

# Development and Application of Analytical Models for Designing Local Actions towards the SDGs

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2 November, 2017 at Century Park Hotel, Bangkok, Thailand

# Improvement of energy access is one of key actions in the SDGs



# Energy access is an issue for developing countries...

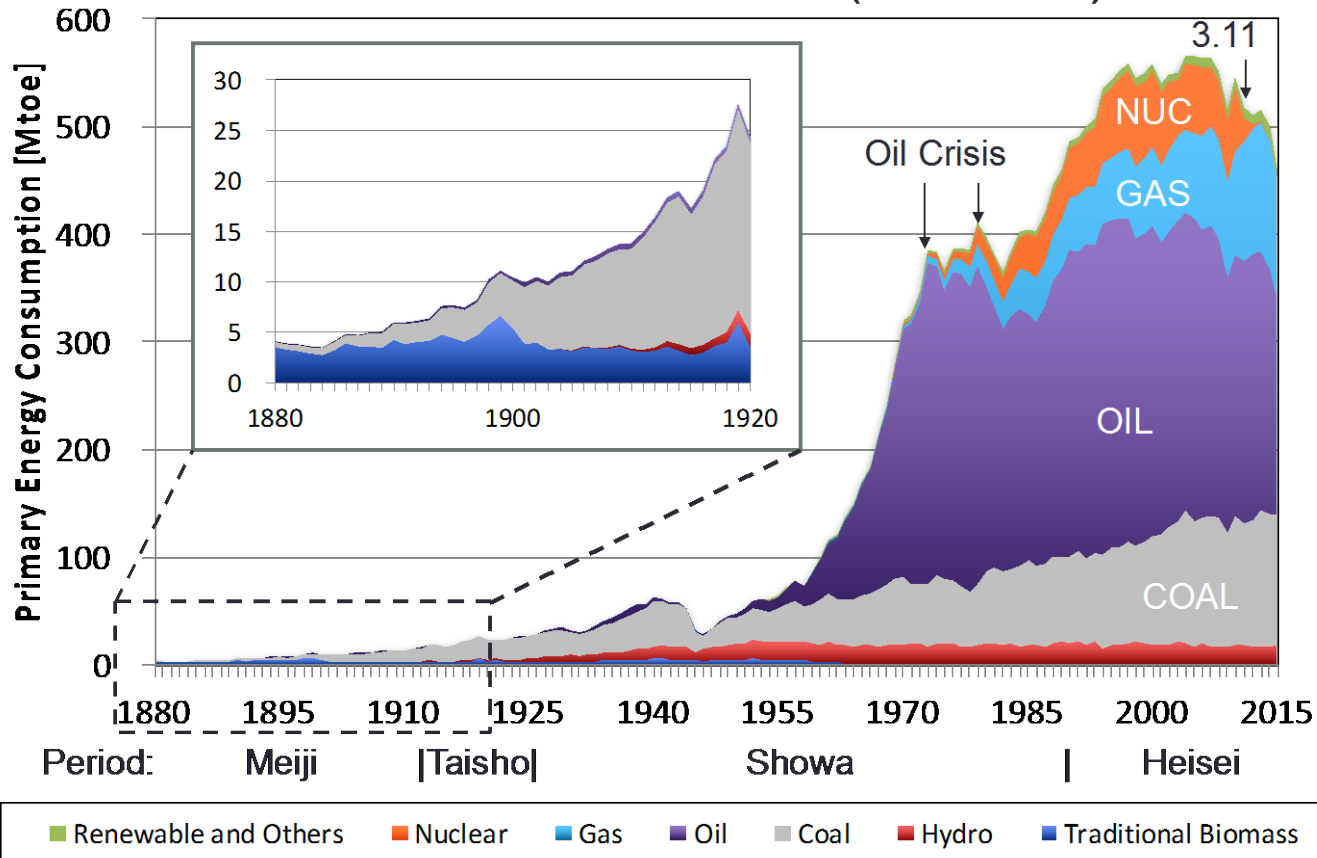
## Electricity access in 2014 - Regional aggregates

Region	Population without electricity  millions	Electrification rate  %	Urban electrification rate  %	Rural electrification rate  %
Developing countries	1,185	79%	92%	67%
Africa	634	45%	71%	28%
North Africa	1	99%	100%	99%
Sub-Saharan Africa	632	35%	63%	19%
Developing Asia	512	86%	96%	79%
China	0	100%	100%	100%
India	244	81%	96%	74%
Latin America	22	95%	98%	85%
Middle East	18	92%	98%	78%
Transition economies & OECD	1	100%	100%	100%
WORLD	1,186	84%	95%	71%

