



Sector Level Policies: Research on Designing Smart Cities towards Low Carbon Society

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The presentation includes research outcomes from The Environment Research and Technology Development Fund (ERTDF, 2-1402, 2-1404, 2-1702 and 2-1711), the “Project to Advance MRV and Related Techniques in Indonesia for the Promotion of a Joint Credit Mechanism (from FY2014-2017)”, the “Project to Promote CO2 Technology Assessment (from FY2014-2017)” of Ministry of the Environment, Japan, and Japan and the Science and Technology Research Partnership for Sustainable Development (SATREPS) by JST/JICA (the Japan Science and Technology Agency and the Japan International Cooperation Agency).

The Training Programme on Climate Change for Bhutanese Policy Makers
February 7, 2018 at Climate Change Research Hall, NIES, Tsukuba

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...

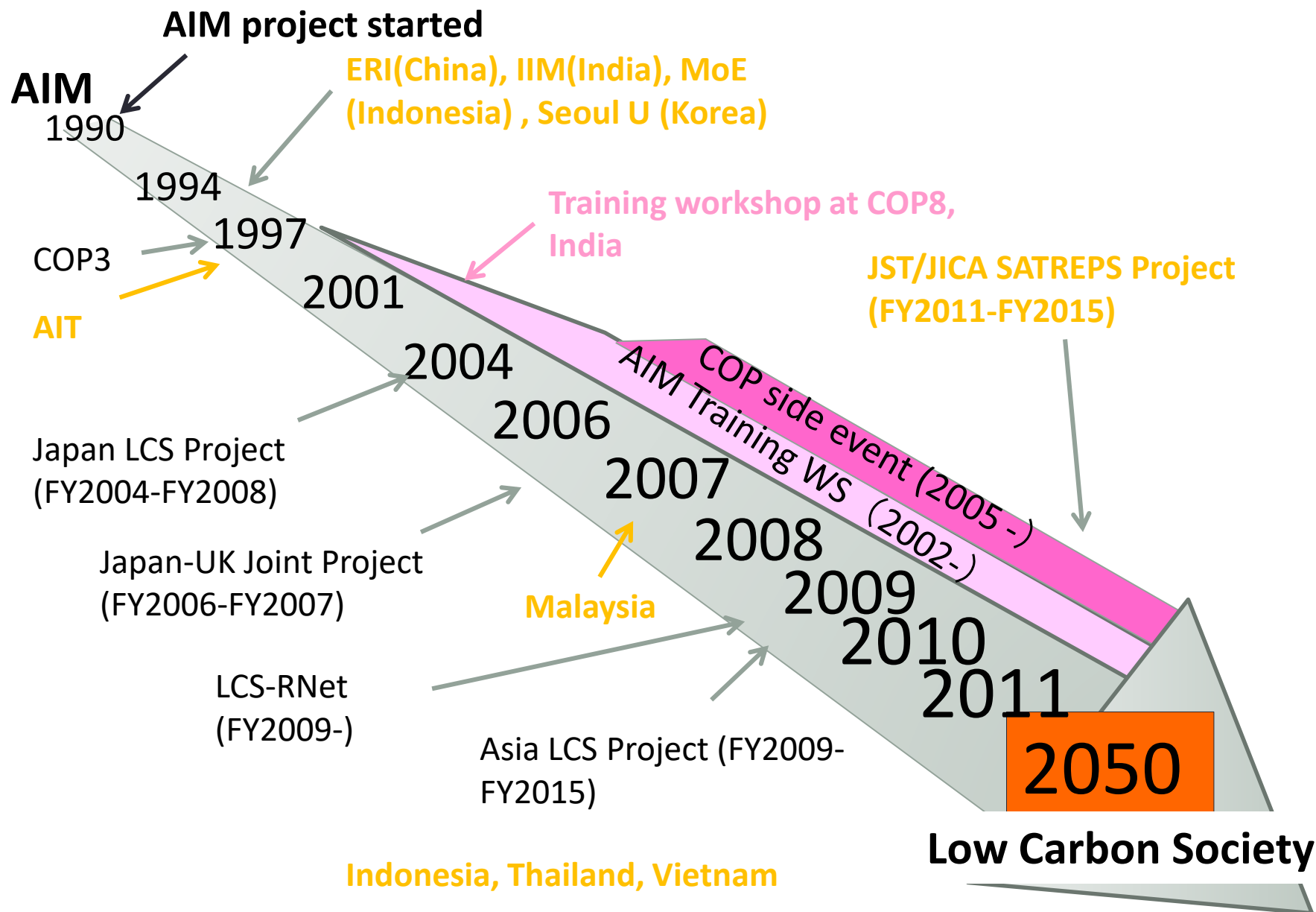
- **All we know** *Taking Action is Important!*
Why We need to Reduce GHGs!

- **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?

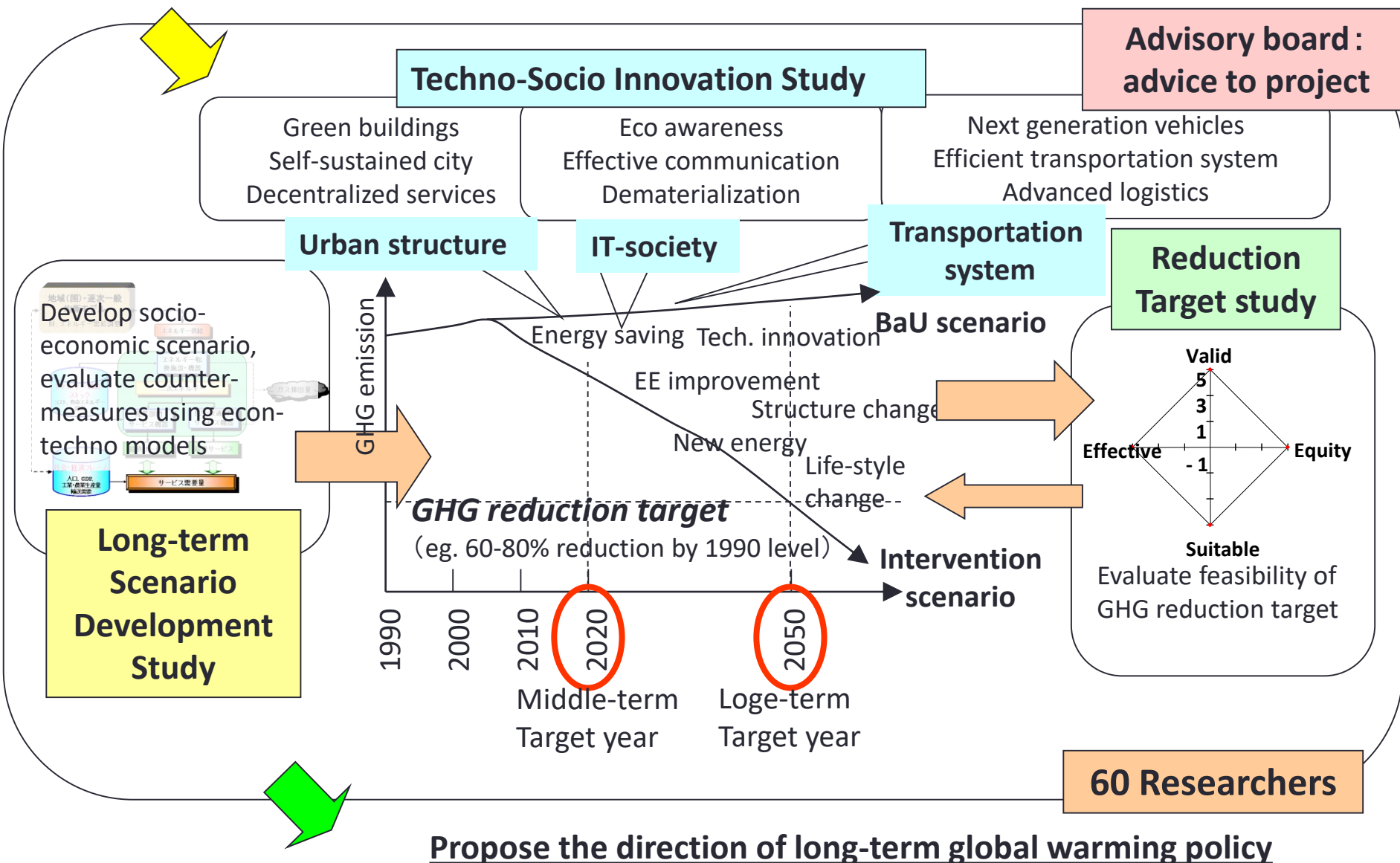


***Science and Research could deliver Solutions and Roadmaps
toward Low Carbon Society***


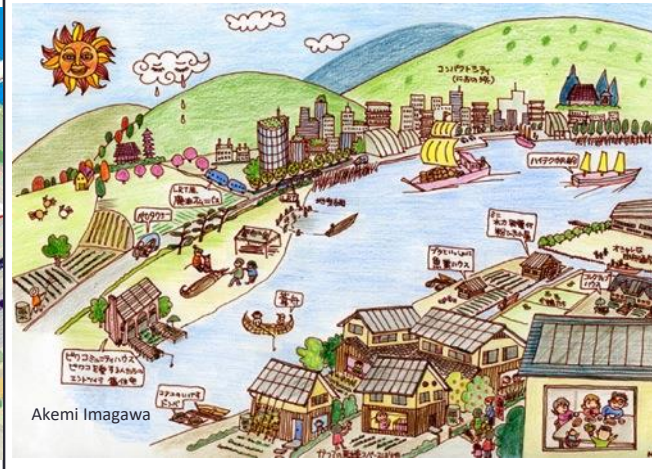
Brief History of Low Carbon Society Study in AIM



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
	 <p data-bbox="821 1292 946 1310">Akemi Imagawa</p>

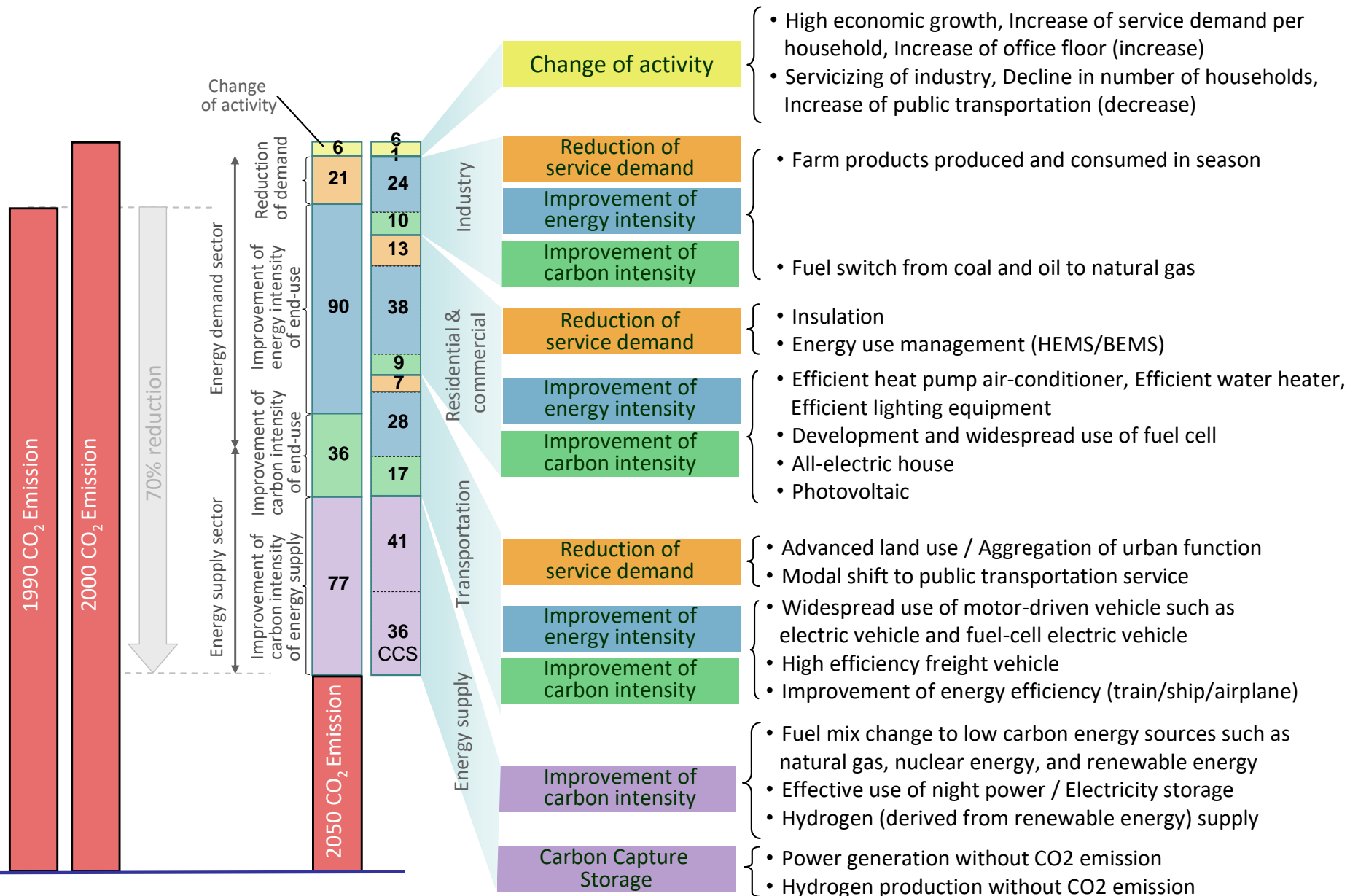


Doraemon is a Japanese comic series created by Fujiko F. Fujio. The series is about a robotic cat named Doraemon, who travels back in time from the 22nd century. He has a pocket, which connects to the fourth dimension and acts like a wormhole.

