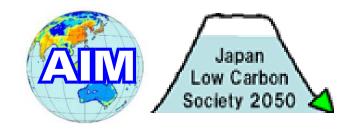
The 15<sup>th</sup> AIM International Workshop February 22, 2010



# Development of the Backcasting model –Application to Japan LCS Study –

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### Summary

What did we do?

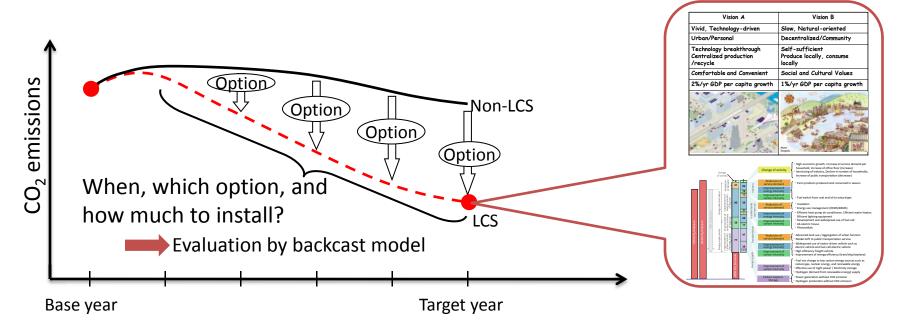
 We draw up future roadmaps for technologies, policies, and optimal investment timing toward the achievement of a low-carbon society in Japan by 2050 using an analytical model based on a backcasting methodology.

What did we find?

- Early actions can lead to pathways for minimizing the costs toward an LCS in Japan. However, to take early actions, large investments will be needed at the initial stages. Because:
  - 1. Technologies have learning-by-doing effects: the additional cost of reducing CO2 emissions will fall as the technologies spread.
  - 2. If actions are delayed, learning-by-doing effects may fail to work sufficiently, resulting in higher total investment requirements for achieving a LCS.
  - 3. No infrastructure can be built immediately; hence it would be difficult to switch suddenly to a LCS in the years just before 2050.
  - 4. Future technological development has several uncertainties. Early actions will open up new opportunities for the spread of alternative actions toward the LCS should a dominant technology fail in some way.

# Current status of Japan LCS Study

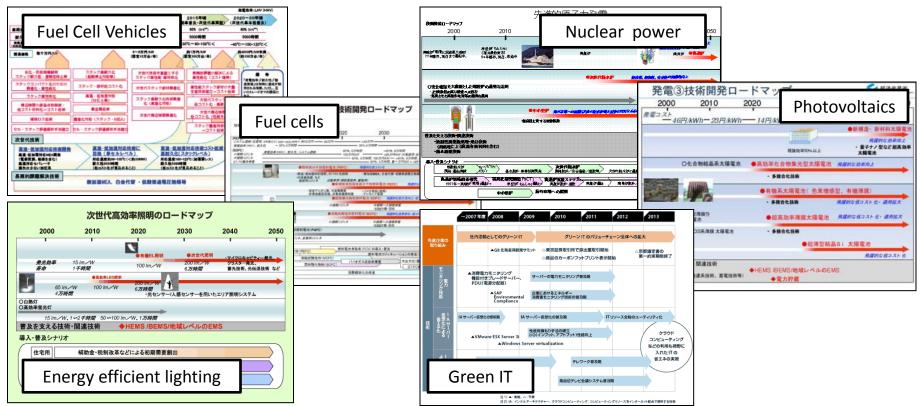
- We have shown feasibilities of Low-carbonization in Japan by 2050.
  - Some journal articles and reports have been published.
  - Our outcomes (probably) affects national policy/strategy about climate change (esp. CO2 reduction).



• Next question: "How to reach the future?"