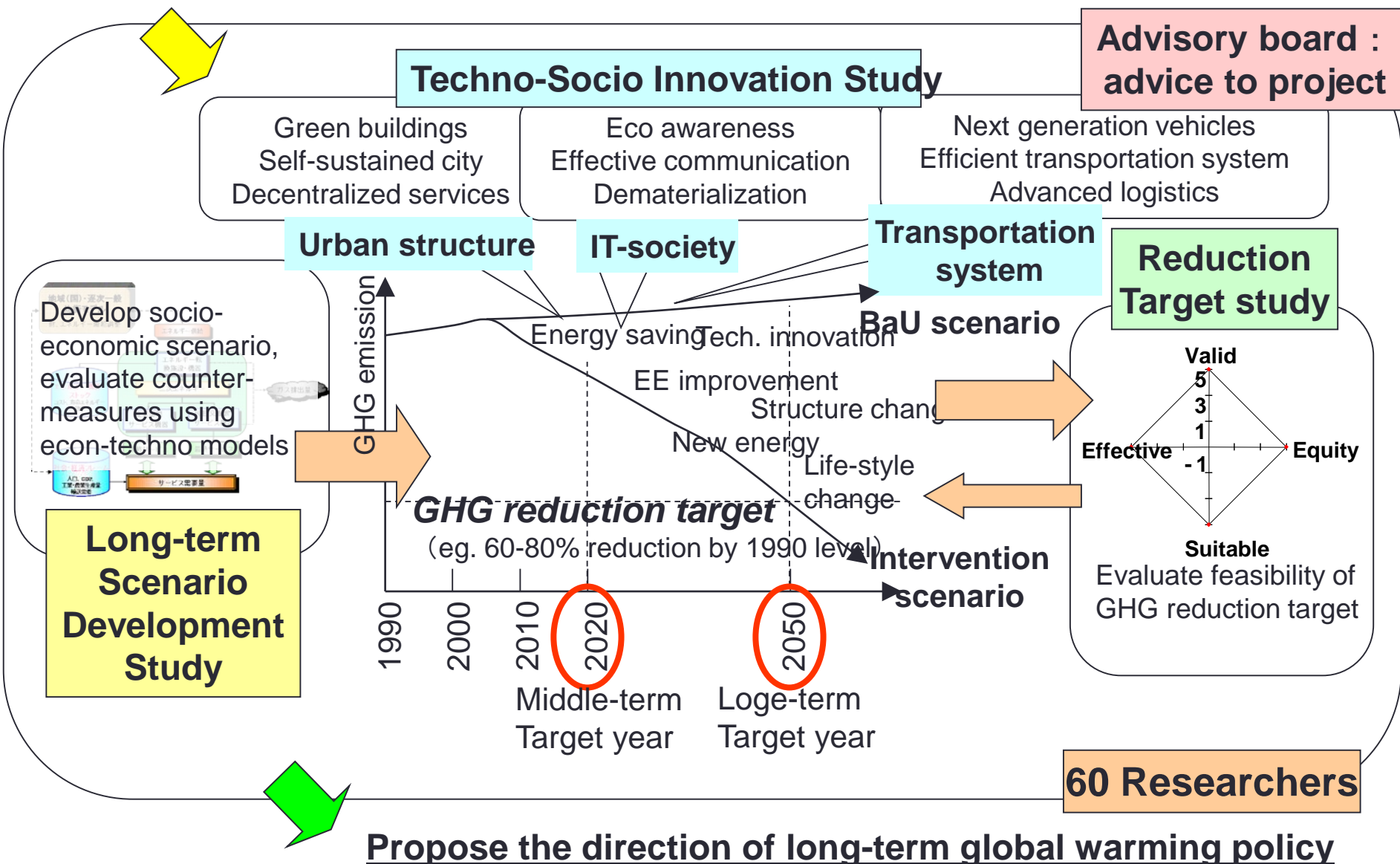
SOURCE: IEA, World Energy Outlook 2016

## AND for *Developed* countries



- Goal 7 of SDGs aims to ensure access to affordable, **reliable**, **sustainable** and modern energy for all.
- Japan depends on almost modern energies.
- These are reliable and sustainable (or clean) ?



# Research Project on Japan Low Carbon Society Scenarios toward 2050



# Depicting Socio-economic Visions in 2050: Two different but likely future societies

Vision A “Doraemon”	Vision B “Satsuki and Mei”
<b>Vivid, Technology-driven</b>	<b>Slow, Natural-oriented</b>
<b>Urban/Personal</b>	<b>Decentralized/Community</b>
<b>Technology breakthrough Centralized production /recycle</b>	<b>Self-sufficient Produce locally, consume locally</b>
<b>Comfortable and Convenient</b>	<b>Social and Cultural Values</b>
<b>2%/yr GDP per capita growth</b>	<b>1%/yr GDP per capita growth</b>
	

Akemi  
Imagawa



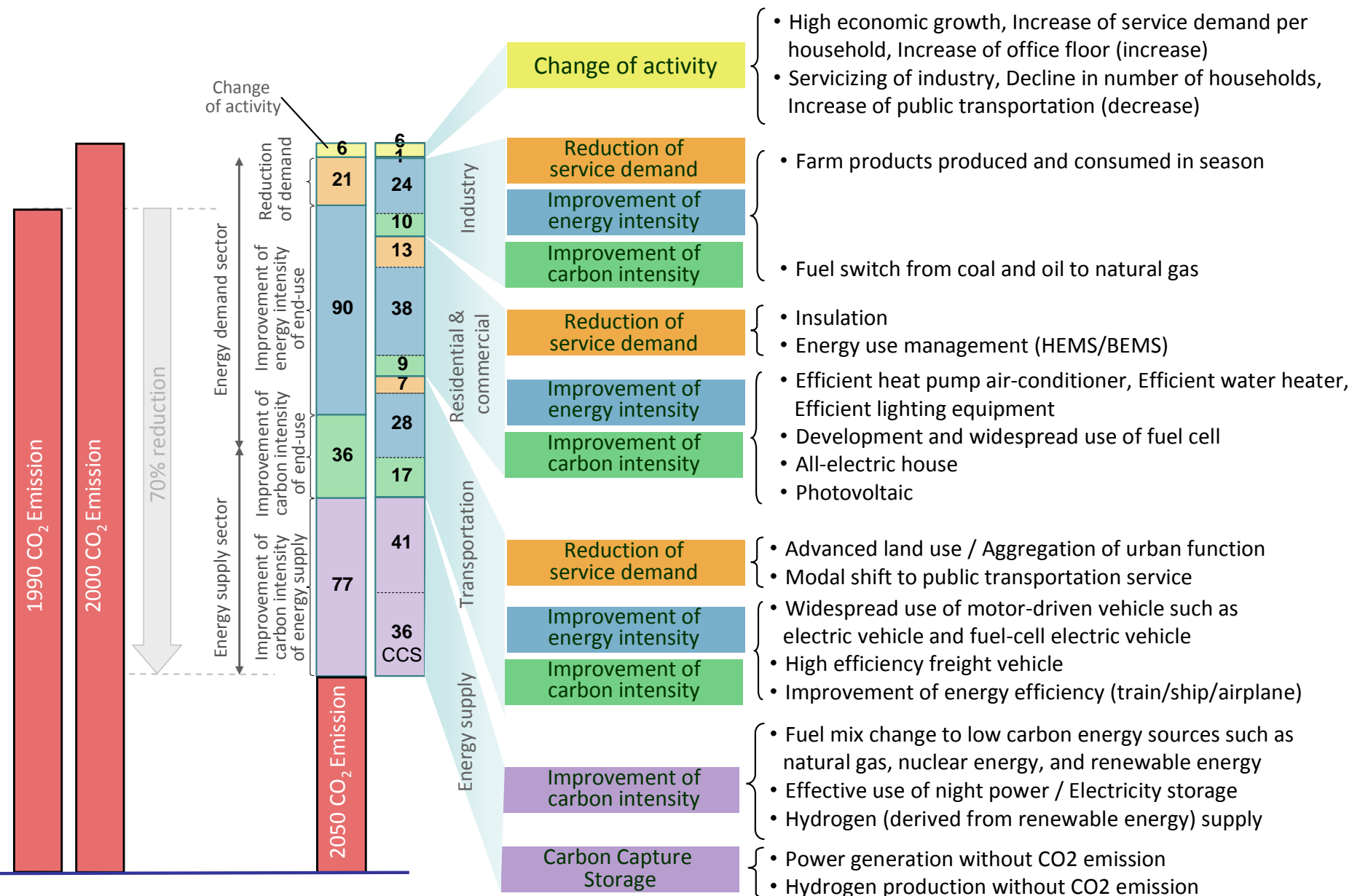
Doraemon is a Japanese comic series created by Fujiko F. Fujio. The series is about a robotic cat named Doraemon, who travels back in time from the 22nd century. He has a pocket, which connects to the fourth dimension and acts like a wormhole.



