

Development of Multi-layered Regional Integrated Modeling System

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The presentation includes research outcomes from The Environment Research and Technology Development Fund (ERTDF, 2-1402 and 2-1404), the “Project to Advance MRV and Related Techniques in Indonesia for the Promotion of a Joint Credit Mechanism (from FY2014-2016)”, and the “Project to Promote CO2 Technology Assessment (from FY2014-2016)” of Ministry of the Environment, Japan.

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December 10, 2016 at Ohyama Memorial Hall, NIES, Tsukuba, Japan

Key Points of the Paris Agreements

- **Long-term goal**

- Keeping warming *below 2 degrees Celsius*, while *pursuing actions to stay under 1.5 degrees*.
- *Reaching net zero GHG emissions* in the second half of the century.

- **Emissions targets**

- Setting national targets for reducing GHG emissions *every five years*.
- Tracking progress towards the long-term goal through a robust transparency and accountability system.

- **Loss and Damages**

- *Recognizing the importance* of averting, minimizing and addressing *loss and damage* associated with the adverse effects of climate change.



What we should do: ***Taking the Actions for LCS ASAP!***

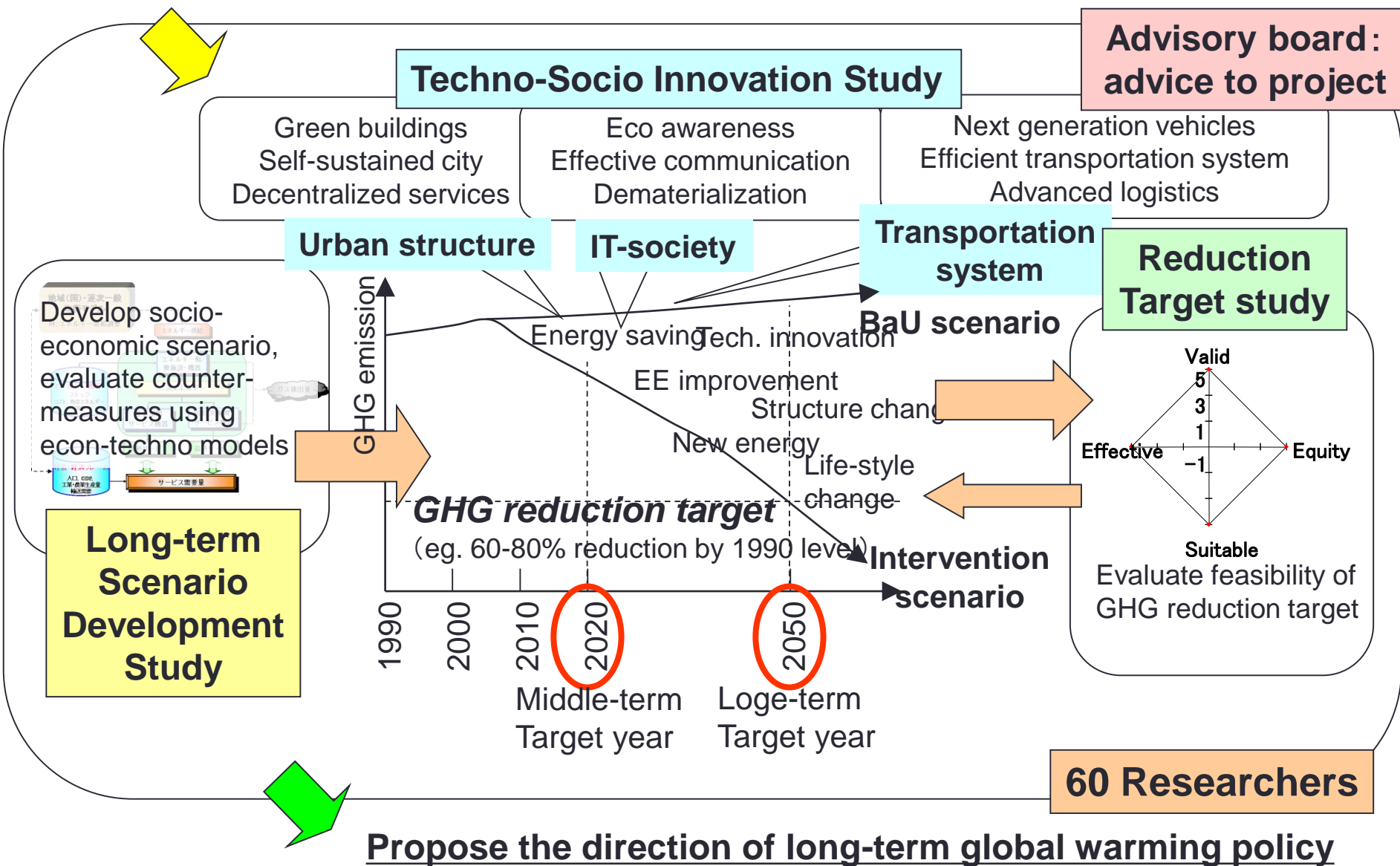
However...

- **All we know** *Taking Action is Important!*
Why We need to Reduce GHGs!
- **Less we know** *How* We Can Reduce GHGs?
What Action is Suite for Us?
Who's Actions are Crucial for?
Where is a Source of GHGs?
How Much does it Cost?