#### How to make a roadmap to the LCS?:

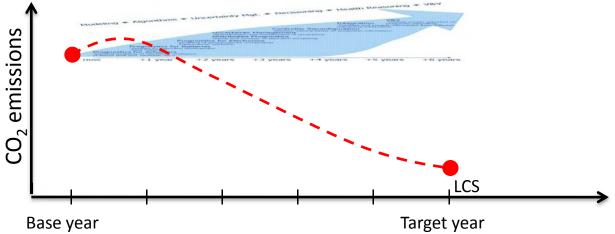
• We already have several roadmaps by experts. But...



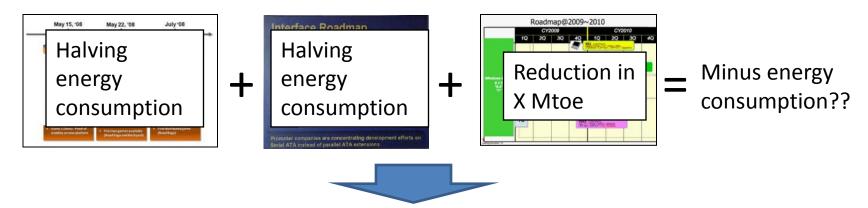
• These roadmaps (usually) focuses one technology/segment in a society.

 In order to find "comprehensive" roadmaps towards LCS, we need to combine the information appropriately. 2010/02/22 The 15th AIM International Workshop Issues to be considered in depicting comprehensive roadmaps

• Each roadmap (explicitly/implicitly) aims to the LCS?



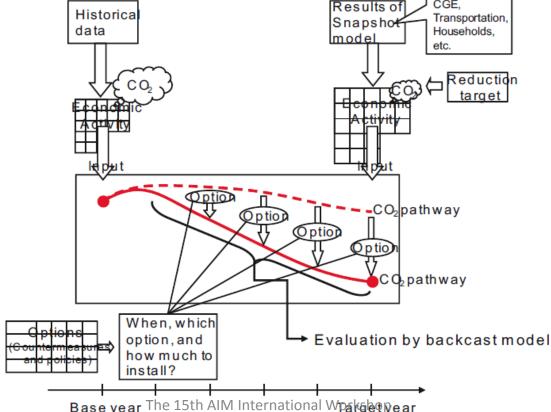
• Combination of roadmaps brings inconsistency in energy balance, economic structure etc ?



In order to find comprehensive roadmap with keeping consistency in energy balance and/or economic activity, an "AIM/Backcast" model has been developed.

#### Overview of the AIM/Backcast model

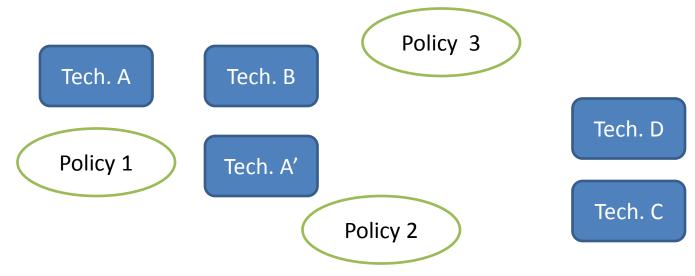
- The model investigates and selects which options (countermeasures and policies) to introduce and when and at what intensity in order to best achieve the future social and economic activities portrayed in the scenarios while satisfying the service demand today and throughout the period up to the target year based on certain criteria.
- The model also presents a Gantt chart with pathways of CO<sub>2</sub> emission, investment



How to address existing roadmaps in the model? (1) Decompose to individual technology and/or policy