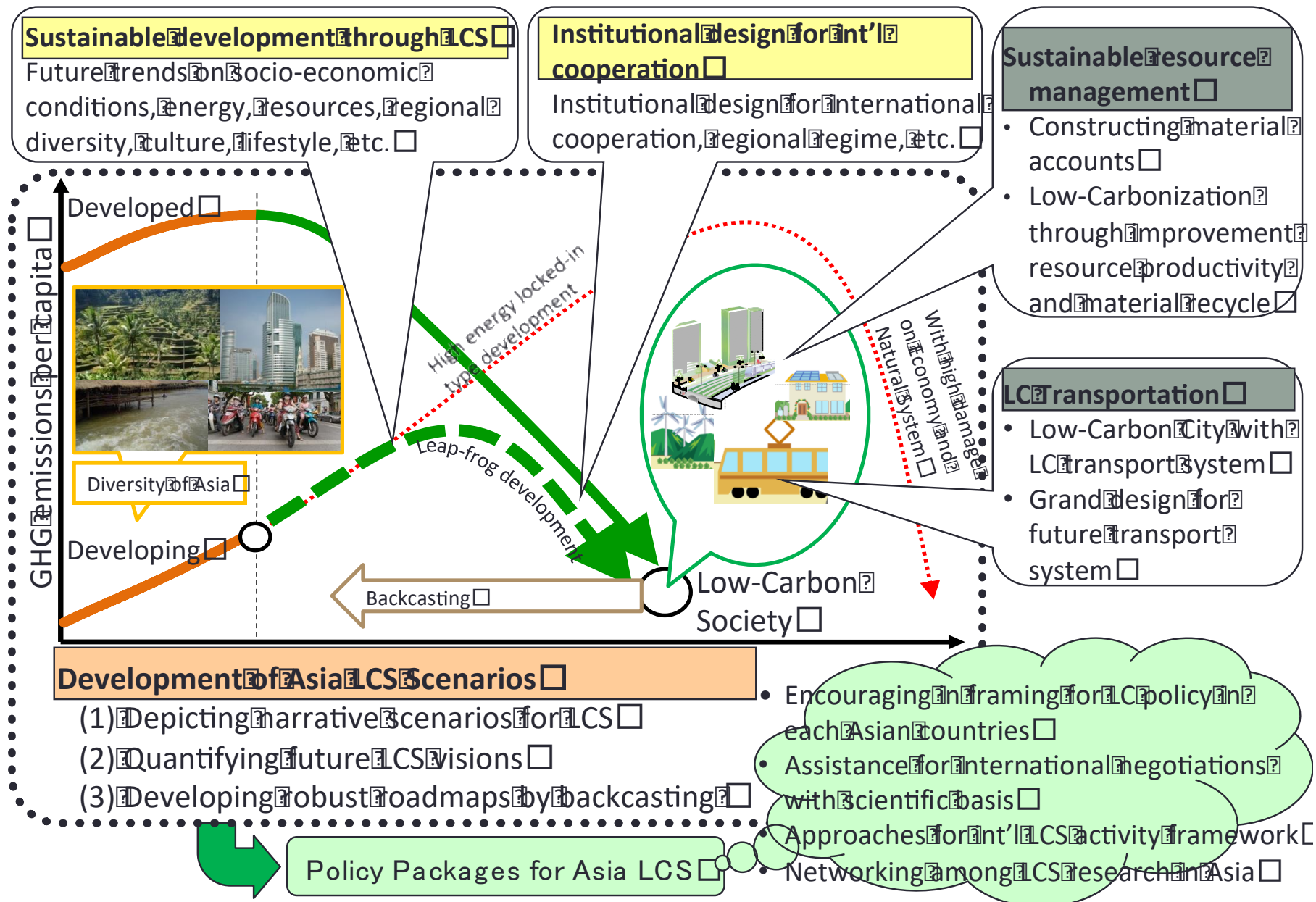


Satsuki and Mei's House reproduced in the 2005 World Expo. Satsuki and Mei are daughters in the film "My Neighbor Totoro". They lived in an old house in rural Japan, near which many curious and magical creatures inhabited.

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

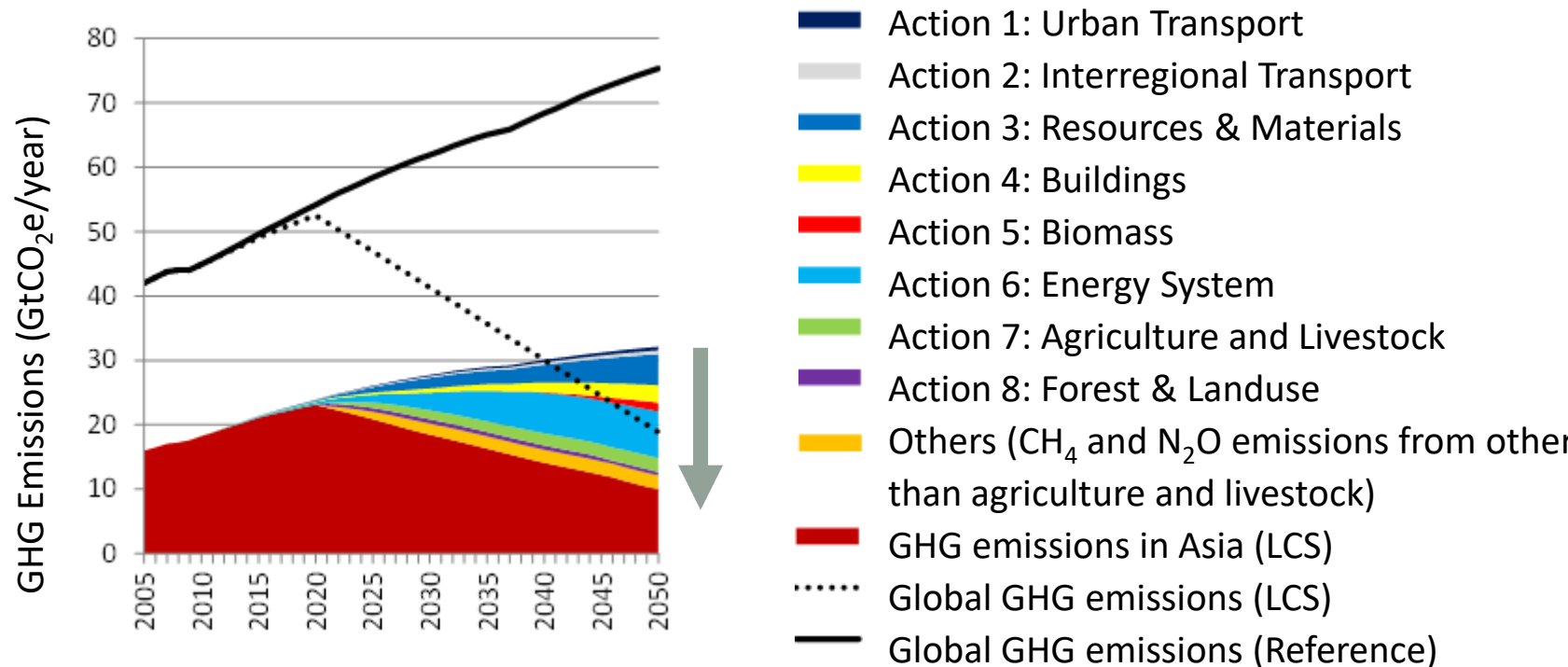


Research Project on Asia Low Carbon Society Scenarios toward 2050



There is potential to reduce GHG emissions by 69% compared to the reference case in Asia

- The global emissions will become 1.8 times larger compared to the 2005 level and emissions in Asia will be doubled under the reference scenario.
- It is feasible to reduce GHG emissions in Asia by 69% by introducing ten actions and Others (CH₄ and N₂O emissions from other than agriculture and livestock) appropriately compared to the reference scenario in 2050.



GHG emissions in Reference and LCS scenarios

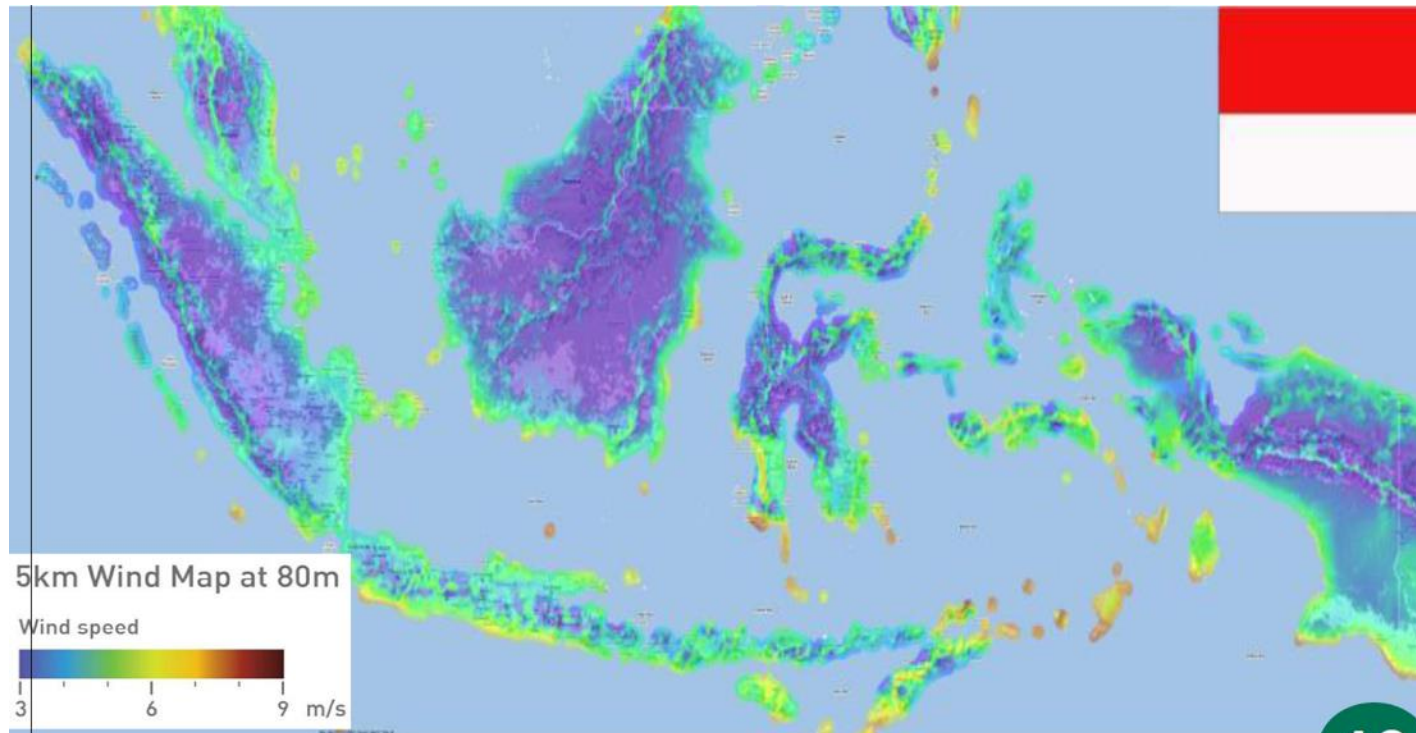
Our Next Challenge: How to Mobilize People and Society?