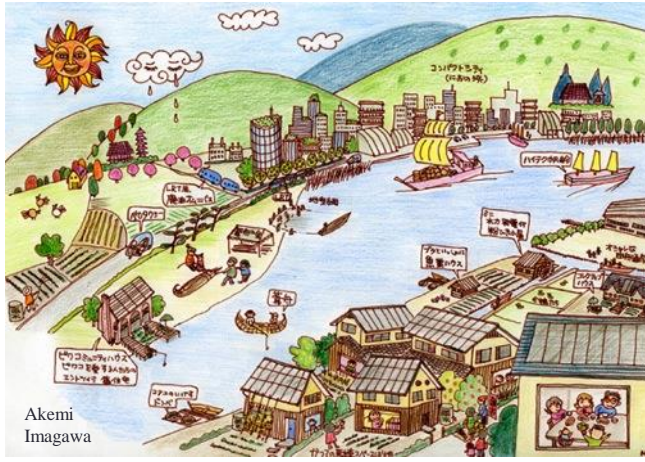


Science and Research could deliver Solutions and Roadmaps toward Low Carbon Society

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”
Vivid, Technology-driven	Slow, Natural-oriented
Urban/Personal	Decentralized/Community
Technology breakthrough Centralized production /recycle	Self-sufficient Produce locally, consume locally
Comfortable and Convenient	Social and Cultural Values
2%/yr GDP per capita growth	1%/yr GDP per capita growth
	

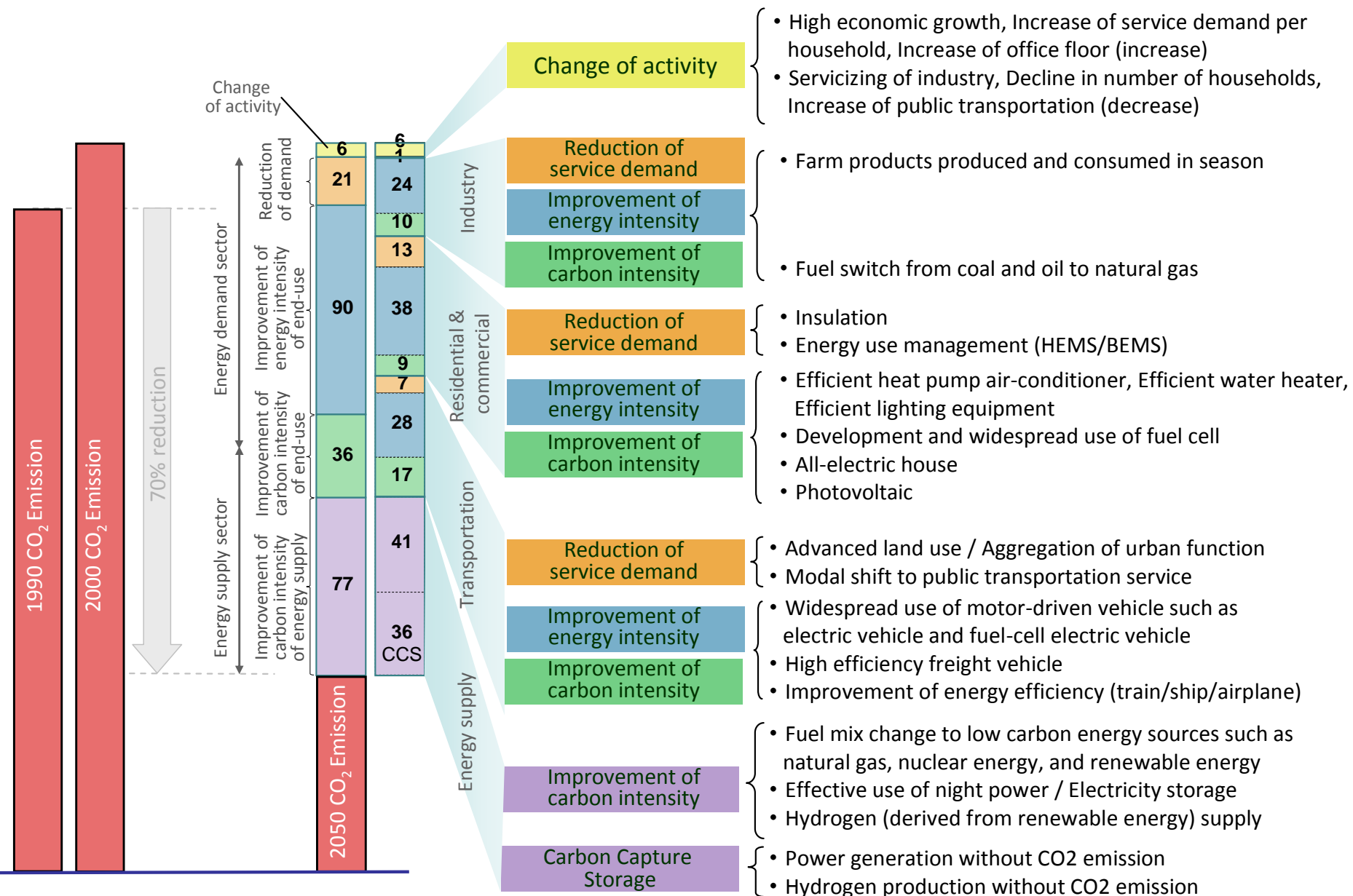


Doraemon is a Japanese comic series created by Fujiko F. Fujio. The series is about a robotic cat named Doraemon, who travels back in time from the 22nd century. He has a pocket, which connects to the fourth dimension and acts like a wormhole.



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 LCS 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!***

Past Experiences in AIM: Designing City LCS Scenario by using IAMs



The AIM has been developed national scenarios and sub-national scenarios such as Kyoto, Shiga and Iskandar Malaysia.