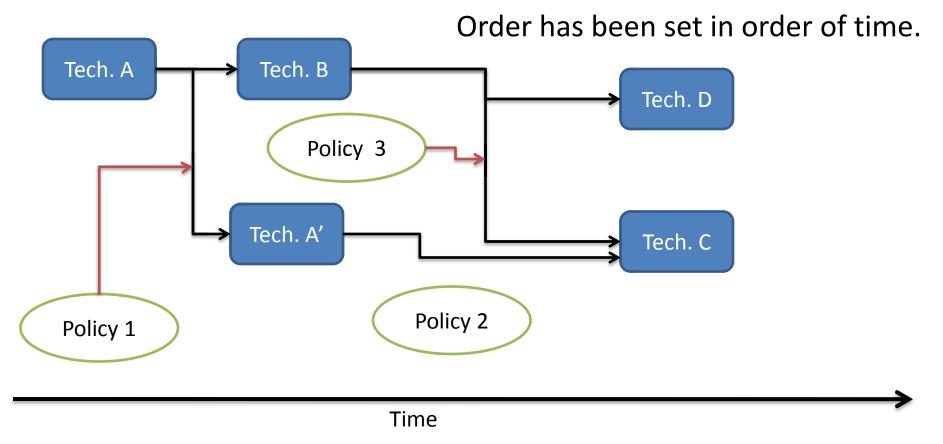


Ex. A roadmap contains five types of technologies and three policies:



# How to address existing roadmaps in the model? (2) Set relationships/order between components

Ex. A roadmap contains five types of technologies and three policies:



How to address existing roadmaps in the model? (3) Set quantitative data for each technology/policy

#### Input

- Future target vision
- Social/Economical conditions
- Set of options

And, each options'

- Sequential order
- Elapsed time
- Kick-off period



#### Output

- Feasibility of the target
- Roadmaps
- CO<sub>2</sub>/Cost trajectories

#### Application to Japan Low-Carbon Society Study - How to reach the society with 70% reduction in CO2 emissions in 2050? -

• Future society visions: Scenario A and Scenario B

Vivid, Technology-driven Urban/Personal	Slow, Natural-oriented Decentralized/Community			of activity					<ul> <li>Servicizing of industry, Decline in number</li> </ul>
Urban/Personal	Decentralized/Community			_	$\backslash$				Increase of public transportation (decreased)
		1		duction	21	24	Istry	Reduction of service demand Improvement of	Farm products produced and consumed
Ta ahu ala ay hua alathu ay ah	Self-sufficient			- Be		10	Indu	energy intensity	{
Technology breakthrough Centralized production	Produce locally, consume			ent of ensity	Pe	13		Improvement of carbon intensity	<ul> <li>Fuel switch from coal and oil to natural gate</li> </ul>
/recycle	locally			gy demai nprovem	00 or end-1	38	ntial & ercial	Reduction of service demand	<ul> <li>Insulation</li> <li>Energy use management (HEMS/BEMS)</li> </ul>
Comfortable and Convenient	Social and Cultural Values	1	uction	Ener tr of Ir sity e		28	Resider	Improvement of energy intensity	Efficient heat pump air-conditioner, Effici     Efficient lighting equipment
2%/yr GDP per capita growth	1%/yr GDP per capita growth	ission	0% red	provemer bon inter	51-00-36	17	ç	Improvement of carbon intensity	Development and widespread use of fuel     All-electric house     Photovoltaic
* 41 1 1		1990 CO <sub>2</sub> Emissi	2	of Im ty car	2	41	ortatic	Reduction of	Advanced land use / Aggregation of urban
1. 1. 1.	The second secon	0 06	2	upply n ent	ddns. 77		ansp	service demand	Modal shift to public transportation service
	The star from the starting	1 1 1	á	prover	energy	36	F	Improvement of energy intensity	Widespread use of motor-driven vehicle su     electric vehicle and fuel-cell electric vehicle
14 . 4	The states	2		표 <u>-</u> 트 명·	5	CCS	Ŋdo	Improvement of carbon intensity	High efficiency freight vehicle     Improvement of energy efficiency (train/sh
III	31 20				nissid		gy sup		Fuel mix change to low carbon energy sou
		*			02 Er		Ener	Improvement of	natural gas, nuclear energy, and renewable • Effective use of night power / Electricity st
19	The state of the second				50 C			carbon intensity	Hydrogen (derived from renewable energy
	Akemi Imagawa				20			Carbon Capture Storage	Power generation without CO2 emission     Hydrogen production without CO2 emissio