- 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!***

Methodology for Designing Regional/City LCS Scenarios: New Paradigm should be proposed

- Region/Subnational is *NOT* miniature version of national situation.
- Regional characteristics should be considered for designing regional/city low carbon society scenarios.

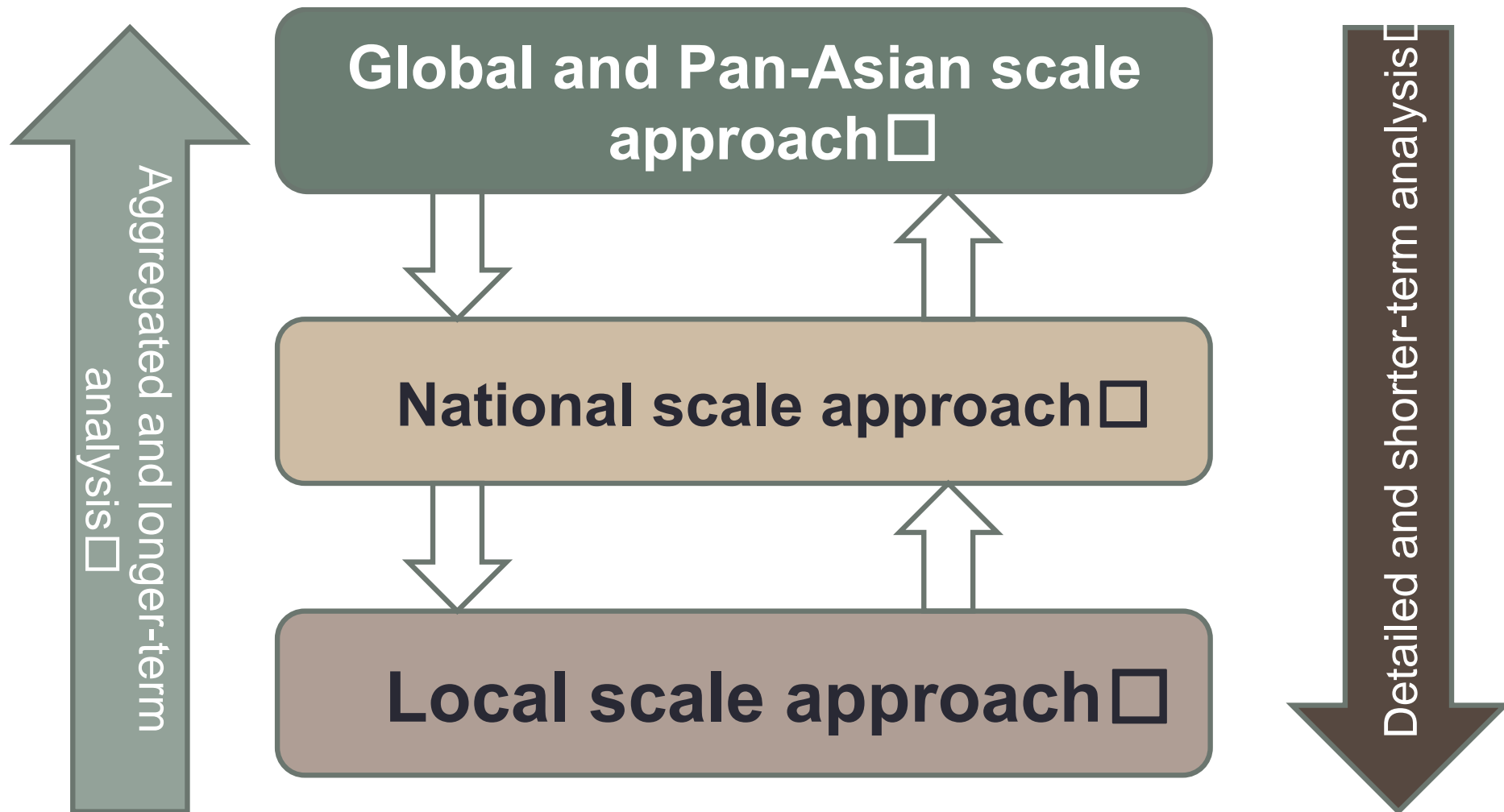
Example: Wind situation differs island and island, and area by area.



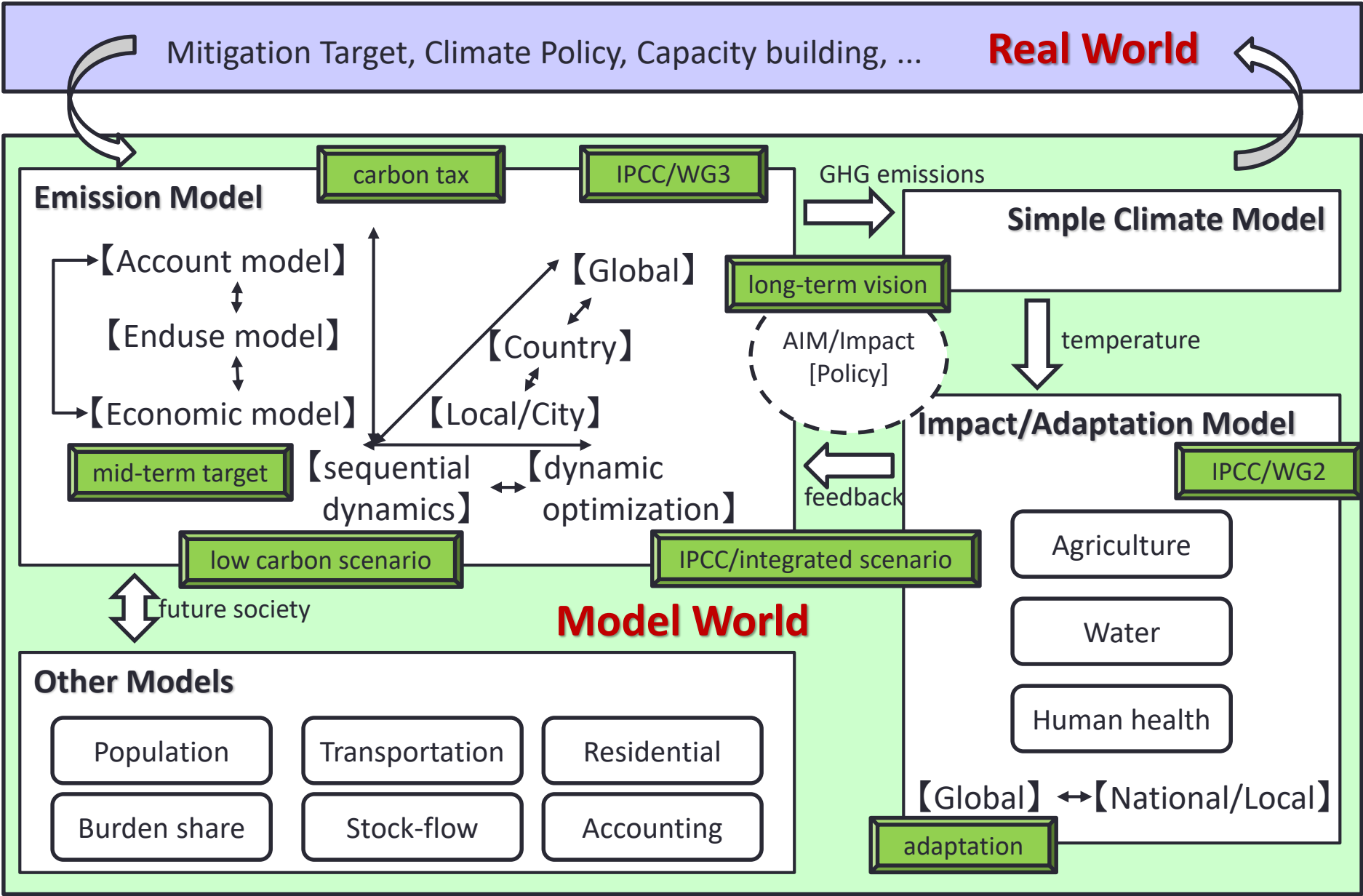
Source: <http://energy-indonesia.com/03dge/Soeripno%20Martosaputro.pdf>

AIM's Approach: Multi Scale Scenario Analysis

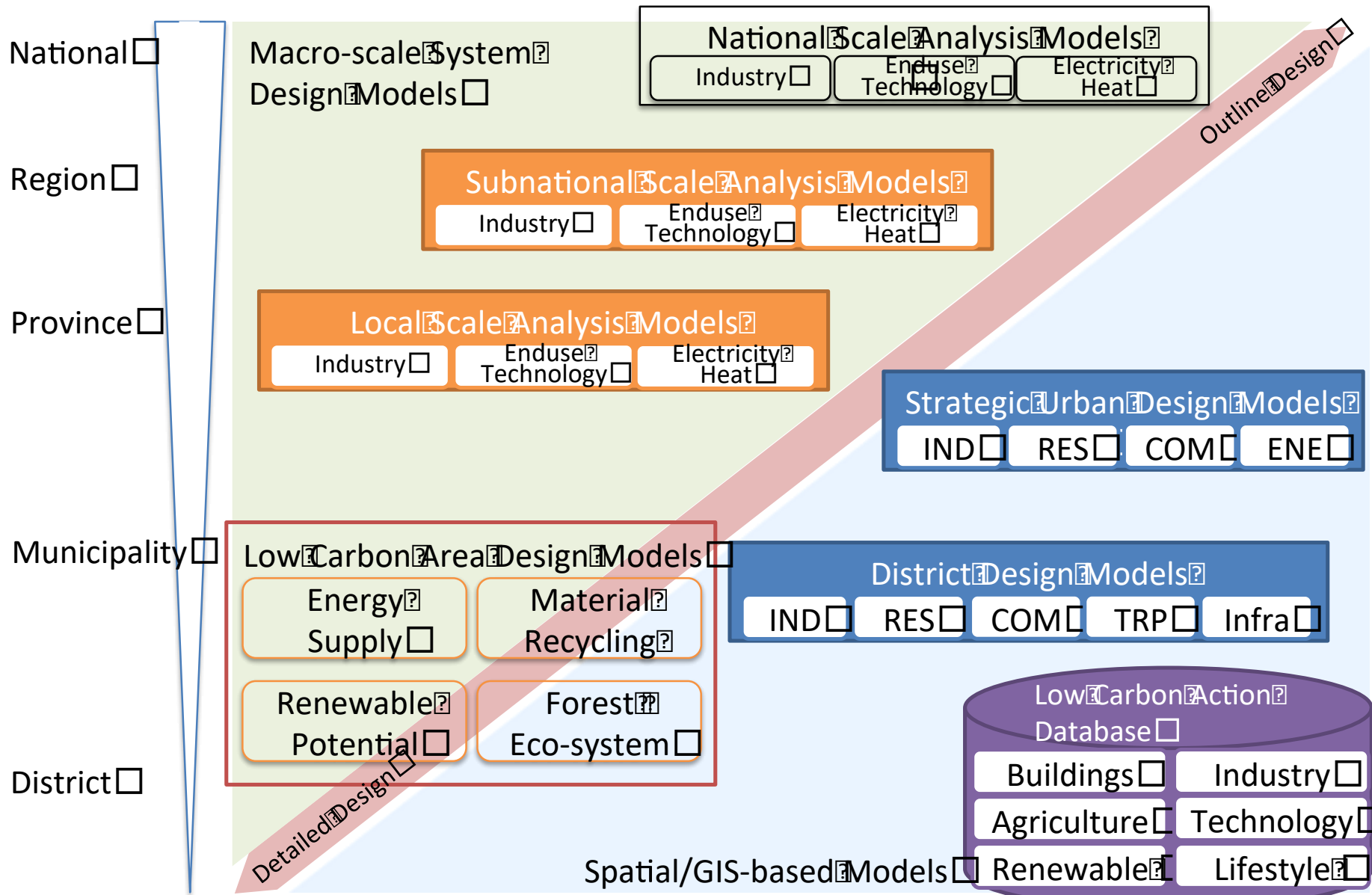
Three different scales but interactive approaches are employed in Low Carbon Society Scenario Study in AIM