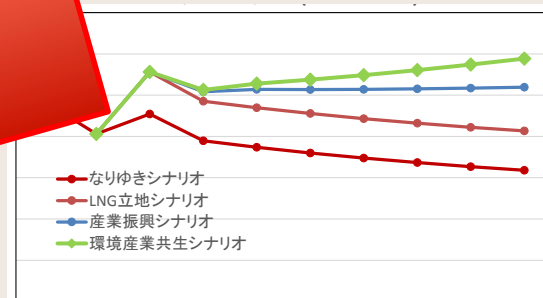
Holistic Design System for Smart City: New Paradigm is Needed

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

1. Macro Design of the city

Alternative
future vision
by locality

DONE!



Vision of the City

2. Spatial Design

Land use zoning
/network design

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

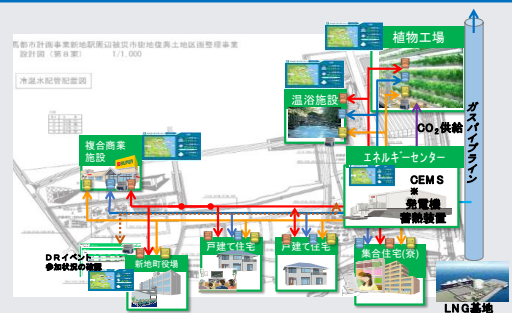


Area Design

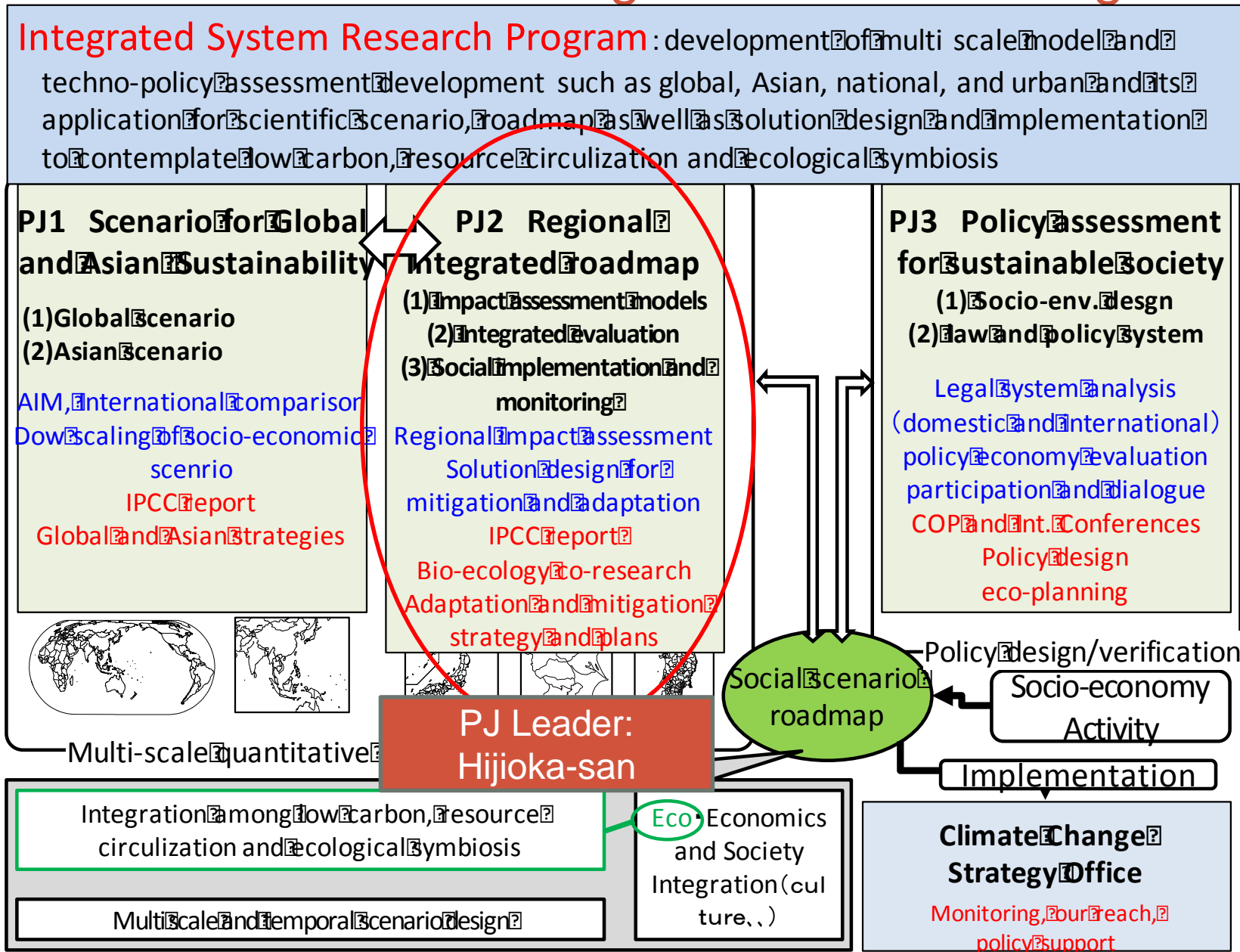
3. Project Design

Core projects for
Smart City

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



Overall Structure of Integrated Research Program



Overview of Regional Energy System Design Models

Energy Demand Analysis

(a-1) Spatial Distribution of Energy Demand

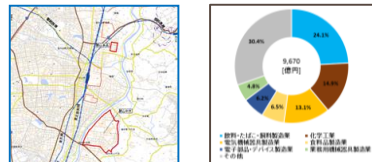
Evaluation of Current and Future Energy Demands by Mesh.