Satsuki and Mei's House reproduced in the 2005 World Expo. Satsuki and Mei are daughters in the film "My Neighbor Totoro". They lived in an old house in rural Japan, near which many curious and magical creatures inhabited.



# GHG 70% reduction in 2050 for Scenario A: Vivid Techno-driven Society



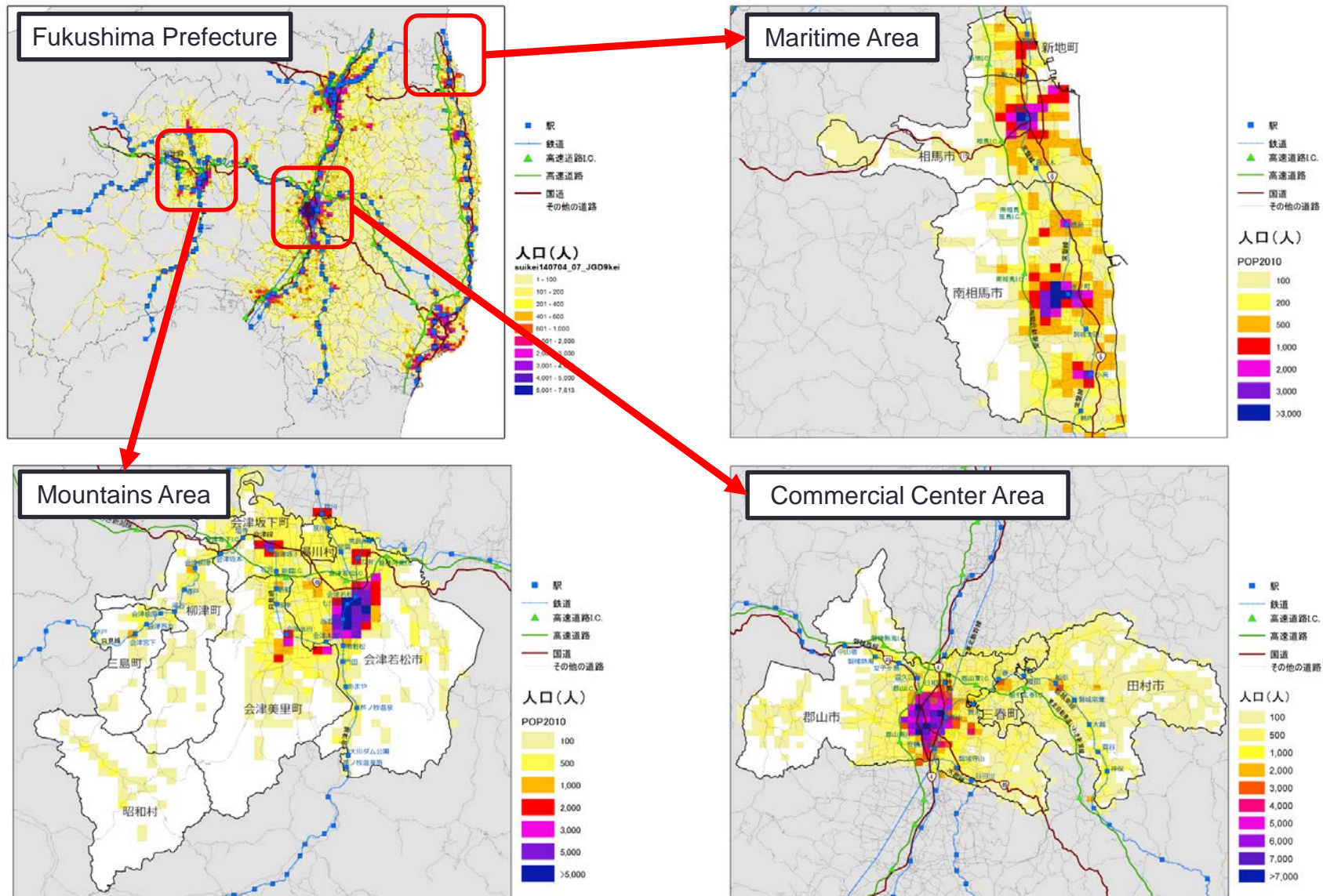
# Our Current Challenge: How to Mobilize People and Society?

- Transition to the Sustainable Society needs to *gain the cooperation of a wide range of stakeholders*, including policy makers, international aid agencies, private companies, local communities and NGOs.
- However, in many cases, *national* solutions are *solutions for somebody that one is not*.
- For getting their concern, science and research are expected to *establish methodologies and deliver actions and roadmaps effective for their daily lives and businesses – **FOR THE CITY!***



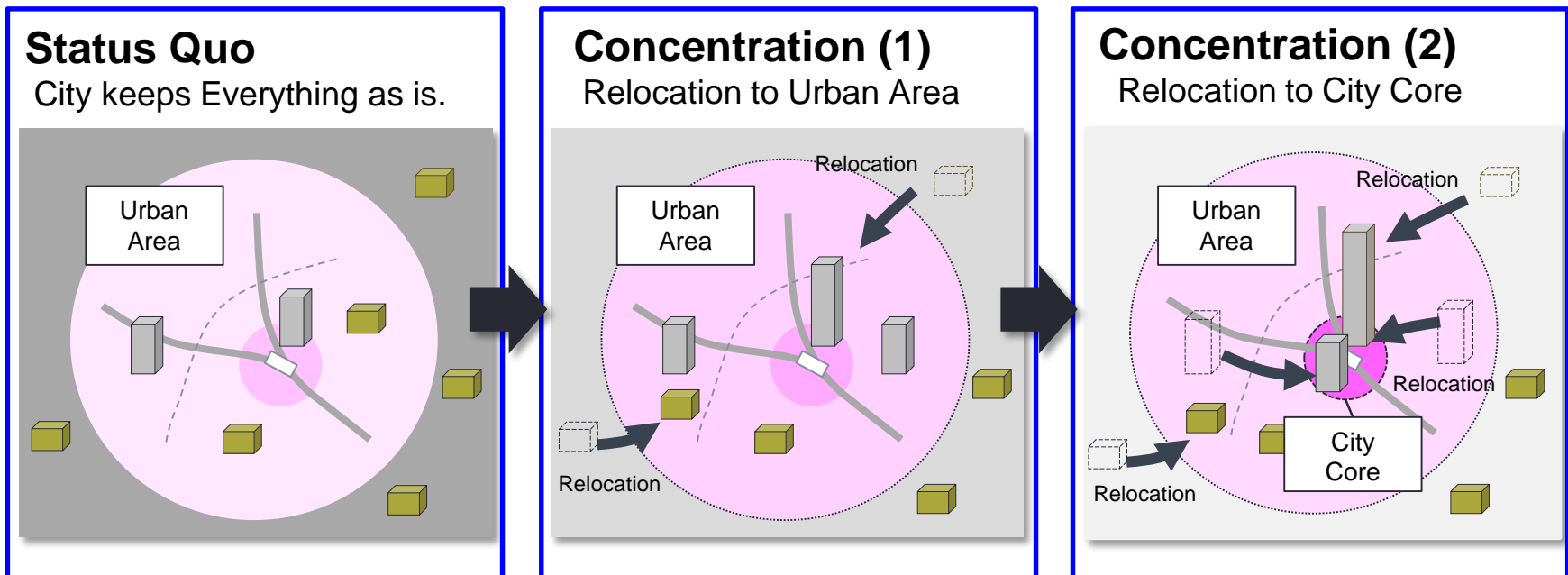
# City is Homogeneous?