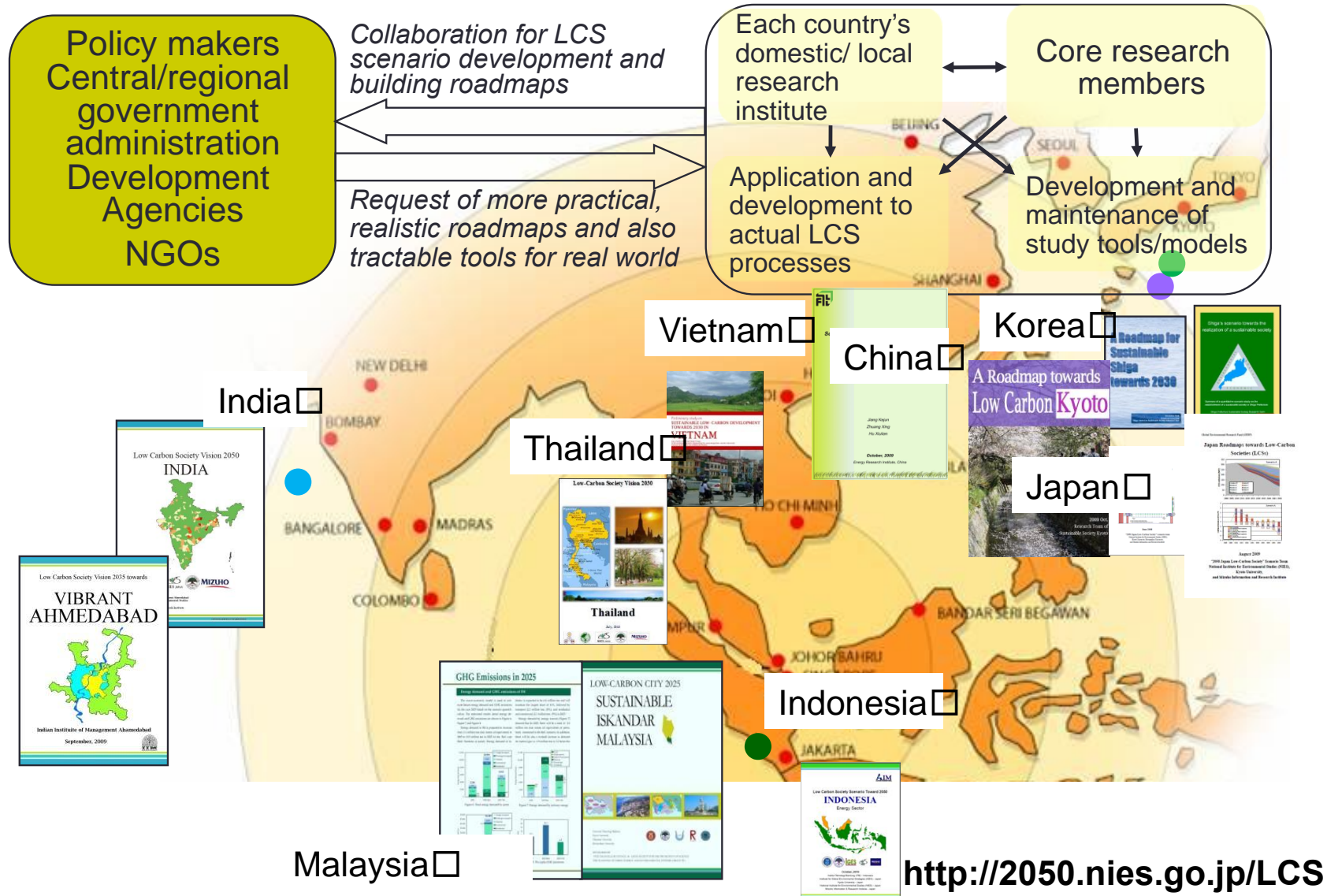
National AIM Models: Integration of Energy-Economy-Environment



New Modeling Approach: Multi-layered Regional Modeling System



Aiming Science to Action: Collaborative Scenario Development with Policymakers



Activities on National LCS studies

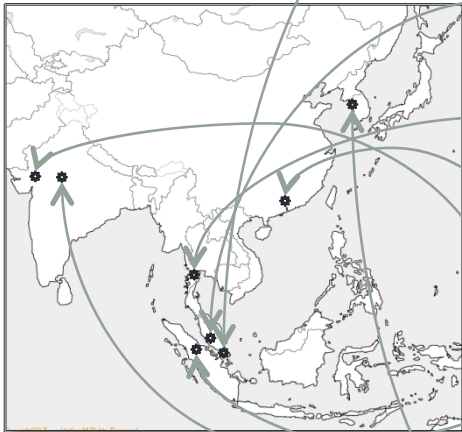
	Progress up to now	Collaborating Research Institutes
China	Up to now, disclosed national LCS scenarios, occasionally. Now preparing provincial energy, industrial, and economic database in order to integrate national level and provincial level scenarios.	China Energy Research Institute
India	Proposed national scenarios with global LCS scenarios by combining AIM/enduse and other models.	IIM Ahmedabad
Thailand	Preliminary analysis of Thailand energy related LCS with ExSS was finished	Thammasat University
Indonesia	Preliminary analysis of Indonesia energy related LCS with ExSS was finished	Institut Teknologi Bandung
Vietnam	Preliminary analysis of Vietnam energy related LCS with ExSS was finished	
Bangladesh	Preparation of related information	
Peninsula Malaysia	Preliminary analysis of Peninsula Malaysia energy related LCS with ExSS was finished	Universiti Teknologi Malaysia



Activities on City-scale LCS Studies

Local region studies

	Progress up to now	Collaborating Research Institutes
Iskandar, Malaysia	Feasibility study finished and consolidating full-scale research task force composed of implementation agencies and research institutions	Universiti Teknologi Malaysia Iskandar Regional Development Authority Federal Department of Town and Country Planning Malaysia Malaysian Green Technology Corporation
Putrajaya, Malaysia	Feasibility study and identification of policy option was finished	Universiti Teknologi Malaysia Putrajaya Corporation
Ratchaburi, Thailand	Preliminary analysis of energy related part almost finished with ExSS, now adding AFOLU part	King Mongkut's University of Technology
Guangzhou, China	Preliminary analysis of energy related part almost finished with ExSS	Guangzhou Institute of Energy Conversion
Ahmedabad, India	Preliminary analysis of energy related part finished with ExSS	IIM Ahmedabad
Bhopal, India	Preliminary analysis of energy related part almost finished with ExSS	Maulana Azad National Institute of Technology, Bhopal School of Planning and Architecture, Bhopal
Liau, Indonesia	Developing FOLU modeling	Bogor Agricultural University
Kyonggi Province, Korea	Preliminary analysis of energy related part are conducting with ExSS	Seoul National University



Recent Progress:

“Bhutan Low-Carbon Society Scenario Study 2050”

Introduction: Overview of the Project

Development of Low Carbon Society Scenarios for Asian Regions



Research Team: Universiti Teknologi Malaysia (UTM), Kyoto University (KU), Okayama University (OU), National Institute for Environmental Studies (NIES)

Joint Coordinating Committee: Iskandar Regional Development Authority (IRDA), Federal Department of Town and Country Planning (JPBD), Malaysia Green Technology Corporation (MGTC)

Sponsorship: Japan International Cooperation Agency (JICA) , Japan Science and Technology (JST)

Period: 2011 - 2016

Research Output:

- i. **Methodology** to create LCS scenarios which is appropriate for Malaysia is developed.
- ii. **LCS scenarios** are created and utilised **for policy development** in IM.
- iii. **Co-benefit of LCS policies** on air pollution and on recycling-based society is quantified in IM
- iv. **Organizational arrangement of UTM** to conduct trainings on LCS scenarios for Malaysia and Asian countries is consolidated, and a network for LCS in Asia is established

Background

Iskandar Malaysia: Key Challenges



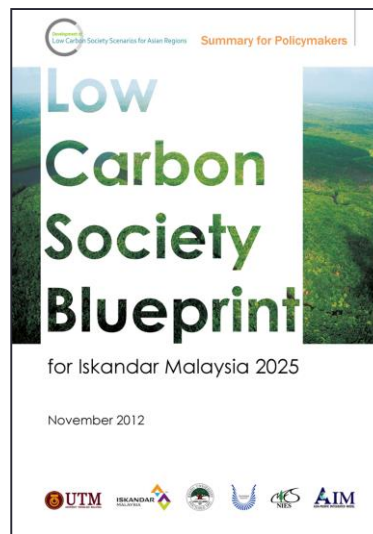
Size: 2,216.3 km²
 Population: 1.3 mil. (2005) | 3.0 mil. (2025)
 GDP: 35.7 bil. RM (2005) | 141.4 bil. RM (2025)



CO₂ Reduction target in Malaysia:
 Voluntary 40% reduction of CO₂ emission intensity by 2020

Issues

Rapid urbanization and industrialization
 Higher energy demand and CO₂ emission
 Decouple economic growth and emission on fossil fuel

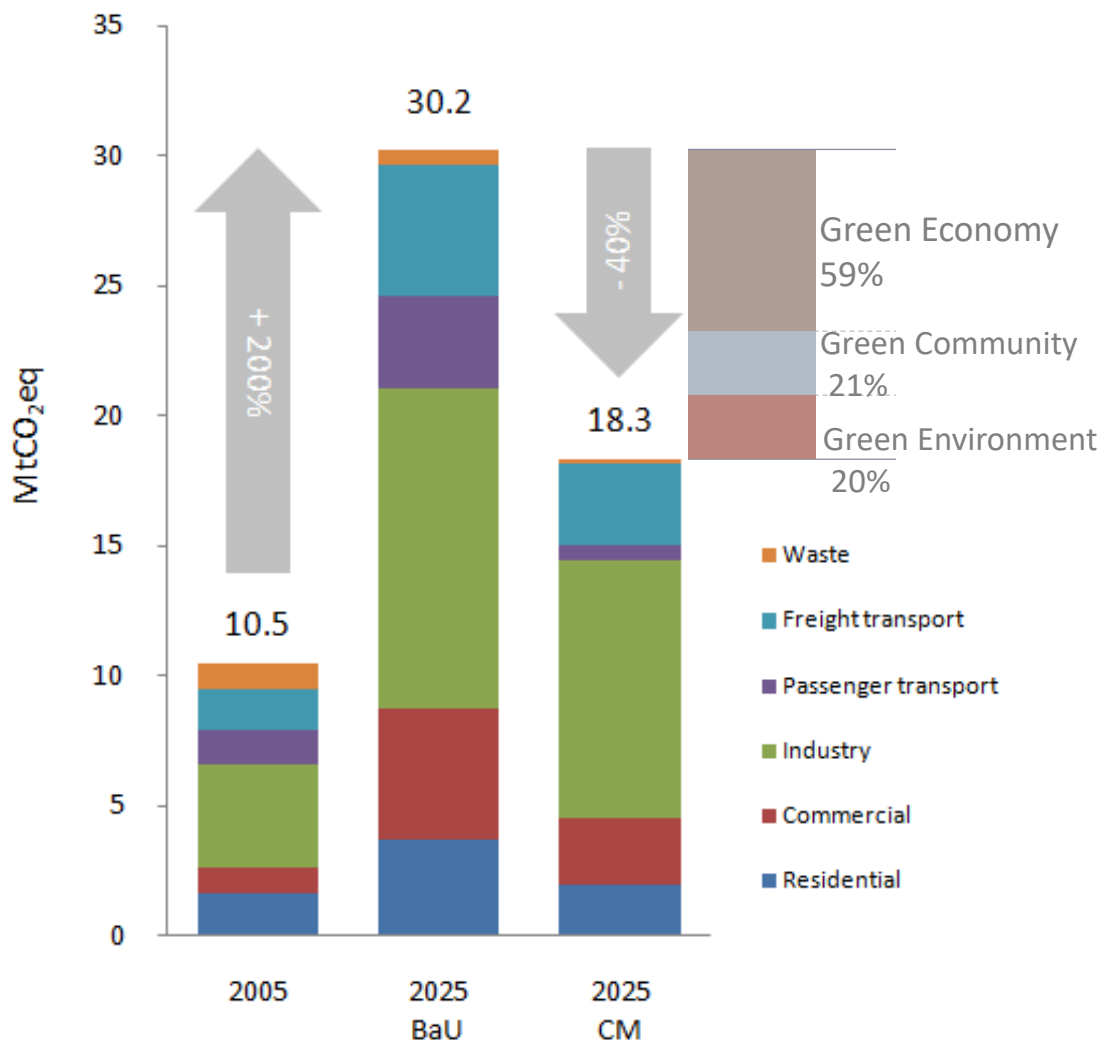


Blueprint – 3 main thrusts –
 Green economy, community and environment.
 =12 actions