(NIES and MRI)

(a-2) Industrial Symbiosis

Industrial Demand and Design System based on idea of Industrial Symbiosis

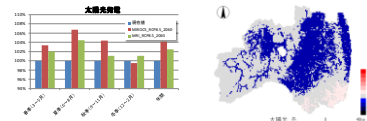


(NIES and Nippon Koei)

Energy Resource Analysis

(b-1) Solar and Wind Potentials

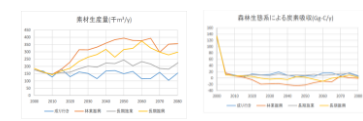
Evaluation of Solar and Wind Potential in consideration of Climate Change



(NIES and MHIR)

(b-2) Design on Biomass Distribution System

Design System for Biomass Distribution and Evaluation of Supply Potential



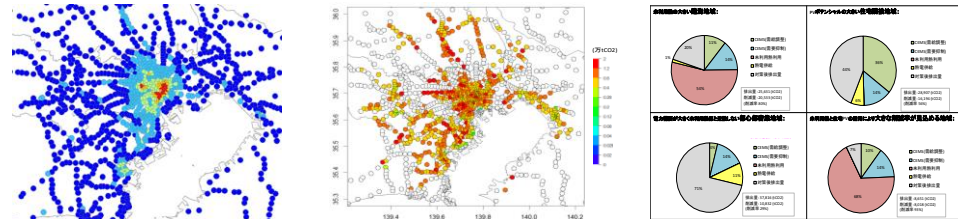
(NIES and MRI)

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.

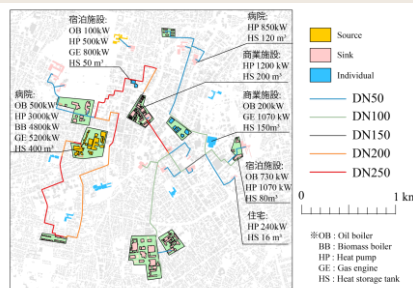
(NIES and MRI)



Design on Energy Infrastructure

(d) Locational Planning on Energy Infrastructure

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

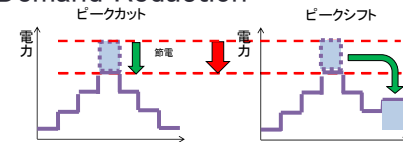


(NIES and Tohoku University)

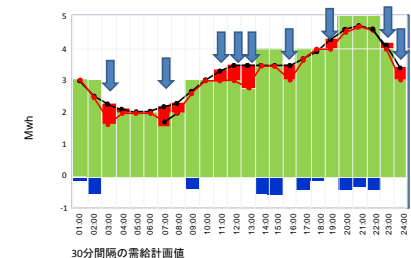
Simulation of Energy Management

(e) Simulation Tool for Energy Demand Management

Simulation Tool for Impacts of Energy Management System on Demand Reduction



(NIES and Infinity Technology)



(b-1) Evaluation of Solar and Wind Potentials in consideration of Climate Change

Objective

- Evaluation of Future Solar and Wind Potentials in consideration of Climate Change
- Future Changes in Insolation and Wind Conditions are determined by using results of GCMs (MIROC, MRI and so on)

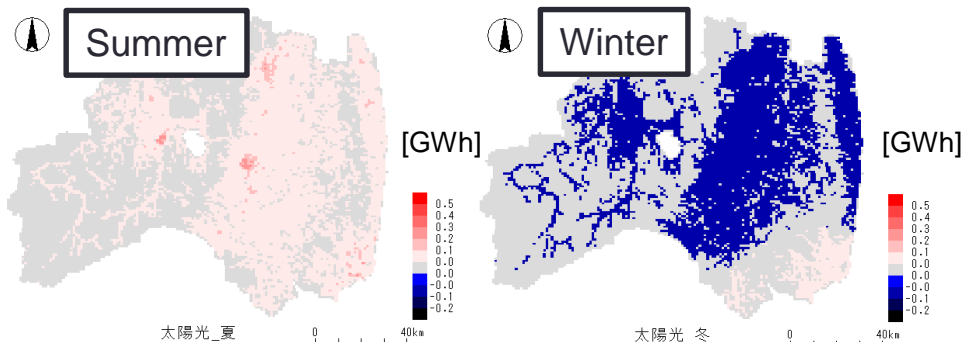
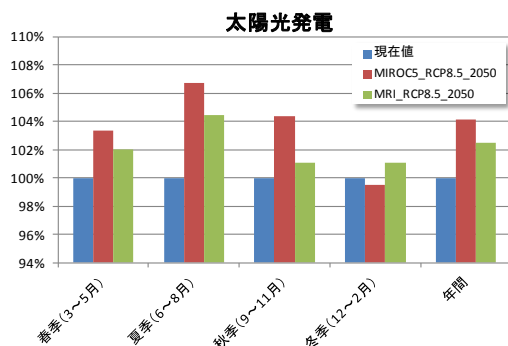
Settings

- Target Area: Fukushima Prefecture, 1 km resolution DEM
- Emission Scenarios: RCPs
- Target Year: 2030, 2050, and 2070

