Output Forecasting for Control of Renewable Energy
- Optimization of Unit Commitment
- Smart House Applying Intelligent techniques
- Demand Response with Electric Vehicle



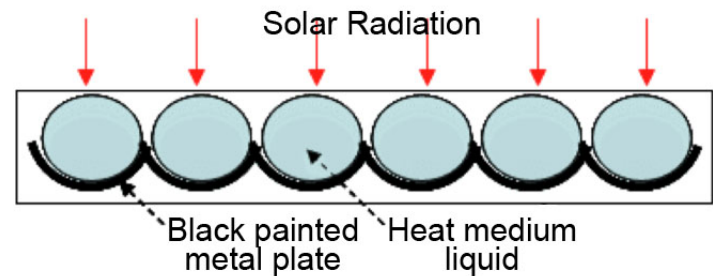
Very High Efficient Solar Collector and Insulation System

- University of the Ryukyus (UR)-type collector
- Heat medium liquid itself is collector.
 - Suspension water with **Bagasse charcoal** powder is used as the heat medium liquid.
 - **Bagasse charcoal** is made from the waste of sugarcane after sugar production.
 - **Bagasse** has porous and honeycomb structure and very wide surface area.

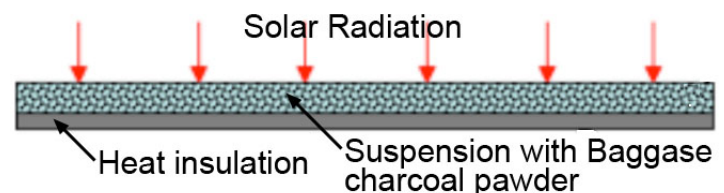


Basic Idea of UR-type Collector

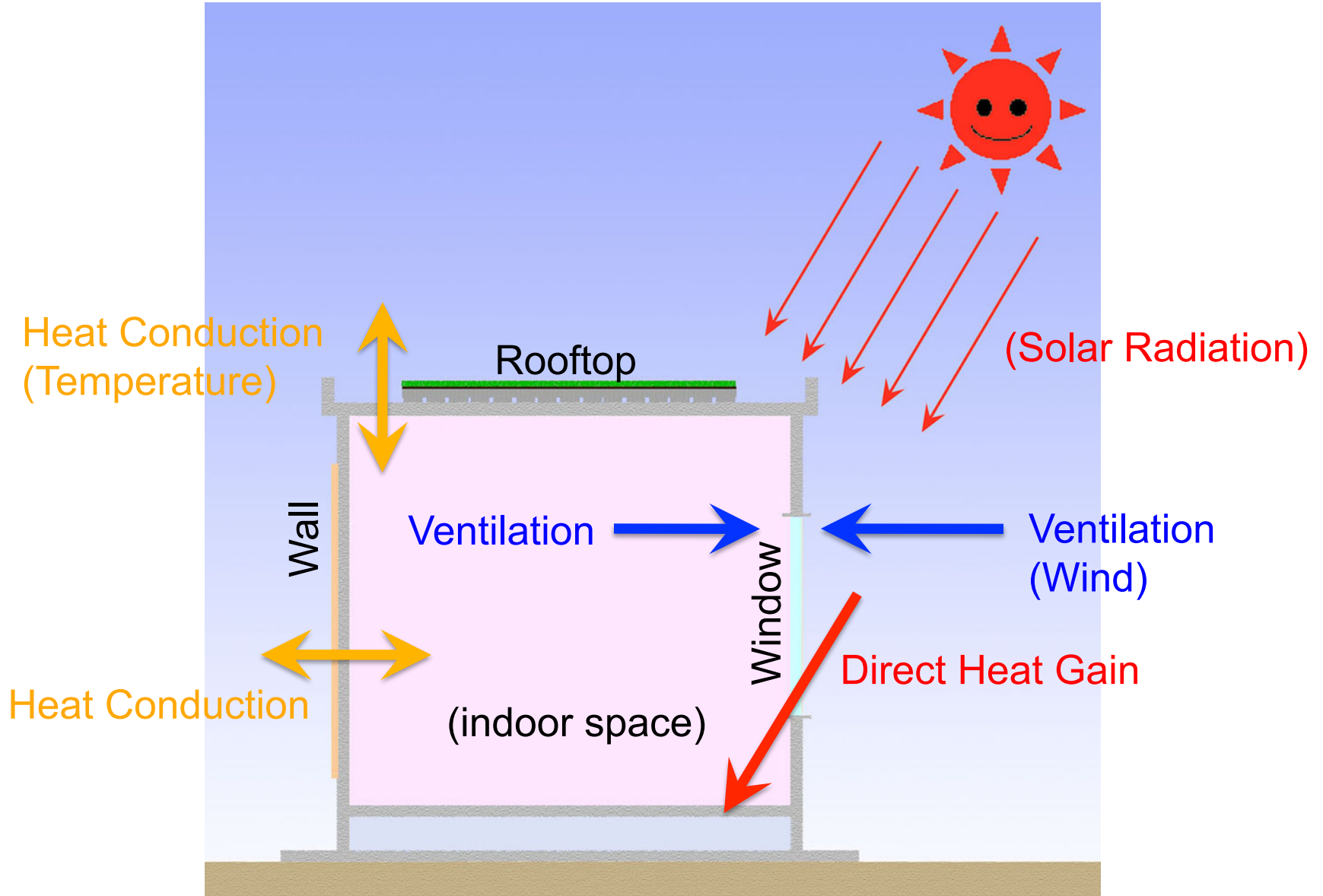
- Conservative or traditional type collector
 - Black painted metal plates (copper or steel) are used to catch the solar radiation.
 - Then, heat medium liquid can get the heat from the plates by **convective heat transfer**.
 - The metal plates emit **infrared radiation** to cool themselves.