Joint collaboration work of
 UTM, KU, NIES under
 SATREPS program

Potential Mitigation Options for Iskandar Malaysia

Green Economy, Green Community and Green Environment



Unit	2005	2025 BaU	2025 CM	2025Ba U	2025CM /2005
Final Energy Demand (Mtoe)	2.5	7.6	5.2	3.11	2.14
GHG emissions (MtCO ₂ eq)	10.5	30.2	18.3	2.88	1.74
Per Capita CO ₂ Emissions (tCO ₂ eq)	7.7	10.1	6.1	1.30	0.78
GHG Intensity (kgCO ₂ eq/RM)	0.29	0.21	0.13	0.73	0.44

Green Economy

- 1 Integrated Green Transportation
- 2 Green Industry
- 3 Low Carbon Urban Governance
- 4 Green Building and Construction
- 5 Green Energy System and Renewable Energy

Green Community

- 6 Low Carbon Lifestyle
- 7 Community Engagement and Consensus Building

Green Environment

- 8 Walkable, Safe and Livable City Design
- 9 Smart Urban Growth
- 10 Green and Blue Infrastructure and Rural Resources
- 11 Sustainable Waste Management
- 12 Clean Air Environment

Potential Mitigation Options for Iskandar Malaysia

12 Actions Towards Low Carbon Future

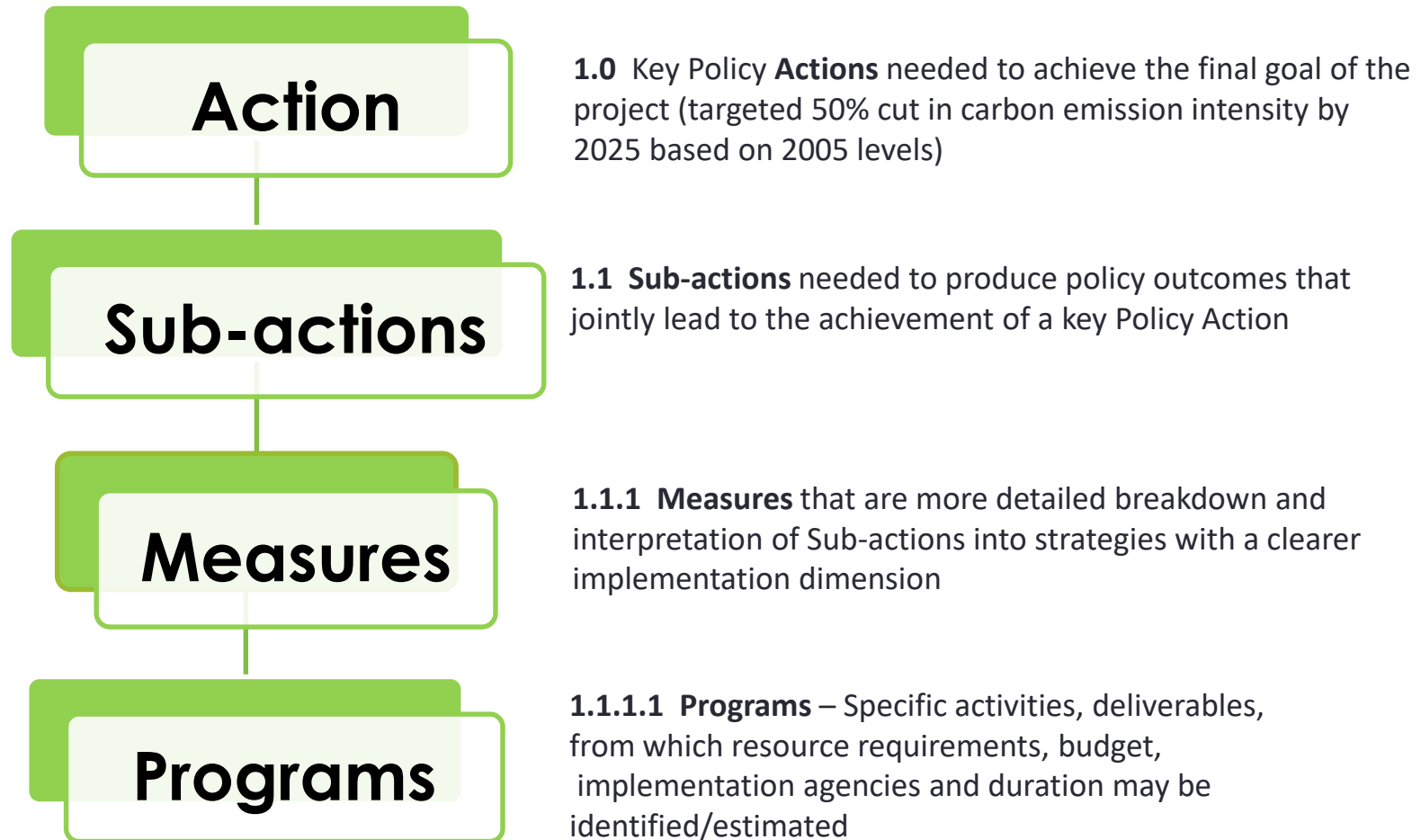
Mitigation Options	CO2 Reduction	%
Green Economy	7,401	59%
Action 1 Integrated Green Transportation	1,916	15%
Action 2 Green Industry	1,085	9%
Action 3 Low Carbon Urban Governance*	-	-
Action 4 Green Building and Construction	1,338	11%
Action 5 Green Energy System and Renewable Energy	3,061	24%
Green Community	2,557	21%
Action 6 Low Carbon Lifestyle	2,557	21%
Action 7 Community Engagement and Consensus Building*	-	-
Green Environment	2,510	20%
Action 8 Walkable, Safe and Livable City Design	264	2%
Action 9 Smart Urban Growth	1,214	10%
Action 10 Green and Blue Infrastructure and Rural Resources	620	5%
Action 11 Sustainable Waste Management	412	3%
Action 12 Clean Air Environment*	-	-
Total	12,467*	100%

* Action 3, 7 and 12 does not have direct emission reduction, but their effect is included in other Actions.

LCS Actions for IM – Work Breakdown Structure

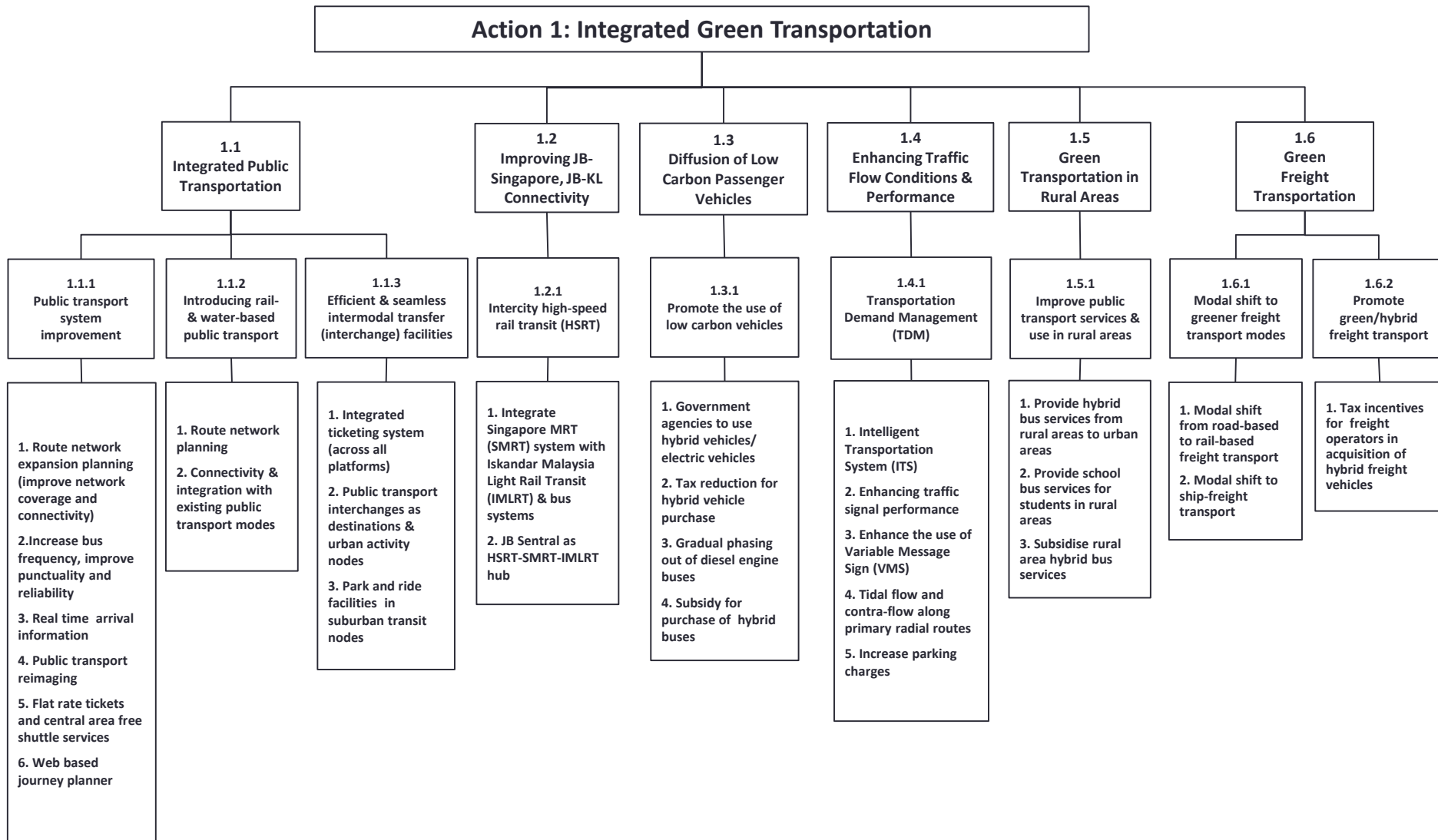
Development of Low Carbon Society Scenarios for Asian Regions

Work Breakdown Structure of 12 LCS Actions

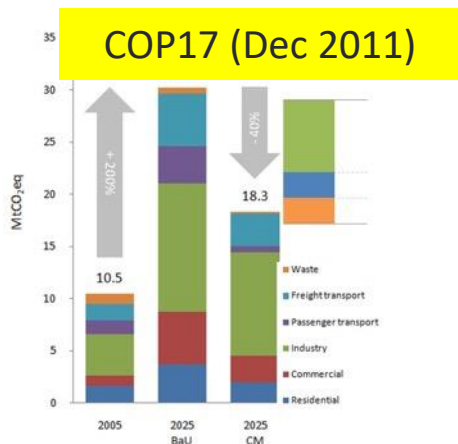


LCS Actions for IM – WBS by Action

Development of Low Carbon Society Scenarios for Asian Regions



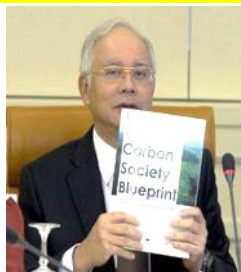
Bridging Research and Policy in Iskandar Malaysia



Identifying Low Carbonizing Potential in IM

Continuous Discussion with Stakeholders including researcher, policymaker, business, NGOs

Approval by PM (Dec 2012)