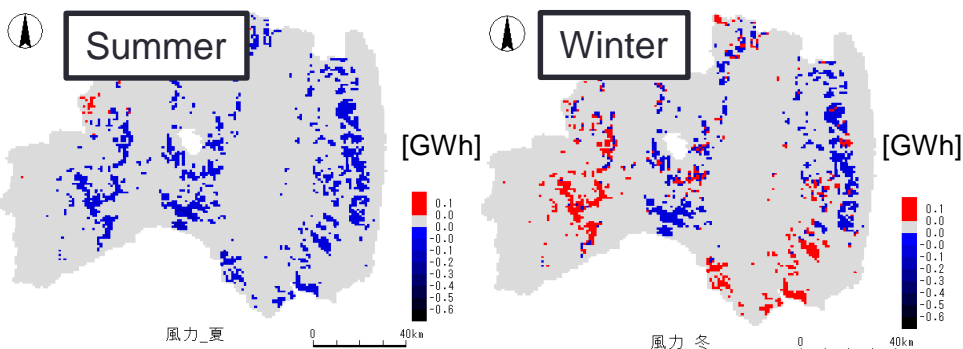
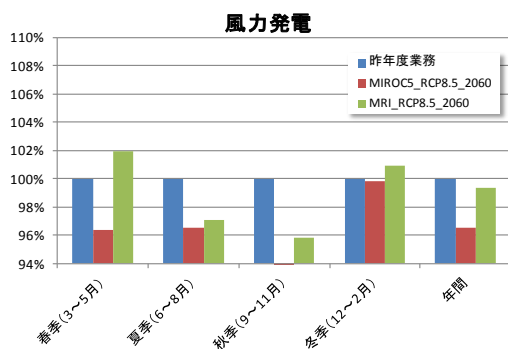
Joint Work with MHIR (Mainly Oka-san)

Outputs

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.



(d) Locational Planning on Energy Infrastructure

Objective

- Design on Locational Planning on Energy Infrastructure based on Spatial Distribution of Energy Demands and Resources by using optimization model.

Settings

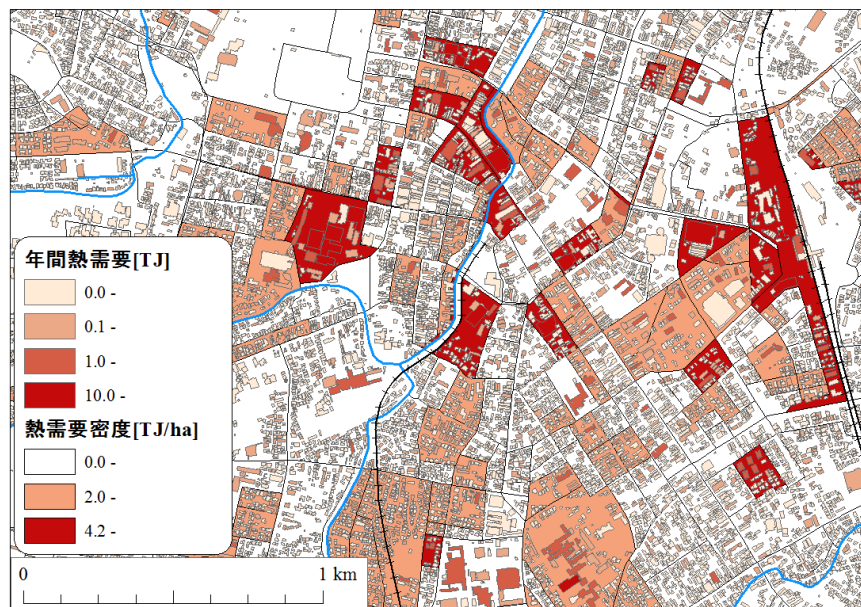
- Modeling Framework: Mixed Integer Linear Programming (MILP)
- Target Area: Urban Area in Fukushima Prefecture with 4–10 km² area
- Time Resolution: 8760 hours in a year

Joint Work with
Tohoku University

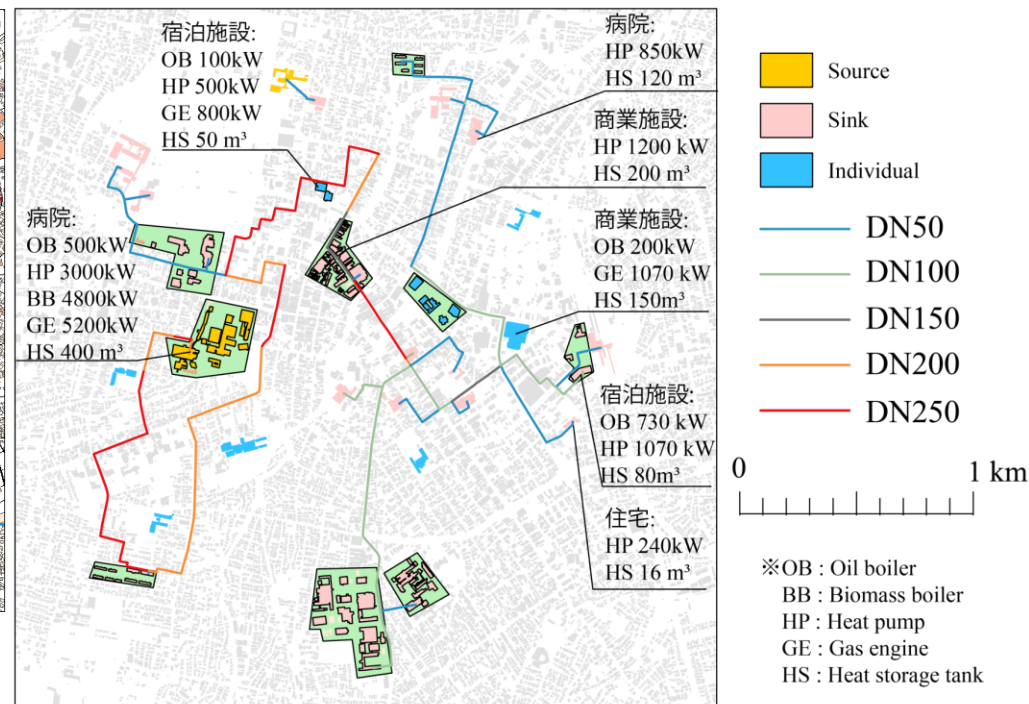
Example Outputs

Past Experiences: Hirosaki city, Aomori Prefecture (Northern Area of Honshu)