Distribution of Population in Fukushima Prefecture, Japan



# Changing City Structure will be Expected both Developing and Developed Countries

- Cities will transform at any one time.
- Some city will be centralized, and others will be decentralized.
- Policy and Business (including transportation authority) lead such transformation.

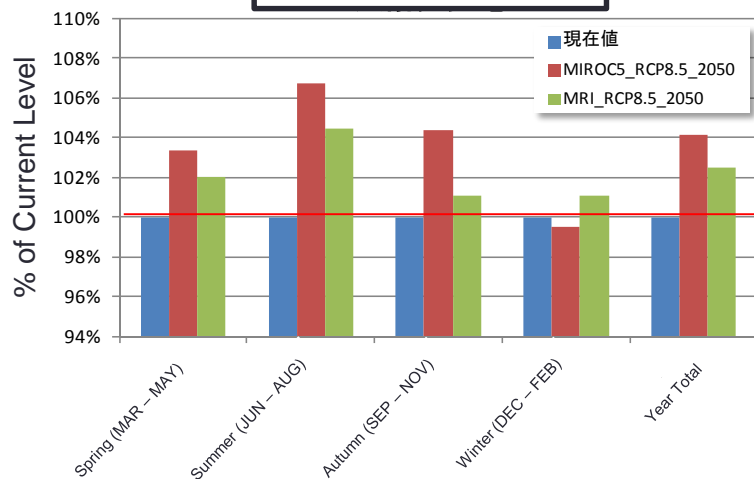


# Climate Change affects Solar and Wind Outputs

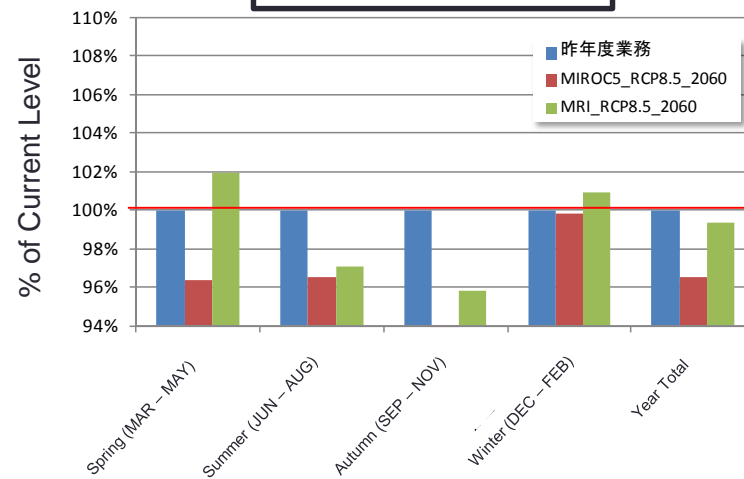
## Renew-able but Vari-able over the Period

- Yearly solar potential will be changed *from 99% to 107%* of current level.
- Yearly wind potential will be changed *from 92% to 102%* of current level.