PM approved Dozen Action as official program in IM

Roadmap towards Low Carbon IM

Item	2013	2014	2015	2020	2025
04-1 CAIA (Green Accord Initiative Award)	Start	Start	Start	Start	Start
04-2 Implementation of Financing Scheme for Green Buildings	Start	Start	Start	Start	Start
04-3 Diffusion of Green Building Design and Technology	Start	Start	Start	Start	Start
04-4 Diffusion of Green Construction	Start	Start	Start	Start	Start
04-5 Energy Efficiency Improvement of Existing Buildings (Eneffing)	Start	Start	Start	Start	Start
04-1 Standardization of Energy Efficiency Standards and Labeling System	Start	Start	Start	Start	Start
04-2 Building Energy Conservation Center in Iskandar Malaysia	Start	Start	Start	Start	Start
04-3 Implementation of Financing Scheme for Renewable/Alternative Energy	Start	Start	Start	Start	Start
04-4 Transition of Renewable/ Alternative Energy with Advanced Energy System	Start	Start	Start	Start	Start



COP19 (Nov 2013)



1. Integrated Green Transportation – Mobility Management System
 2. Green Economy Guidelines
 3. Eco-life Challenge Schools Project
 4. Portal on Green Technology
 5. Trees for Urban Parks
 6. Responsible Tourism and Biodiversity Conservation
 7. Bukit Batu Eco-Community
 8. CAIA – Green Accord Initiative Award
 9. Low Carbon Village FELDA Taib Andak
- Special Feature: Smart City-Nafas Baru Pair Gudang-Green and Healthy City

Proposal of 10 Actions by IRDA



March 2014
 Approvals and Implementation Committee (AIC) in IRDA endorsed the BP and Roadmap as formal government plan

Local, National, and International Actions are Needed for Achieving SDGs



SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY



2 ZERO HUNGER



3 GOOD HEALTH AND WELL-BEING



4 QUALITY EDUCATION



5 GENDER EQUALITY



6 CLEAN WATER AND SANITATION



7 AFFORDABLE AND CLEAN ENERGY



8 DECENT WORK AND ECONOMIC GROWTH



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



10 REDUCED INEQUALITIES



11 SUSTAINABLE CITIES AND COMMUNITIES



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



13 CLIMATE ACTION



14 LIFE BELOW WATER



15 LIFE ON LAND



16 PEACE, JUSTICE AND STRONG INSTITUTIONS



17 PARTNERSHIPS FOR THE GOALS



SUSTAINABLE DEVELOPMENT GOALS

For example, energy access (Goal 7) needs to take actions in rural area...

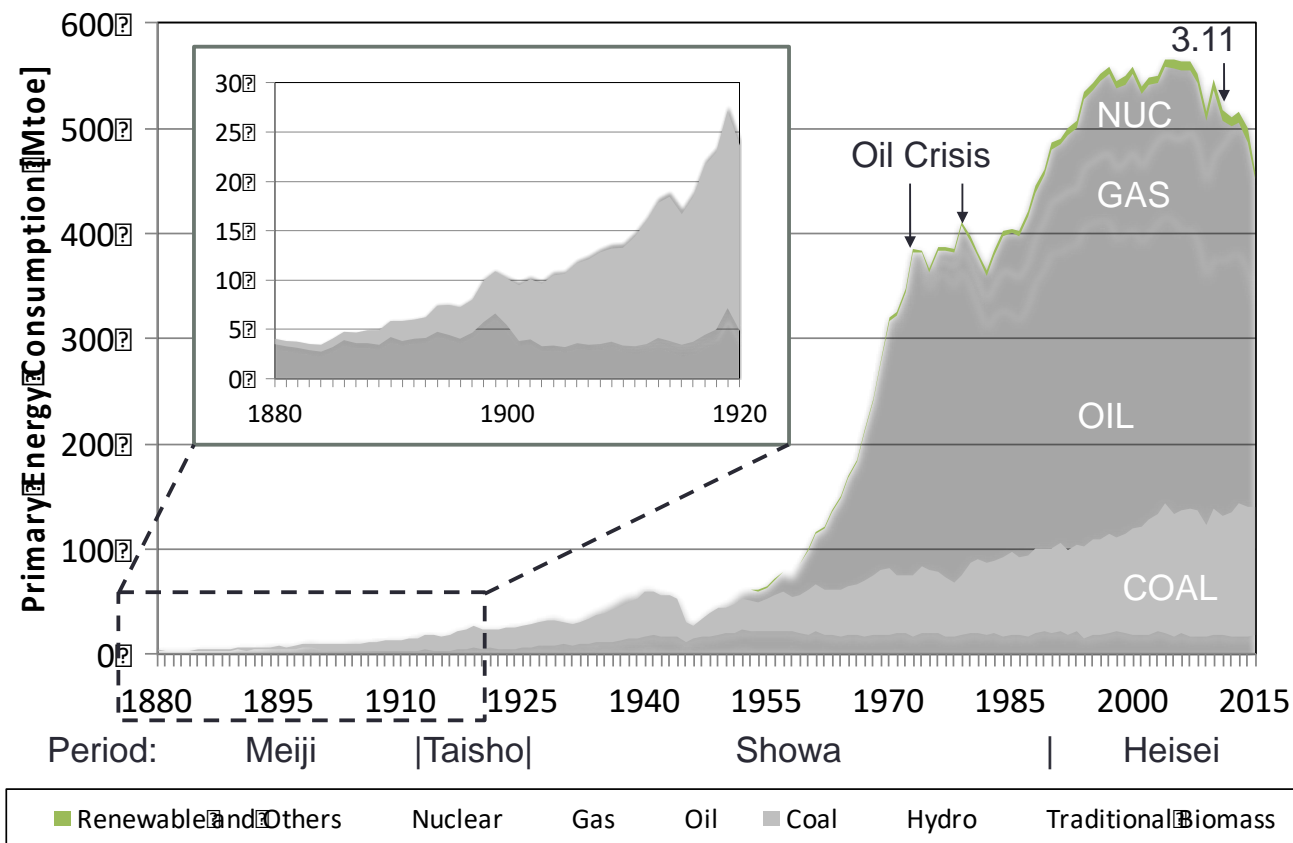
Electricity access in 2014 - Regional aggregates

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

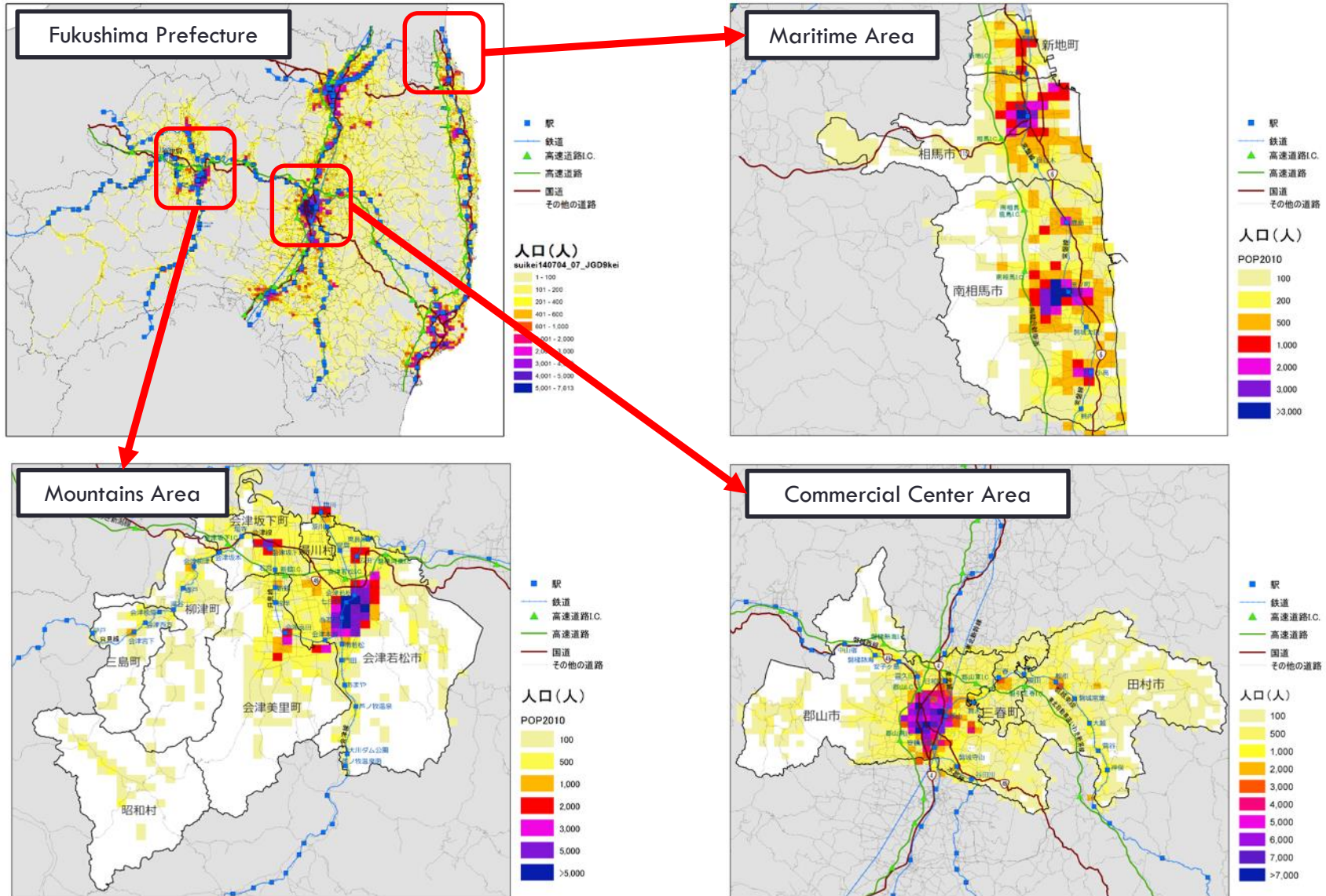
AND for *Developed* countries

- 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) ?
- Developed countries also need to innovative city design.



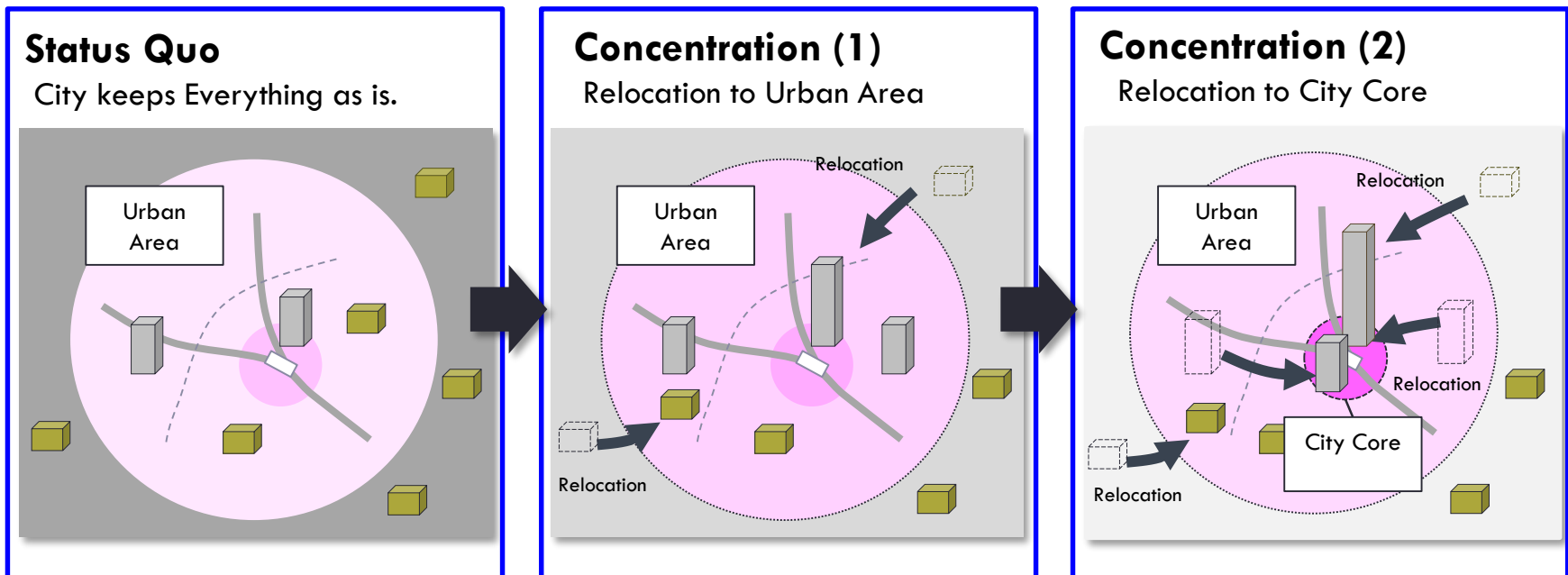
City is Spatially Homogeneous?