◆ Heat Demand Map



◆ Locational Planning of Energy Infrastructure



(e) Simulation Tool for Energy Demand Management

Objective

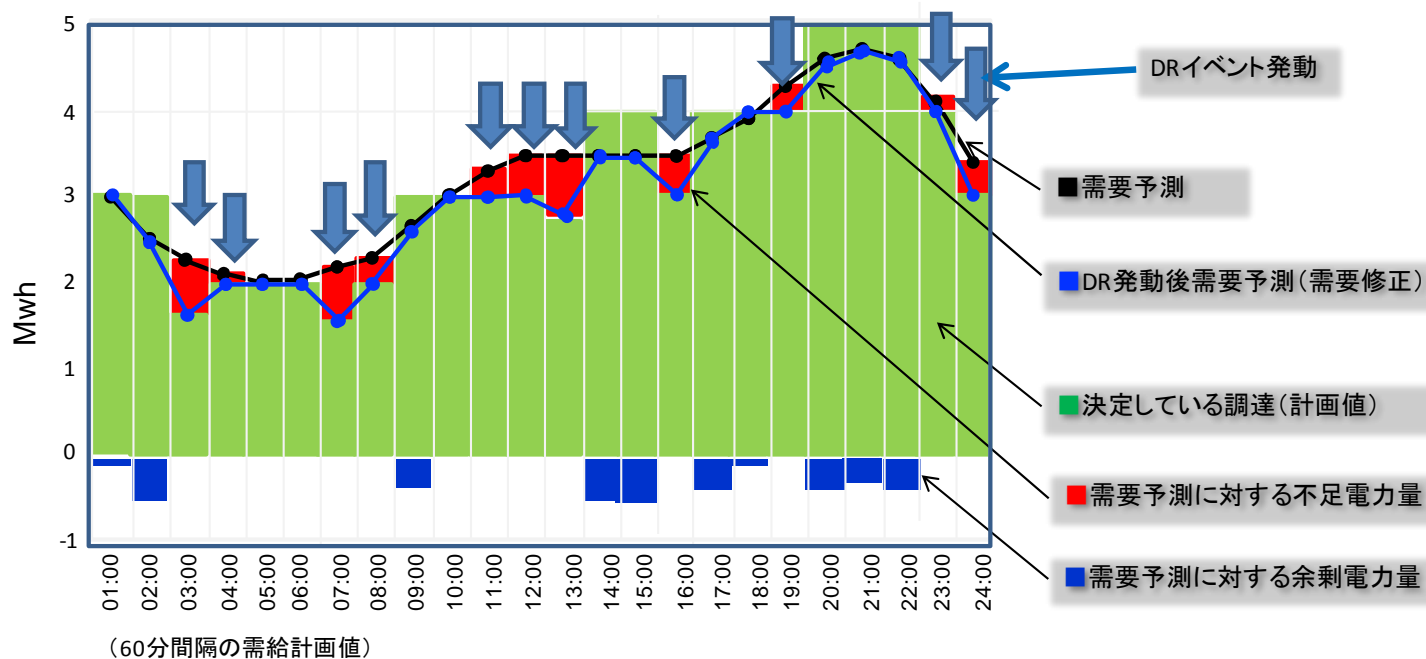
- Development of Simulation Tool for Energy Management in the Residential, Commercial and Industrial Sectors. The Tool includes
- Developed System will be implemented in Cloud Server.

Settings

- Time Resolution: 8760 hours in a year
- The System includes Energy Consumption Prediction for Next Day.

Joint Work with
Infinity Technology

Expected Outputs



$$P_n = \alpha \times \beta \times B_n$$

P_n : 時刻 n の電力需要量(MWh) B_n : 時刻 n のベース電力需要量(MWh)