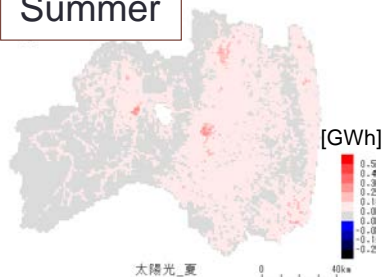
### Solar Potential



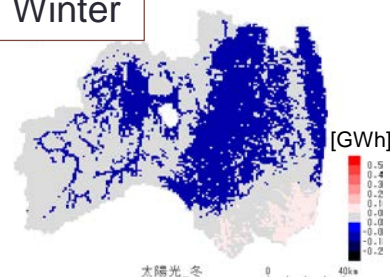
### Wind Potential



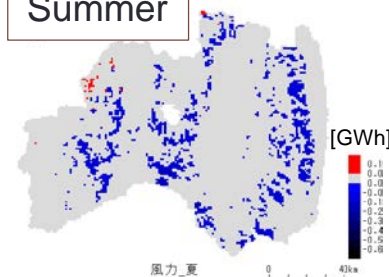
### Summer



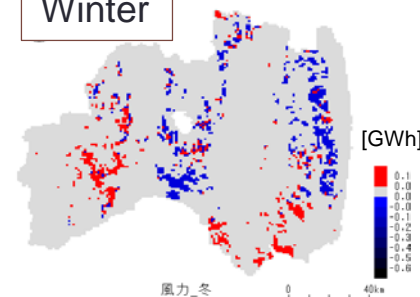
### Winter



### Summer



### Winter



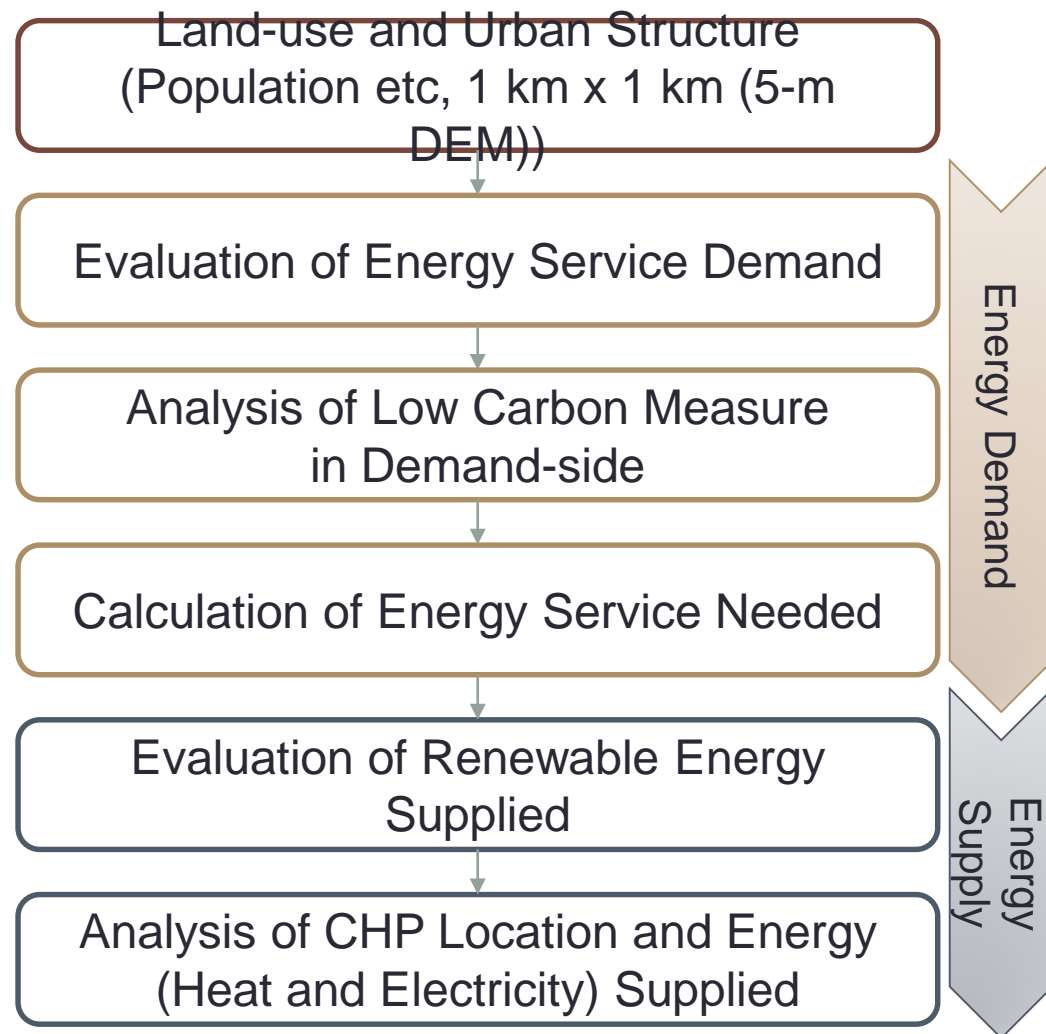
Decrease (Blue) ← Current Level → Increase (Red)

Decrease (Blue) ← Current Level → Increase (Red)

GCMs (MIROC and MRI) are used for future climate change / Target area: Fukushima Prefecture, 1 km resolution DEM / Target Year: 2030, 2050, and 2070

# Analytical Flow of Developed Model

- The model calculate energy service demand and energy supplied **based on Land-use and urban structure**.
- **5-m DEM** is used for energy service calculation.
- Energy supplied from renewables and CHPs are determined energy demand-supply balance in the city/area.



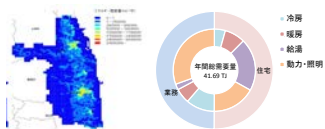


# Detailed Structure of Developed Model

## Energy Demand Analysis

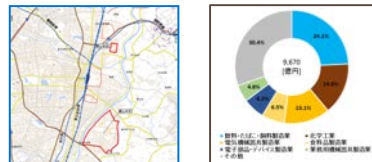
### Spatial Distribution of Energy Demand

Evaluation of Current and Future Energy Demands by Mesh.



### Industrial Symbiosis

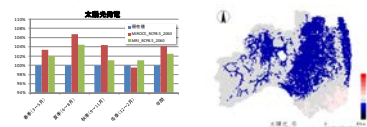
Industrial Demand and Design System based on idea of Industrial Symbiosis



## Energy Resource Analysis

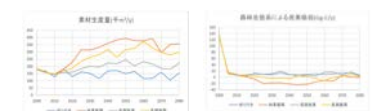
### Solar and Wind Potentials

Evaluation of Solar and Wind Potential in consideration of Climate Change



### Design on Biomass Distribution System

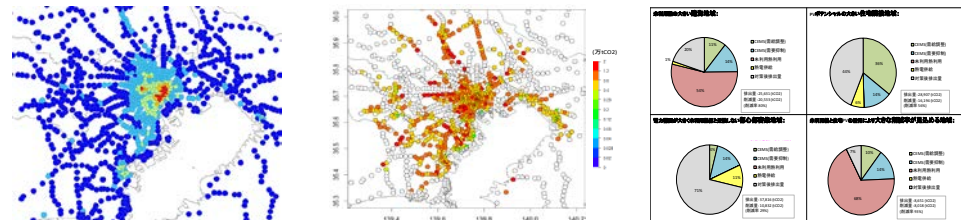
Design System for Biomass Distribution and Evaluation of Supply Potential



## Comprehensive Design on Regional Energy System

### (c) Low Carbon Energy System Design Model for Region and Urban Area (Regional AIM/Enduse)

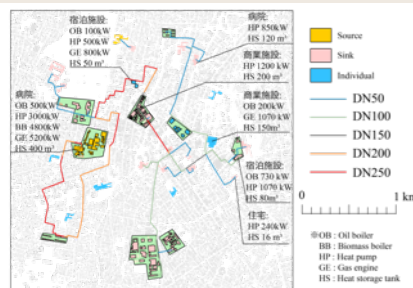
Design on Regional/Urban Area Energy System based on Spatial Distribution of Energy Demands and Resources, and Evaluation of Impacts on Low Carbon (CO2 Reduction) by Implementing the Designed System.



## Design on Energy Infrastructure

### Locational Planning on Energy Infrastructure

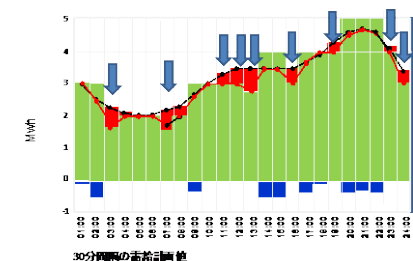
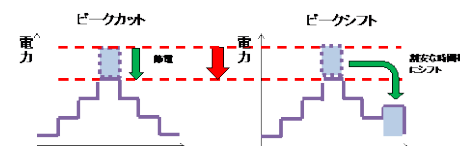
Design on Locational Planning on Energy Infrastructure based on Spatial Distribution of Energy Demands and Resources.