Distribution of Population in Fukushima Prefecture, Japan

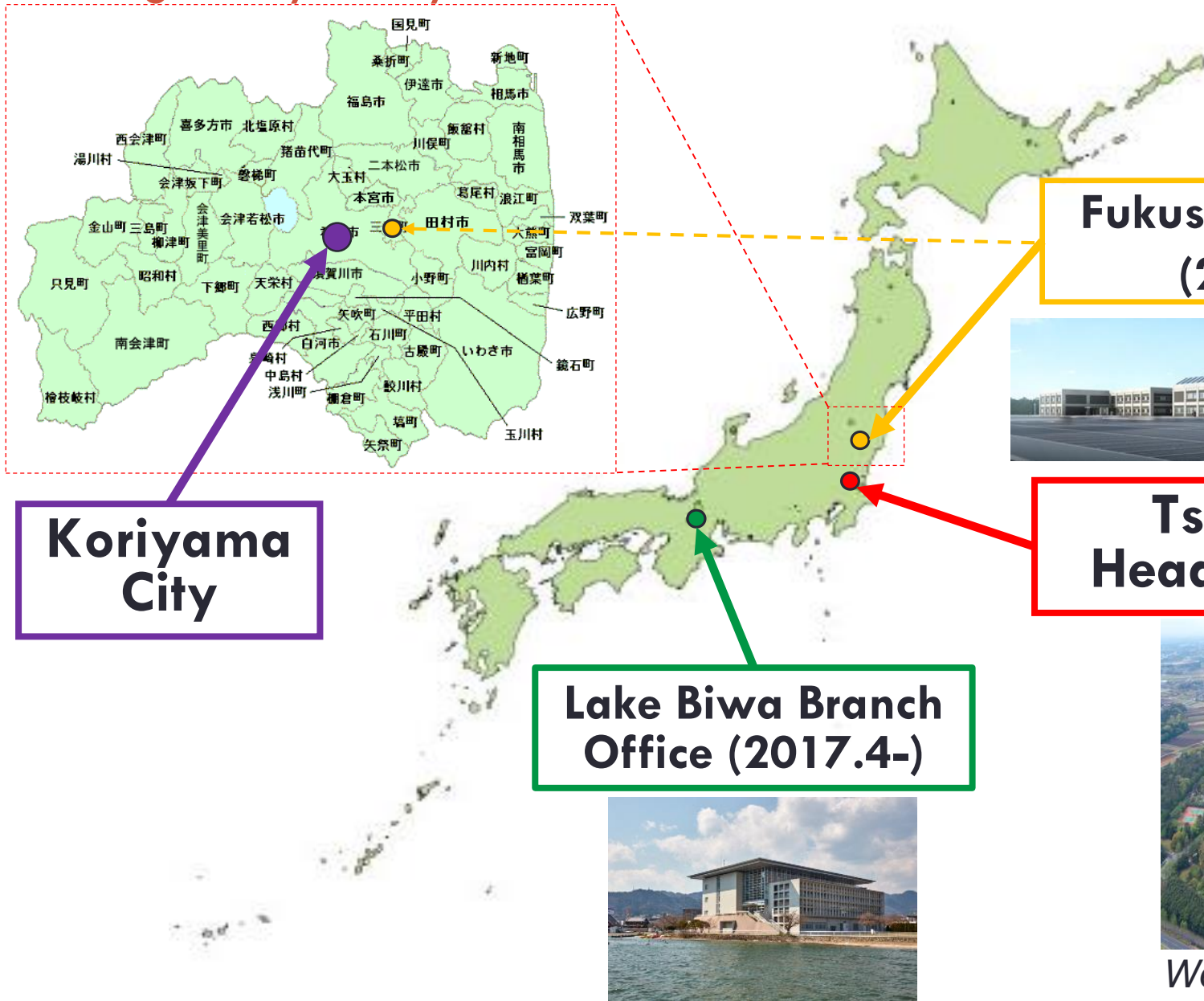


Changing City Structure will be Expected both Developing and Developed Countries

- 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.



Target City: Koriyama in Fukushima



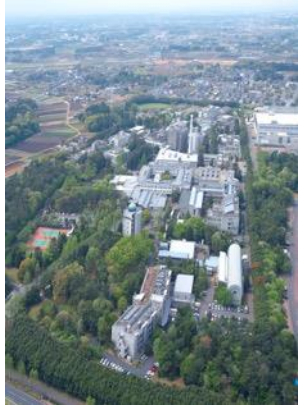
Koriyama City

Fukushima Branch (2016.4-)



Tsukuba Headquarters

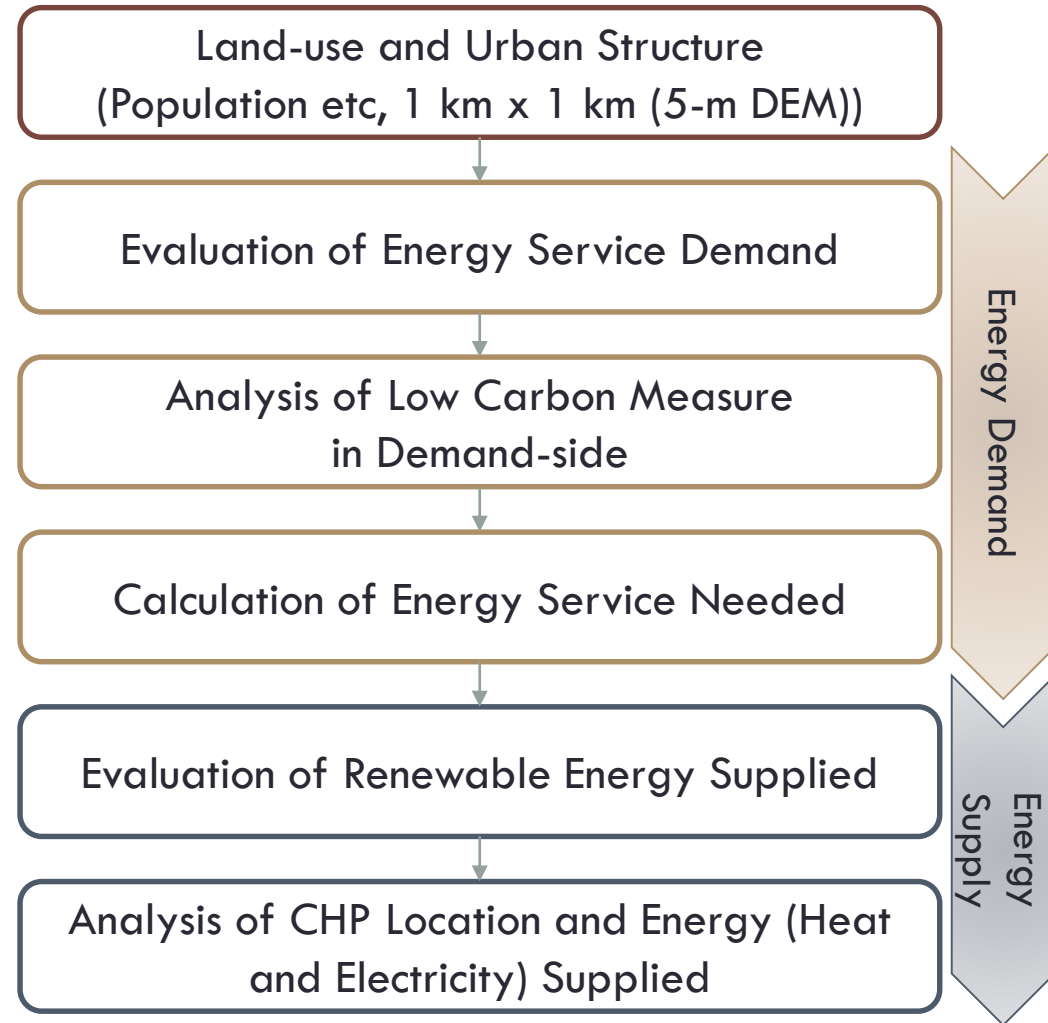
Lake Biwa Branch Office (2017.4-)



We are Here!

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.

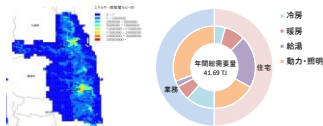


Detailed Structure of Developed Model

Energy Demand Analysis

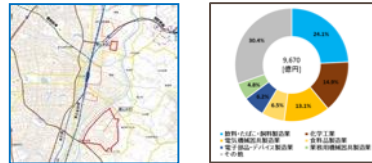
Spatial Distribution of Energy Demand

Evaluation of Current and Future Energy Demands by Mesh.



Industrial Symbiosis

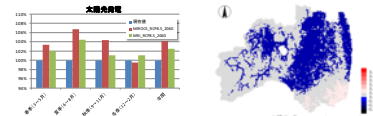
Industrial Demand and Design System based on idea of Industrial Symbiosis



Energy Resource Analysis

Solar and Wind Potentials

Evaluation of Solar and Wind Potential in consideration of Climate Change



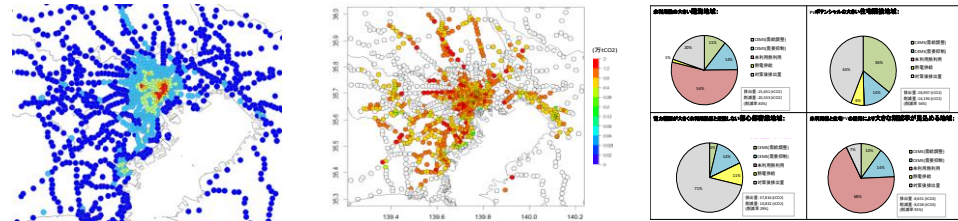
Design on Biomass Distribution System
Design System for Biomass Distribution and Evaluation of Supply Potential



Comprehensive Design on Regional Energy System

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

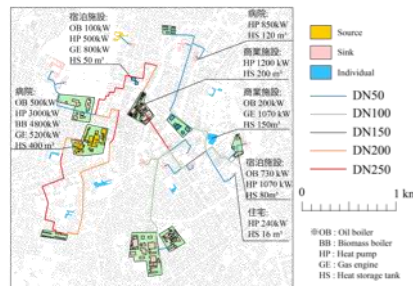
Design on Regional/Urban Area Energy System based on Spatial Distribution of Energy Demands and Resources, and Evaluation of Impacts on Low Carbon (CO2 Reduction) by Implementing the Designed System.



Design on Energy Infrastructure

Locational Planning on Energy Infrastructure

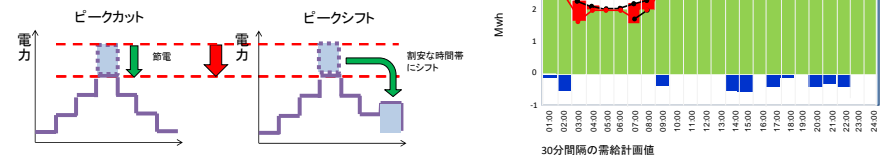
Design on Locational Planning on Energy Infrastructure based on Spatial Distribution of Energy Demands and Resources.