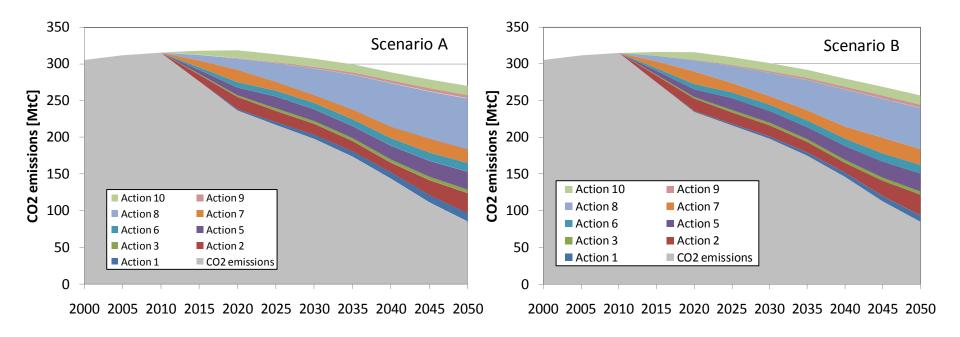
 Individual roadmaps and technology/policy are set based on "Dozen Actions" which is one of comprehensive and qualitative study about roadmaps towards LCS.

<ol> <li>Labeling to Encourage Smart and rational Ch Publicizing of energy use and CO<sub>2</sub> costs inform smart choices of LC goods and service by consi and public achnowledgement of such consume</li> </ol>	ation for umers,	(All sectors)	(All sectors)	Huma Carbo	Carbon Society Leadership n resource development for building "Low- n Society" and recognizing extraordinary butions.
5. Environmentally Enlightened Business and Industry Businesses aiming at creating and operating in LC market. Supplying LC and high value-added goods & services through energy efficient production systems		30-35 MtC reduction	9581 MtC reduction	n (==	10. Next Generation Fuels Development of carbon free hydrogen- and/or biomass-based energy supply system with require infrastructure
<ol> <li>Consuming In-Season Local Using local and renewable buildings materials and products.</li> </ol>	-	La the	Relation of	(	9. Local Renewables for Local Demand Enhancing local renewables use, such as solar, win biomass and others.
<ol> <li>Promoting Seasonal Local Food</li> <li>Supply of seasonal and safe low carbon local foods for local cuisine</li> </ol>	-	56-48 MtC reduction	44-45 MtC reductio		8. Low-Carbon Electricity Supplying low carbon electricity by large-scale renewables, nuclear power and CCS-equipped foss (and biomass) fired plants
<ol> <li>Anytime, Anywhere Appropriate Appliances Use of Top-runner and Appropriate appliances. Initial cost reduction by rent and release system resulting in improved availability.</li> </ol>	•			-	7. Pedestrian Friendly City Design City design requiring short trips and pedestrian (an bicycle) friendly transport, augmented by efficient public transport
<ol> <li>Comfortable and Green Built Environment Efficiently use of sunlight and energy efficient built environment design. Intelligent buildings</li> </ol>	•	& Residential	Transportation	*	<ol> <li>Swift and Smooth Logistics Networking seamless logistics systems with supply chain management, using both transportation and ICT infrastructure</li> </ol>