α : 休日変動係数 β : 日時変動係数

$$DR_n = \sum_s (S_{s,n} \times \gamma_{s,n} \times r_{s,n})$$

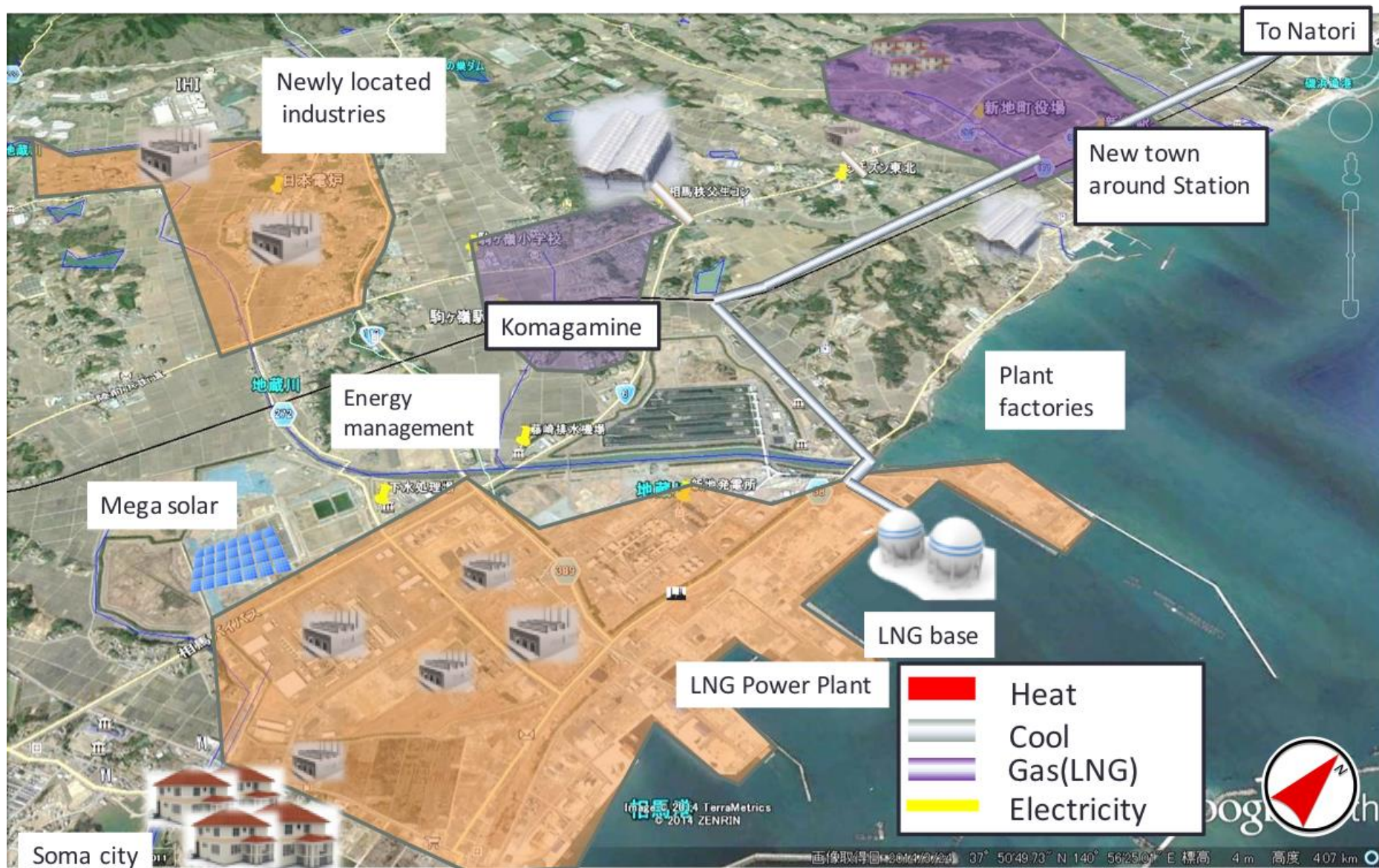
DR_n : 時刻 n のDR可能量(MWh) $S_{s,n}$: 時刻 n のDR対応設備需要量(MWh)

S : DR対応可能負荷種類

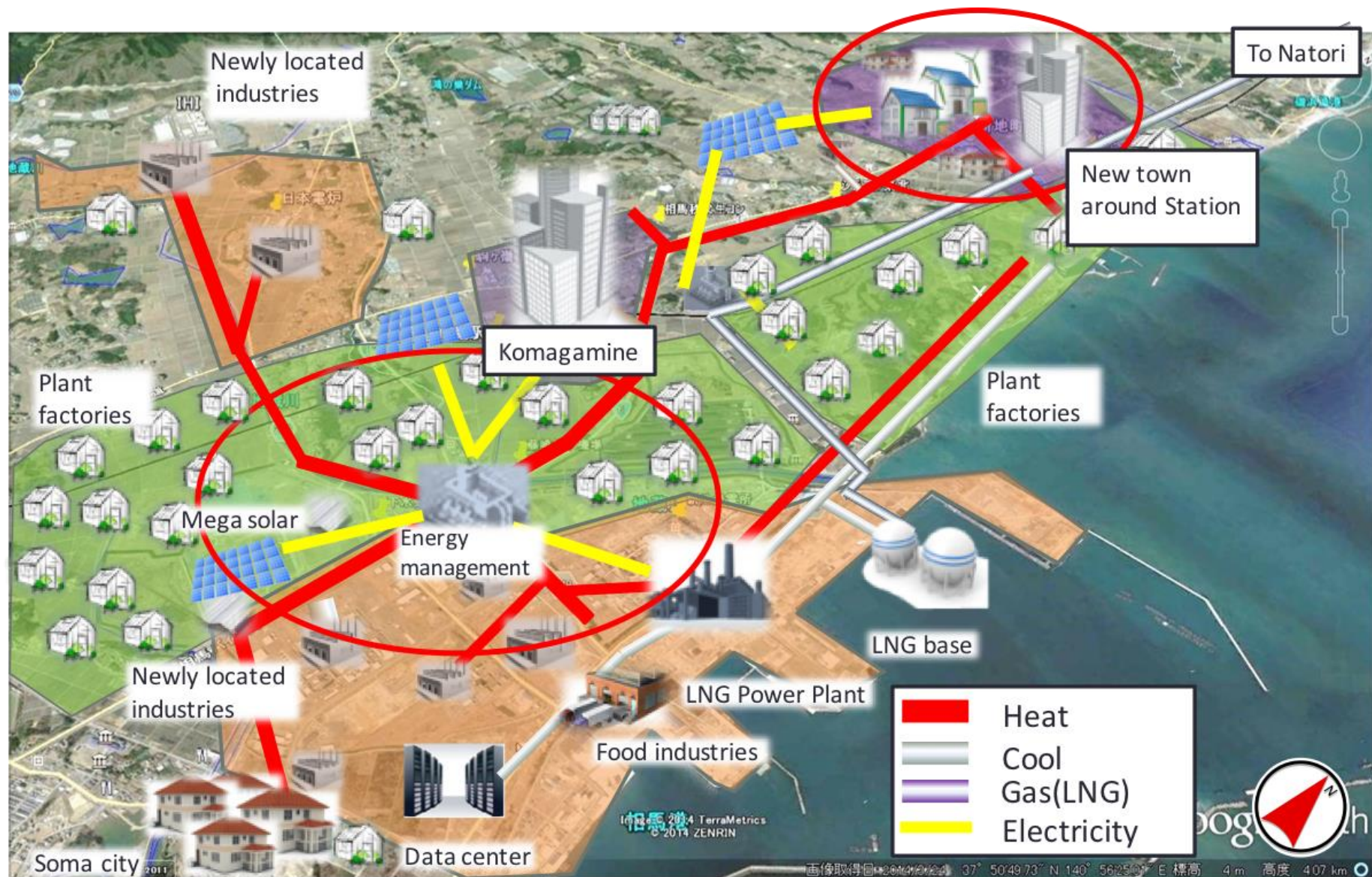
$\gamma_{s,n}$: 時刻 n のDR対応可能な需要抑制率(%)