- UR-type Solar collector
 - Heat medium liquid itself works as solar heat catcher.
 - Infrared radiation from **Baggase charcoal** is absorbed by the medium liquid.



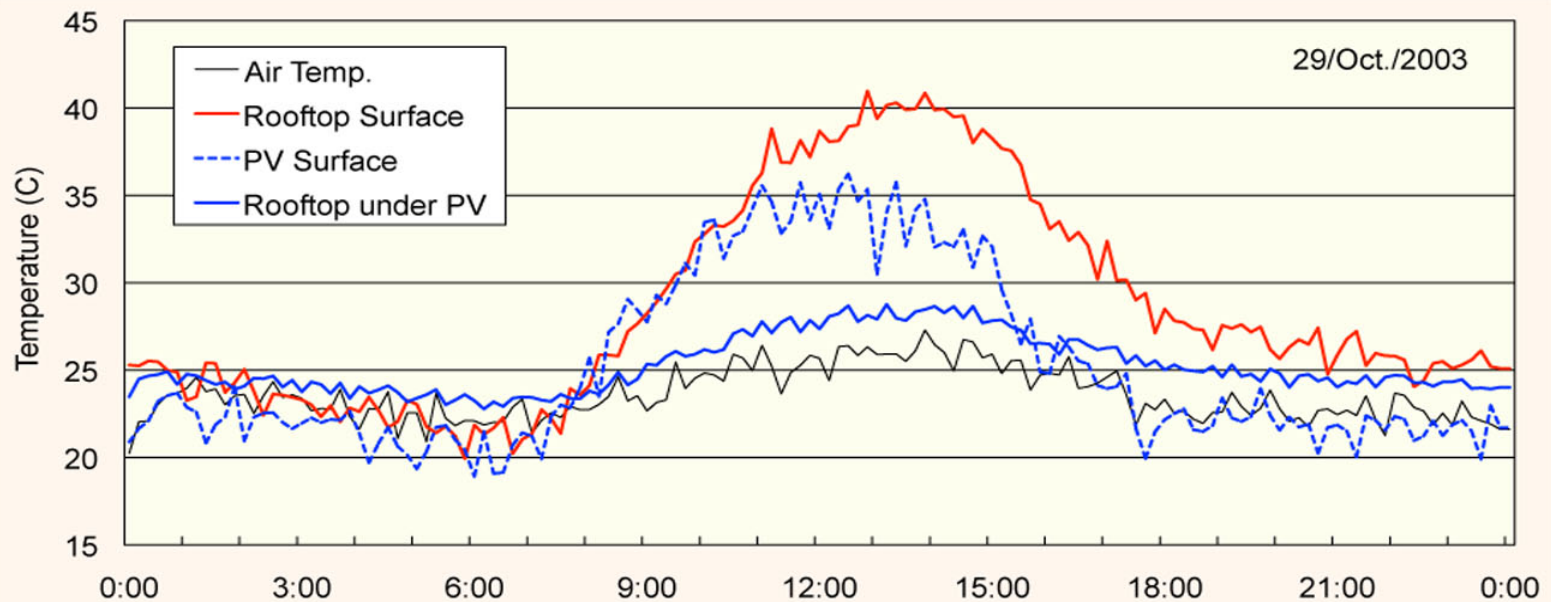
Thermal Impact on a House



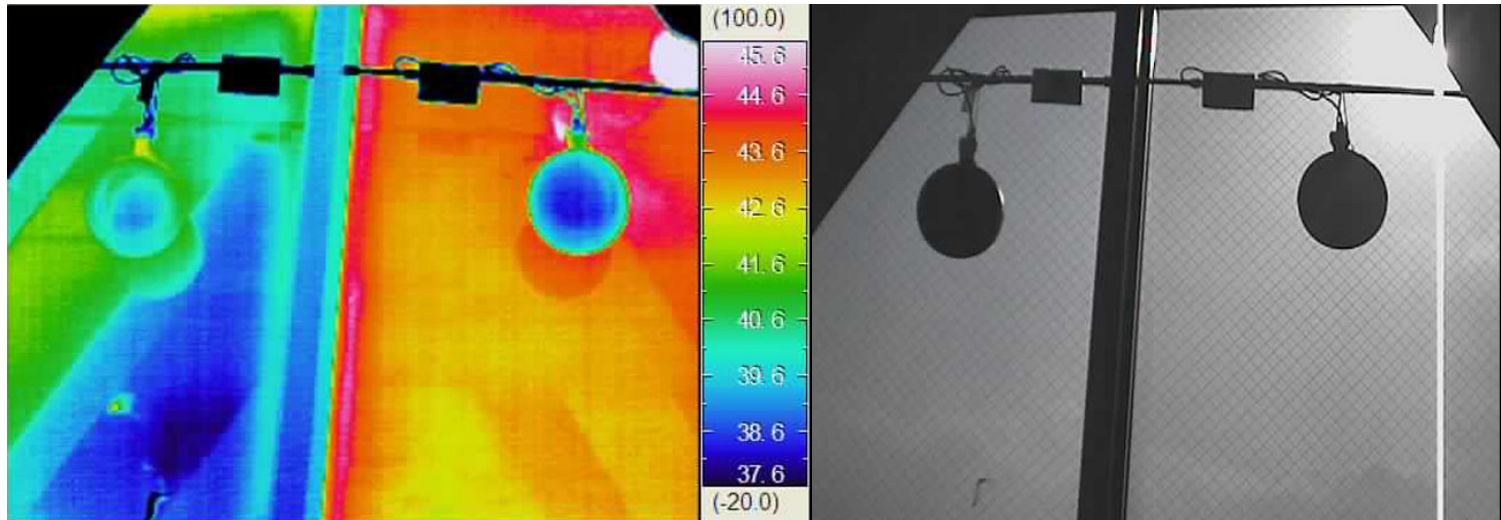
Protection by Photovoltaic Module



Solar Protection by Photovoltaic Modules



Protection on Window Pane



Heat Cut Paint on Window Pane



Vertical Louvers



Smart Energy Island Projects by Okinawa Prefecture

- **Smart Energy Houses for Warm-Humid Region**
 - Energy saving design of residential houses fit for life style in warm-humid area
- **Energy management of a chain of retailing stores**
 - Energy management of a series of chain stores covered by energy saving law amended in 2010
- **System interconnection of natural energy**
 - Increase and stabilization of interconnection of solar and wind energy to an existing power grid
- **Leveling system of natural energy**
 - Leveling the fluctuation of natural energy with other demand
- **Development of electric bus**
 - Conversion from diesel buses to electric buses
- **Three energy projects in Miyako Island**