Criteria : Cost minimization
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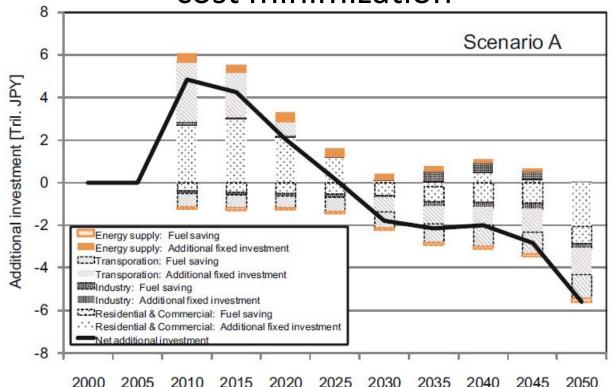
Barriors	Hesidential Associate energy densing : 42% those Protocolared     Building Note area energy densing 1 - 42% draw Protocy keek	Future Objectives
Complex energy- array performance metrics, high calculation costs, mulficient personnel	Divisesanation of diagnosis practitioners for energy-saving and CO; reduction efficiences	Solar and Wash sellipstion design
lastficient acentres for housing energy- aring residences	Earthindowent of simplified evaluation particle for environmental efficiency of residences and buildings	Passer-files.
end becklarge	Organizing training classes and events for passing on knowledge of autility trails we have logies	Numering of worker skills i information
	Introduction and expression of residence and Fueldage Indefing critics for exercutaneousle efficiency (new building, transcoling, manufatory auforation upon lensing)	Francisco
	Implementation and expansion of tax breaks and low mierrol lows financing based on the environmental efficiency label	

## Results: CO2 pathways towards LCS



- When the CO2 target for 2050 is set 70% lower than the 1990 level, the pathways to reach the target in scenarios A and B are quite similar.
- The optimum course in terms of total cost is to start introducing measures by as early as 2010 and reduce emissions by 17% compared to the 1990 level by 2020 and by 30% by 2030.

# Investment pathways for achieving LCS under the total cost minimization



- The investigation has also revealed a key piece of information to be determined for prompt action, namely, the necessary initial investment.
- In both scenarios sharply as a consequence of learning-by-doing effects and reductions in the demand for transportation services due to changes in the structure of cities. By 2020, the costs reach close to zero.
- Meanwhile, however, the additional fixed costs in the residential and commercial sectors stay at around 2 trillion JPY per year until 2030.

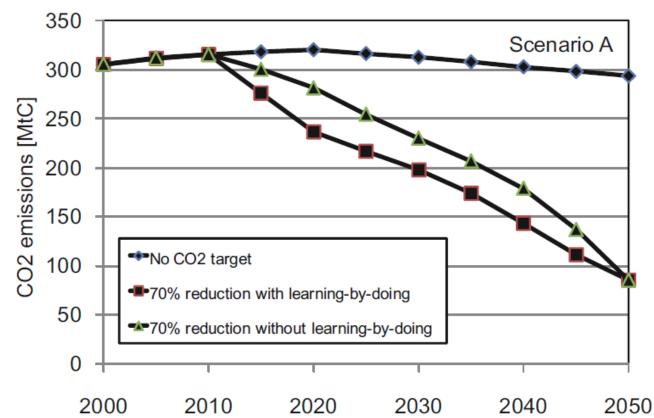
# Gantt Chart towards LCS (a part)

Residential and commertial sector				
Introduction of simplified methods for assessing the performance	•			
of buildings	<b>V</b>			
Spread technologies for insulated houses and buildings			 	$\rightarrow$
Spread insulated houses and buildings				
Introduce a system for labeling houses and buildings	•	$\diamond$		
Revise the top-runner standards	$\diamond$	•		
Spread the use of energy-efficient household appliances				$\rightarrow$
Spread the use of energy-efficient office appliances			 	$\rightarrow$
Introduce solar water heating appliance				
Agriculture	•			
Introducing labeling for farm products	$\diamond$			
Increase consumer awareness of low-carbon farm products				
Encourage the consumption of seasonal foods				$\rightarrow$
Spread energy-efficient devices in agriculture				$\rightarrow$
ndustry				
Introduce a CO2 emission disclosure system by each company	^			
and office	$\checkmark$			
Establish a CO2 emission disclosure system on the entire indust	try 🔷			
Spread energy-efficient devices in industry				$\rightarrow$
Fuel shift to gas in industry				$\rightarrow$
Promote electrification in industry			 	$\rightarrow$
Spread steel furnances with CCS installed	ernational Wo	rkshon	 	13