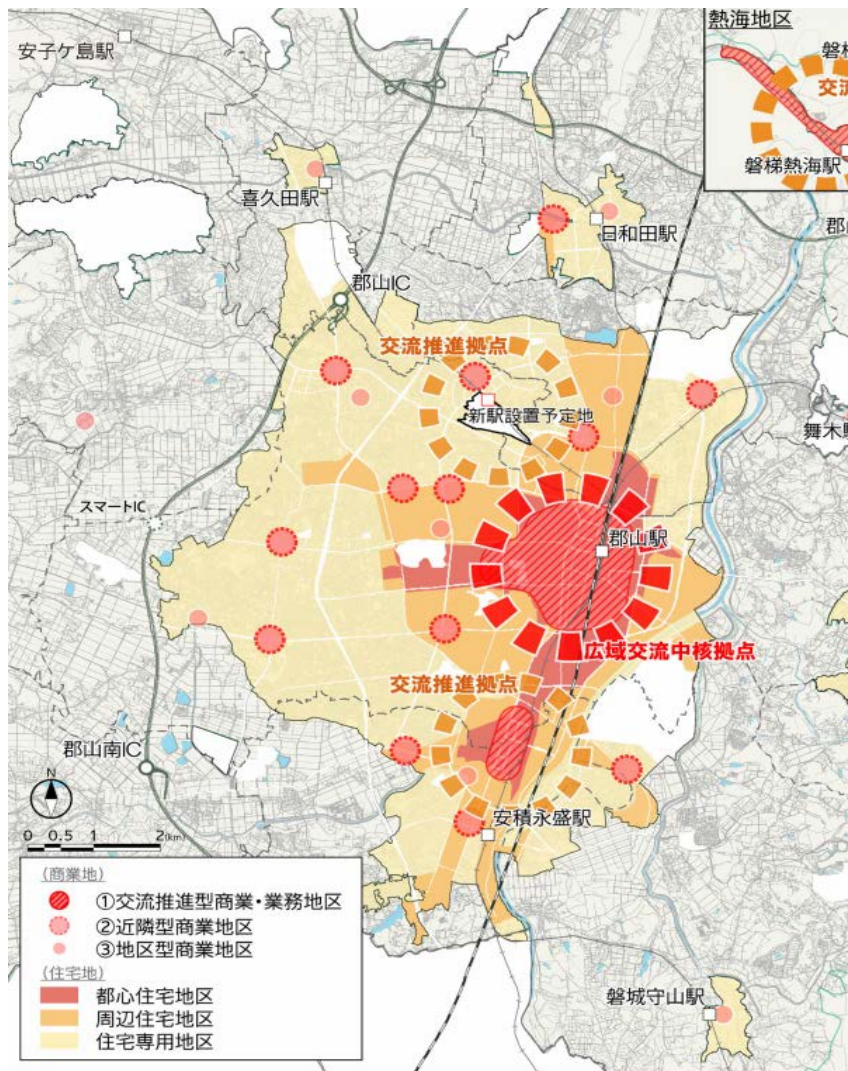
## Simulation of Energy Management

### Simulation Tool for Energy Demand Management

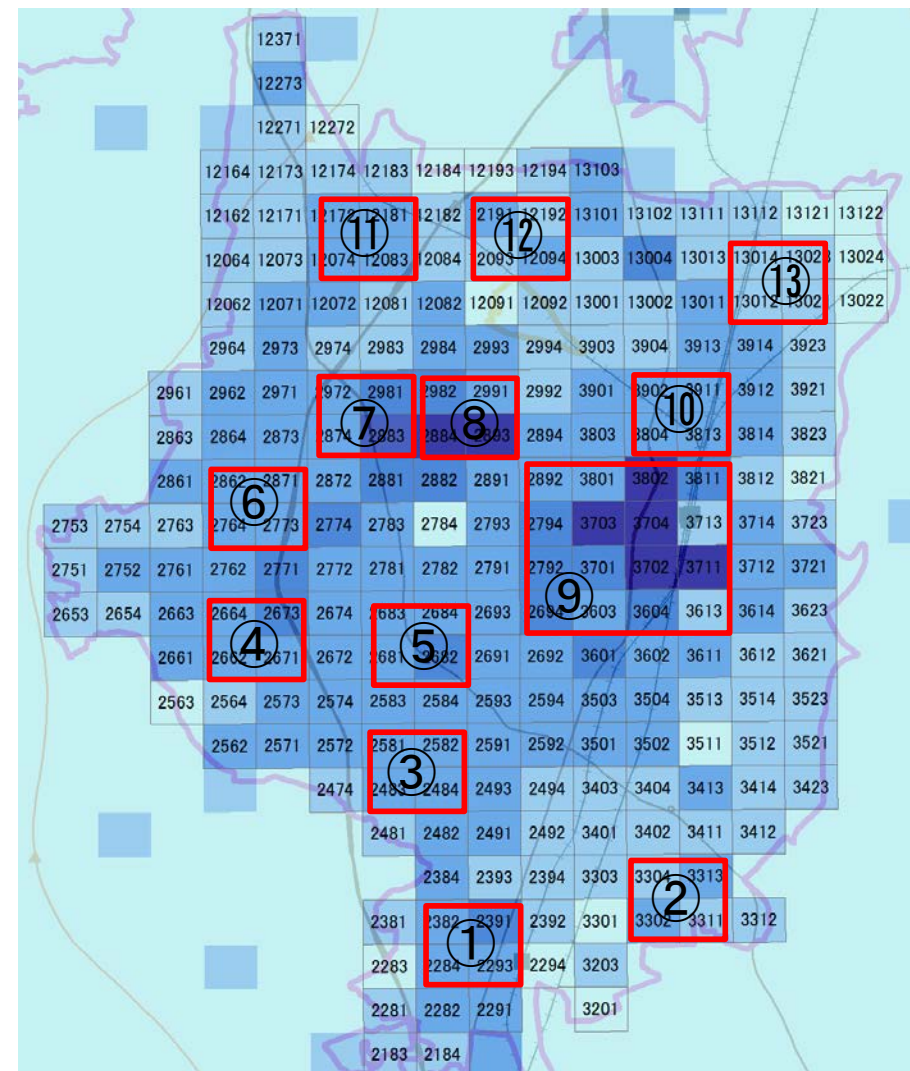
Simulation Tool for Impacts of Energy Management System on Demand Reduction