Simulation of Energy Management

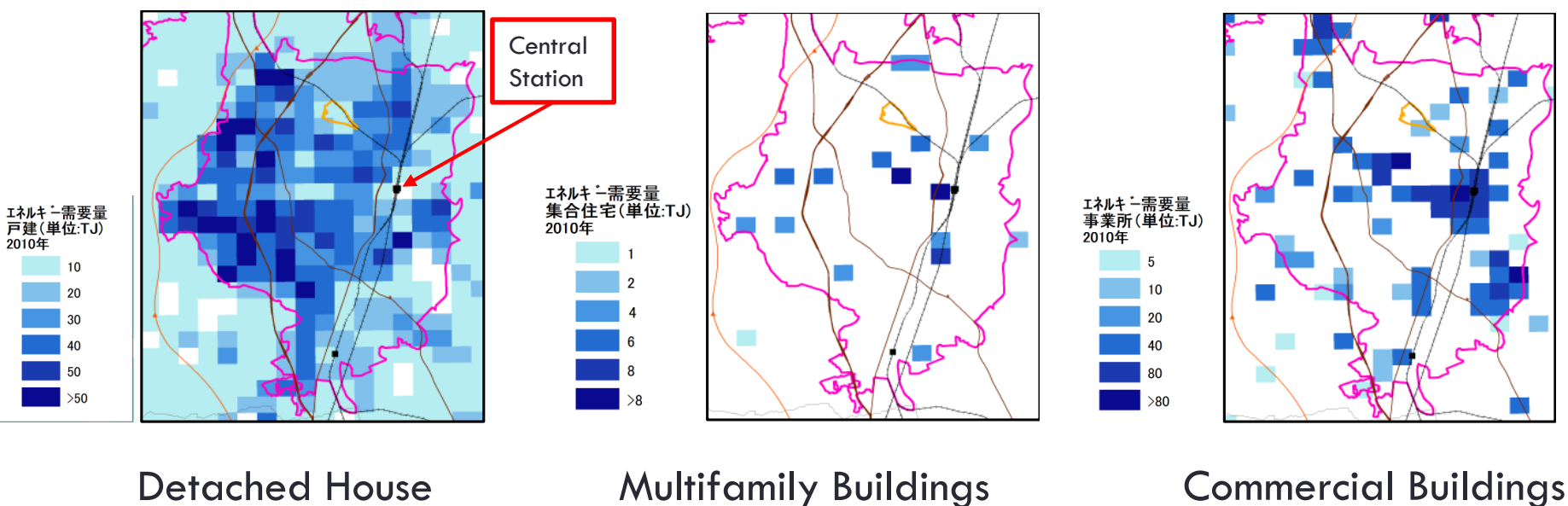
Simulation Tool for Energy Demand Management

Simulation Tool for Impacts of Energy Management System on Demand Reduction



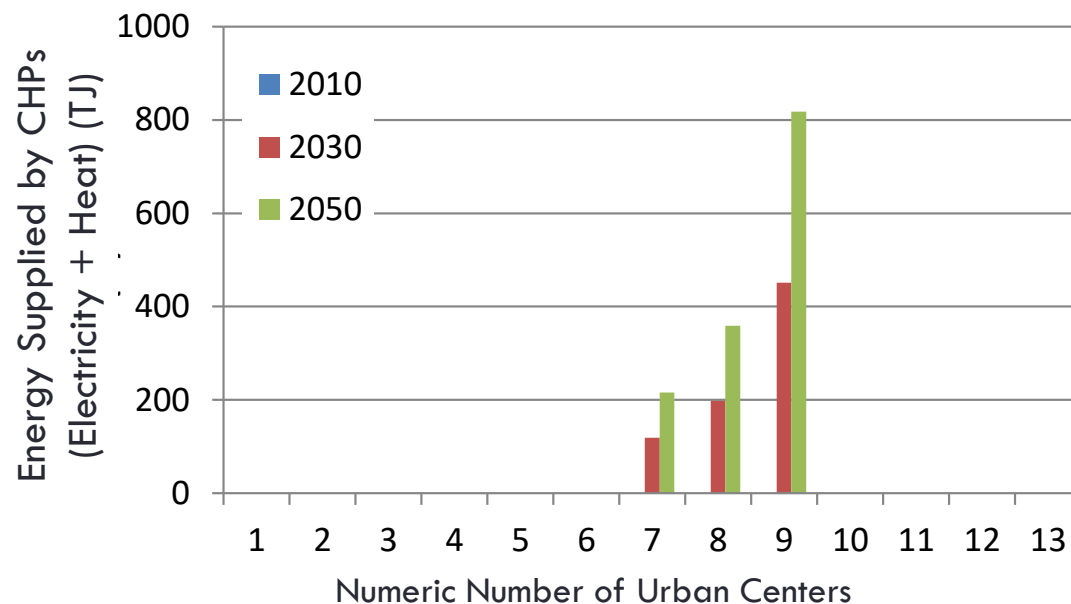
Results in Koriyama: Energy Service Demands

- 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**.



Results in Koriyama: Feasibility of CHPs

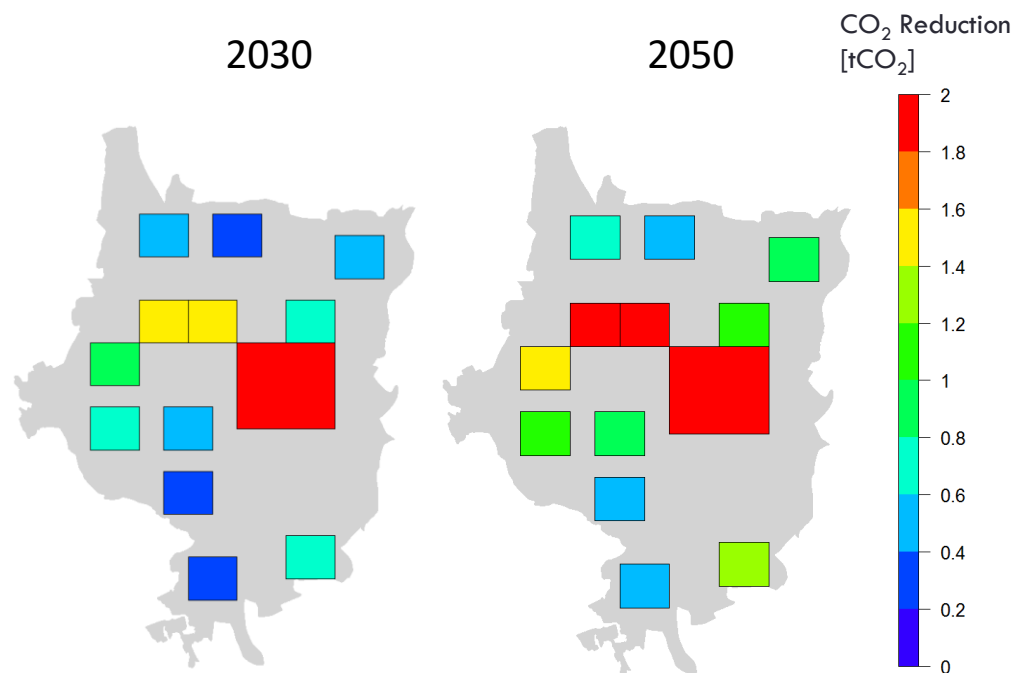
- CHP business could be successful in the area with **7,000 person/km²** and **7,000 employees/km²**.
- Only three (3) center cores can be installed CHP system.
 - Center 7 and 8: Surrounding Area of City Hall, Hospitals and Shopping Centers
 - Center 9: Surrounding Area of Central Station



Amount of Energy Supplied by CHPs

Results in Koriyama: Reduction of CO₂ Emissions

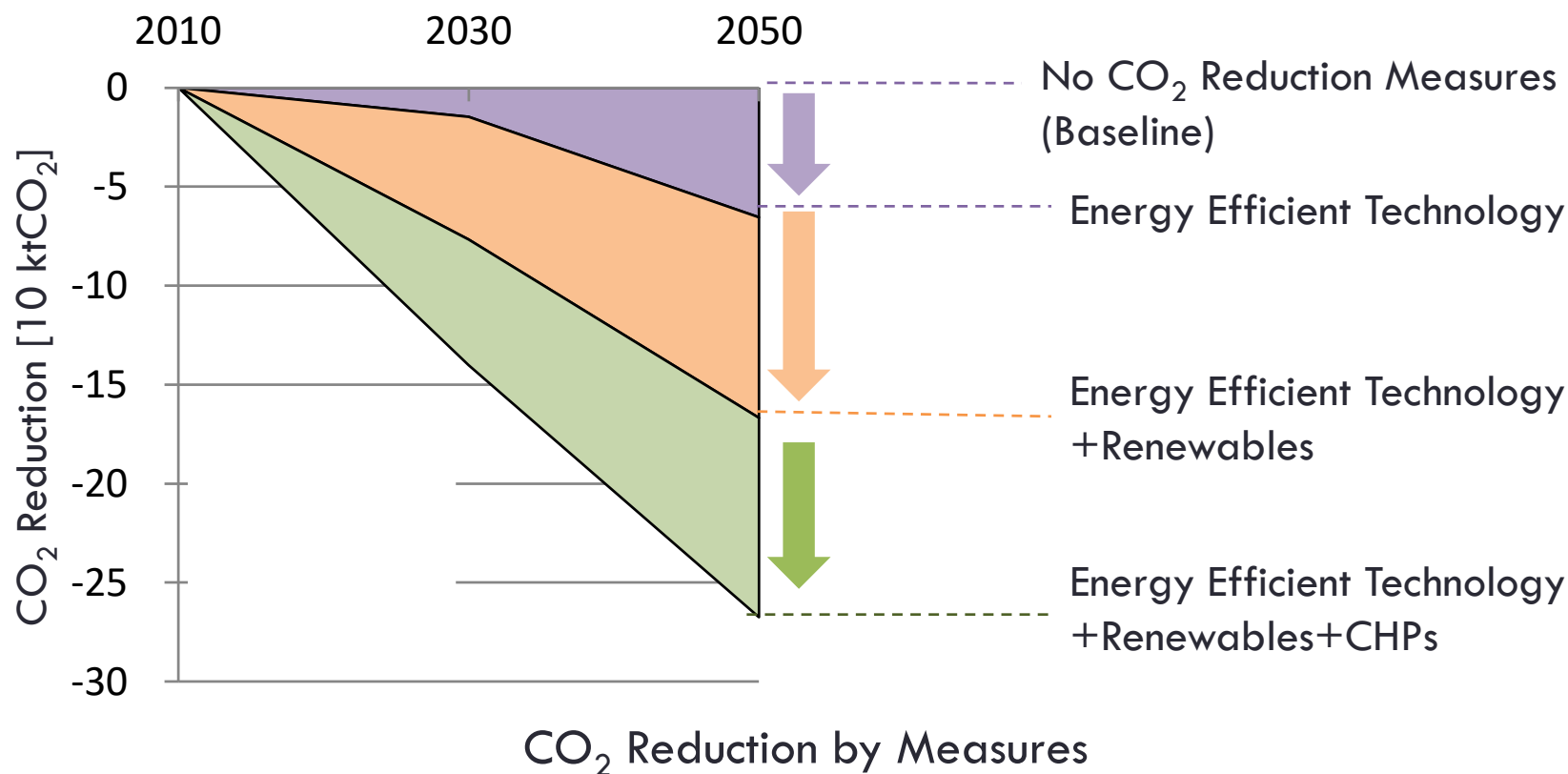
- Installation of **PV system and CHPs** leads to the reduction of CO₂ emissions in Center 7 & 8 (**near City Hall**) and Center 9 (**near Central Station**).
- **Energy efficient appliances and renewables** are main sources of CO₂ reduction in **suburb area**.



Amount of CO₂ reduction by Centers

Results in Koriyama: Contribution by Measures

- Total amount of CO₂ reduction in 2050 is **270 ktCO₂**.
 - **22.7%** of total CO₂ emissions in 2007 (1,187 ktCO₂)
- CO₂ reduction comes from **24% of energy efficient technologies, 38% of PV and 38% of CHPs.**



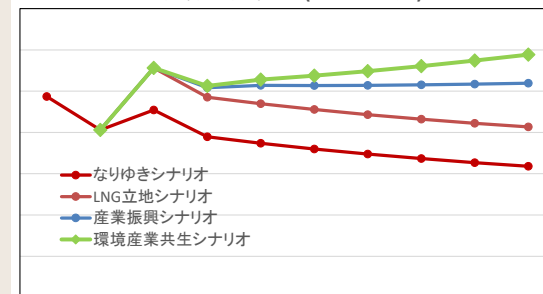
Current Challenge(1) : Holistic Design System for Smart City

- 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



Vision of the City

2. Spatial Design

Land use zoning /network design

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

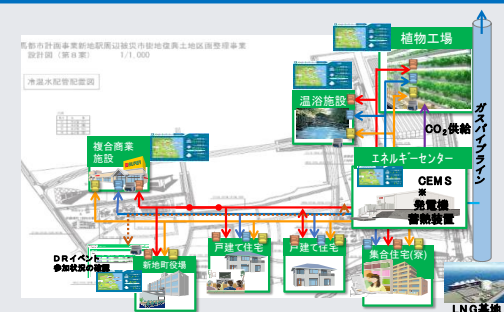


Area Design

3. Project Design

Core projects for Smart City

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



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!