 - Energy management system of whole island
 - Large scale solar power on rented roofs of all houses in Kurima Is.
 - Development of small size electric vehicles

Samples of Smart Energy Island Projects



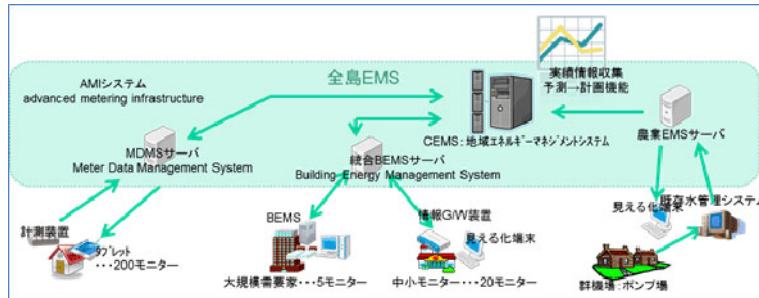
Smart Energy House



EV Bus

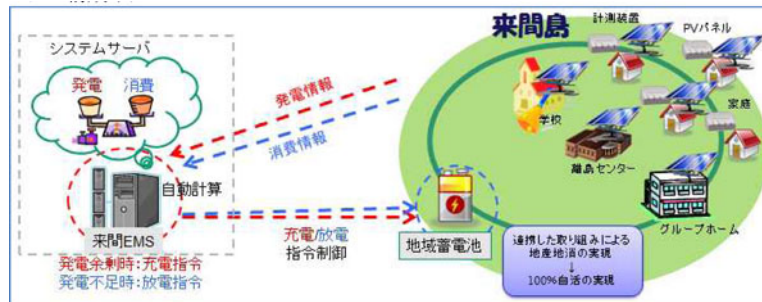


Promotion of EMS
by “**MIERUKA**”
(Visualization)



EMS of Whole Island

Solar Power on Rented Roof



Original Small Size EV



Important Remarks

- **Geographical Characteristics of Okinawa**
 - Okinawa is regarded as a suitable place for small-scale smart grids with clean energy technologies, because it is an isolated archipelagic area rich with people, culture and social infra structures.
- **Not Test Field But Living Environment**
 - However, Okinawa is not only a test field, but an actual living environment for 1.4 millions residential people and 6 millions tourists to apply the advanced technologies.
- **Environmental Impacts of New Technologies**
 - To estimate the impacts of new technologies and further developments on the limited valuable subtropical natural and living environments in Okinawa is essential.