# Target City: Koriyama in Fukushima



Urban Strategy by the Government

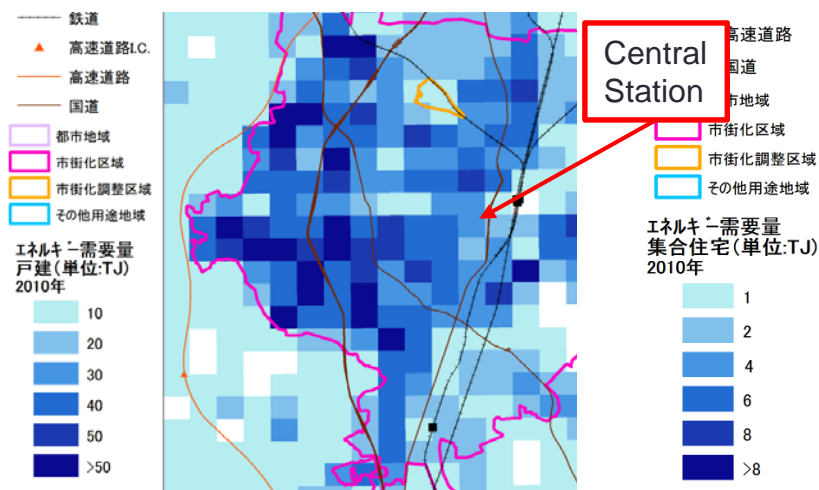


Modeled Urban Centers and Population Distribution

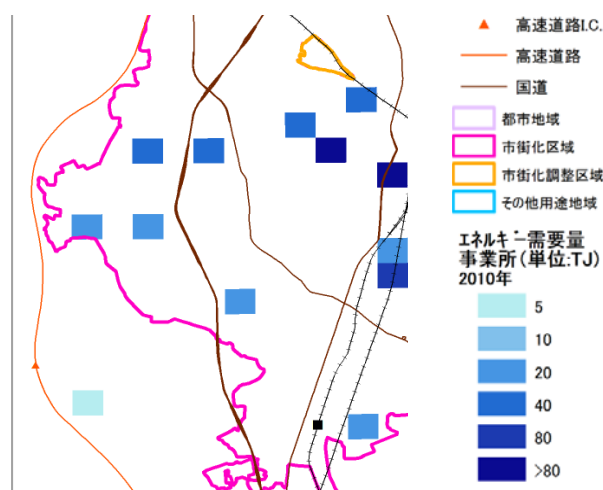


## Results in Koriyama: Energy Service Demands

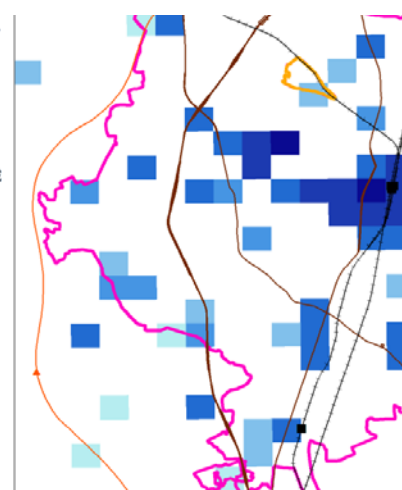
- Energy service demand distributes almost in accordance with urban area.
- High energy service demands for **detached house** can be observed **suburbs**, in contrast, that for **multifamily buildings and commercial buildings** are in **city centers**.



Detached House



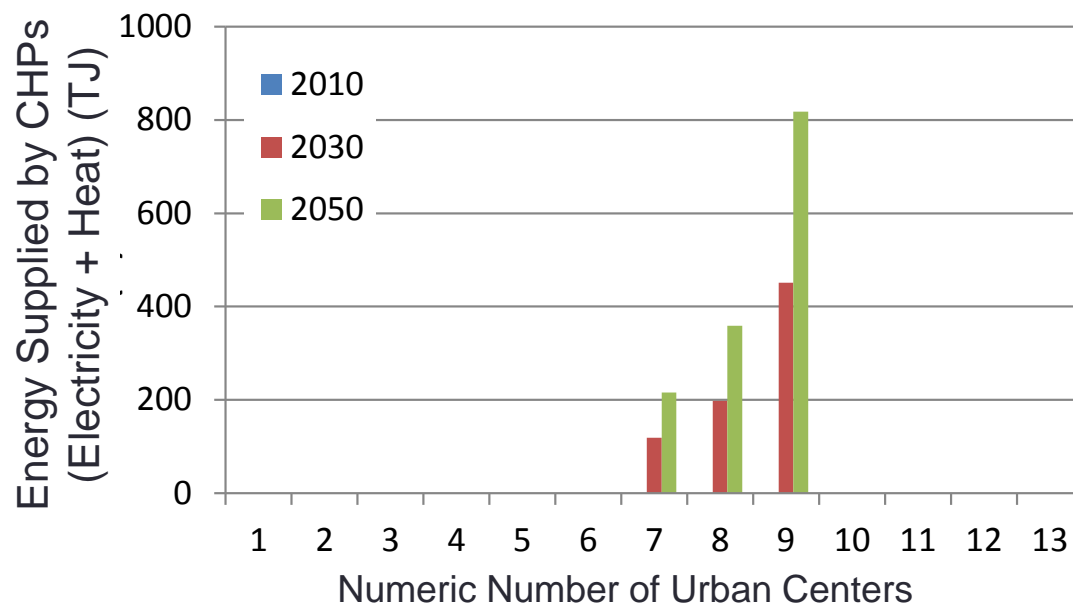
Multifamily Buildings



Commercial Buildings

## Results in Koriyama: Feasibility of CHPs

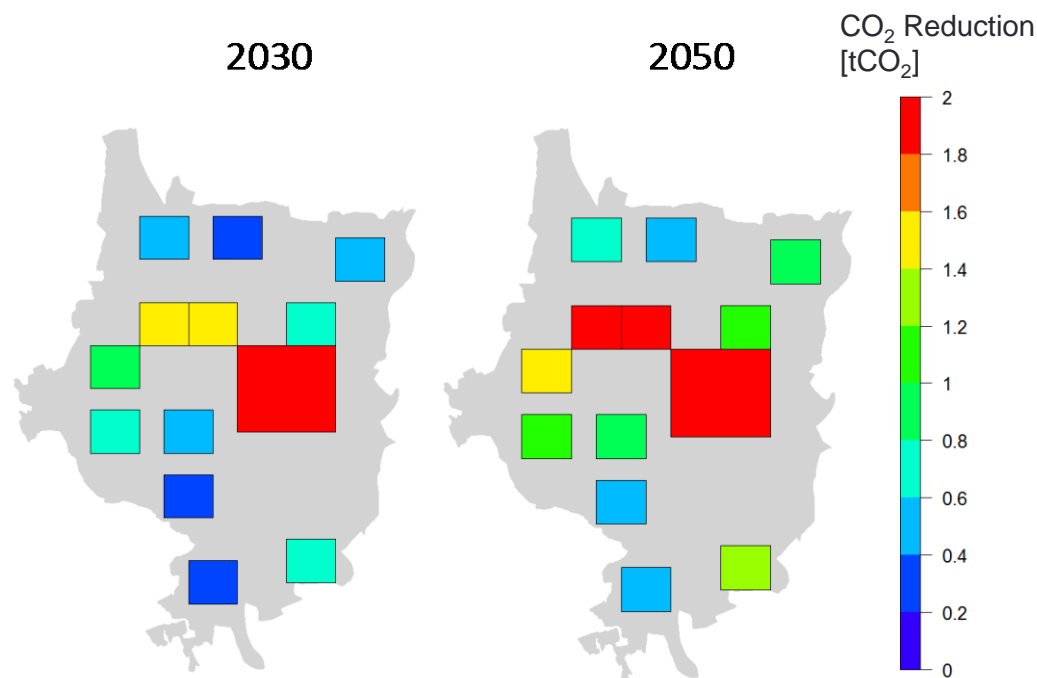
- CHP business could be successful in the area with **7,000 person/km<sup>2</sup> and 7,000 employees/km<sup>2</sup>**.
- Only three (3) center cores can be installed CHP system.
  - Center 7 and 8: Surrounding Area of City Hall, Hospitals and Shopping Centers
  - Center 9: Surrounding Area of Central Station