$r_{s,n}$: 時刻 n のDR受諾率(%)

Spatial Design under the BaU scenario in 2030



Spatial Design for the Smart City in 2030



Evaluation of Impacts on Smart City

Alternative Spatial Scenario

Quantification of Impacts and Costs

BAU



+Compact
City

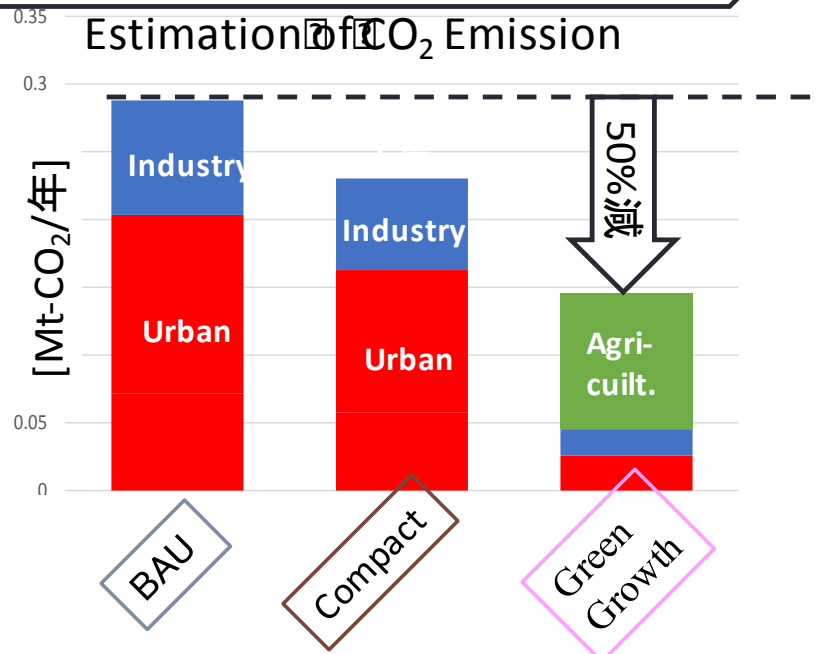


+Green
Growth



Effects of Local
Energy Management

Estimation of CO₂ Emission



Green growth can double the Carbon Efficiency

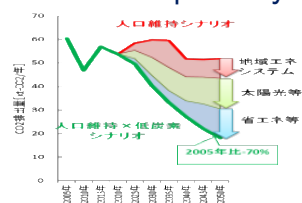
Next Challenge: Integration of Adaptation and Mitigation

【Mitigation Research】

Future scenario

Regional targets for decarbonization

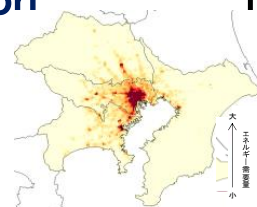
Socio-economic activities
Alternative pathways



Spatial scenario and tech-policy assessment

Spatial distribution scenario

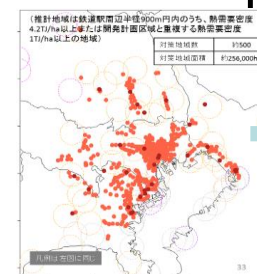
BAU, Land use control for concentration and adaptaion



Suitable tech.

Location assessment

mitigation and adaptation technology distribution

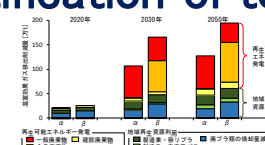


Future grand design

Integrative Local design for Eco-growth



Verification and certification of tech-poli.



Project design for eco-innovation

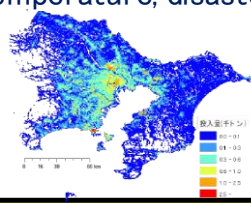
技術複合
需要供給
社会制度転換



Scientific verification through implementation research

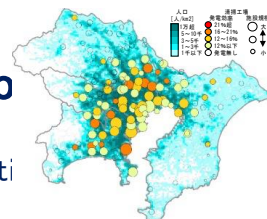
Climate change forecast with Regional Scale

Precipitation
temperature, disaster



Vulnerability assessment map

disaster resilience
agro-forestry product
health impacts



【Adaptation research】

National Institute for Environmental Studies

strives to contribute to society through

Networking, Integrating, Evolving and Synthesizing

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

Thank You for Your Kind Attention!