Amount of Energy Supplied by CHPs

## Results in Koriyama: Reduction of CO<sub>2</sub> Emissions

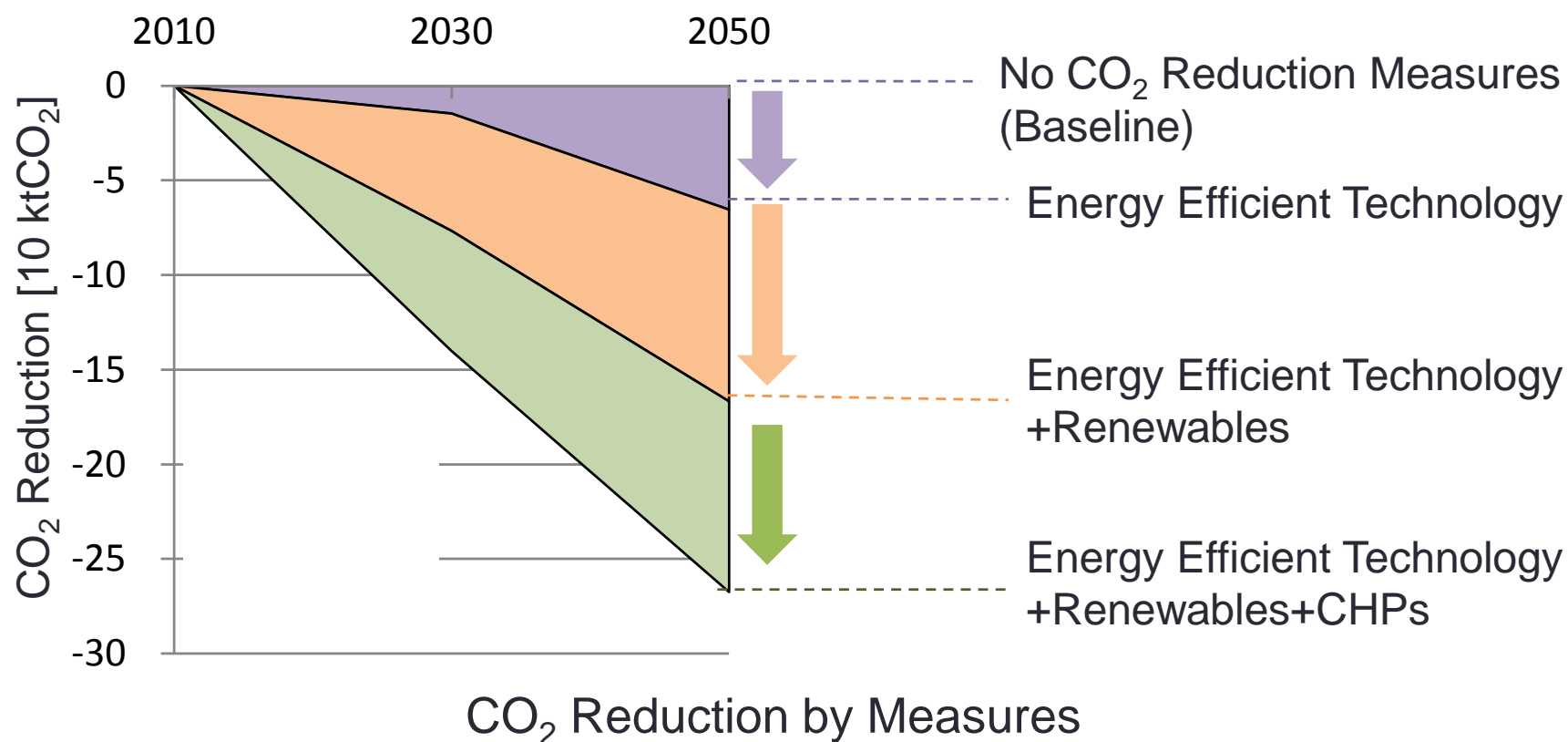
- Installation of **PV system and CHPs** leads to the reduction of CO<sub>2</sub> emissions in Center 7 & 8 (**near City Hall**) and Center 9 (**near Central Station**).
- **Energy efficient appliances and renewables** are main sources of CO<sub>2</sub> reduction in **suburb area**.



Amount of CO<sub>2</sub> reduction by Centers

## Results in Koriyama: Contribution by Measures

- Total amount of CO<sub>2</sub> reduction in 2050 is **270 ktCO<sub>2</sub>**.
  - **22.7%** of total CO<sub>2</sub> emissions in 2007 (1,187 ktCO<sub>2</sub>)
- CO<sub>2</sub> reduction comes from **24% of energy efficient technologies, 38% of PV and 38% of CHPs**.



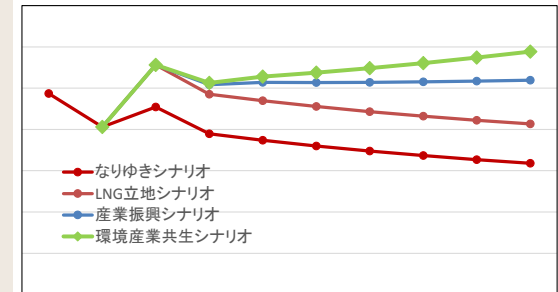
# Holistic Design System for Smart City: New Paradigm is Needed

- Three different but mutually interrelated designing methodology should be developed.

## 1. Macro Design of the city

**Alternative future vision**

- Population, industries
- Core developments
- Energy locality



## 2. Spatial Design

**Land use zoning /network design**

Vision of the City

- Land use distribution patterns
- Local energy network
- Location of core developments

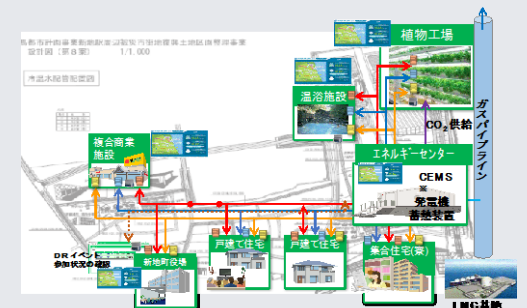


## 3. Project Design

**Core projects for Smart City**

Area Design

- Zoning and regulation
- District planning
- HEMS/BEMS/CEMS
- Energy grid design



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*environment research based on a firm  
understanding of the interaction between  
nature, society, and life on our planet.*

Thank You for Your Kind Attention!