Viewpoints of future pathways: Four reasons for taking early actions

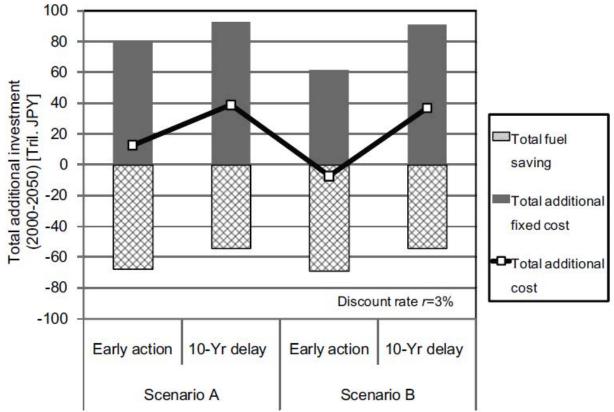
- 1. Technologies have learning-by-doing effects: the additional cost of low-carbon technologies will fall as the technologies spread.
- 2. If actions are delayed, learning-by-doing effects may fail to work sufficiently, resulting in higher total investment requirements to achieve a LCS.
- 3. No infrastructure can be built immediately; hence it would be difficult to switch suddenly to a LCS in the years just before 2050.
- 4. Future technological development has several uncertainties. If one of the currently dominant technologies falls behind schedule, it will fail to spread as expected and CO<sub>2</sub> emission targets will not be met. Early actions will open up new opportunities for the spread of alternative actions toward the LCS should a dominant technology fail in some way.

Point 1: Learning-by-doing effects



- In the absence of learning-by-doing effects, the CO2 reduction pathway will be delayed.
- The introduction of major CO2 reduction options through the early-stage ۲ investment of large sums will not only gradually reduce the cost via learning-by-doing effects but also reduce the total investment required for achieving a LCS. 2010/02/22

Point 2: Delays in initiating action will push up costs



- If actions are taken quickly, the total additional investment will be 12.7 trillion JPY in scenario A and 7 trillion JPY in scenario B.
- If action is delayed by 10 years, the total additional fixed costs will increase to 93 trillion JPY in scenario A and 91 trillion JPY in scenario B. The fuel cost savings, meanwhile, will come to only 54 trillion JPY in both scenarios, as these options will spread late. Thus, the resultant additional investment from 2010 to 2050 will be 39 trillion and 37 trillion JPY in scenarios A
   2010/ard B, respectively. The 15th AIM International Workshop

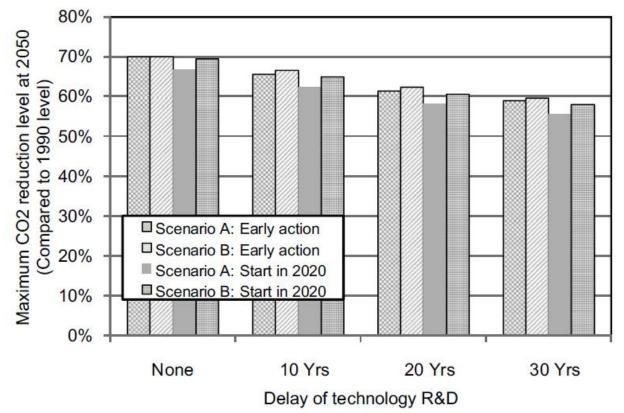
#### Point 3: It takes time to construct infrastructure

- Infrastructure (city infrastructure, transportation systems, energy infrastructure, buildings, etc.) generally has a long service life and cannot easily be modified once constructed.
- The infrastructure built today is likely to be in use in 2050. Thus, the framework of a LCS is already being established.

Sector/Assets	Average service life (Yr.)
Road	51
Harbor	49
Airport	16
Former Japan National Railways	22
Japan Railway Construction Public Corporation, etc.	26
Subways, etc.	34
Former Nippon Telegraph and Telephone Public Corporation	18
Sewerage	57
Waste disposal	40
Water works	39
City park	43
Education (Schools and academic facilities)	39
Education (social education, physical education and cultural facilities)	41
Flood control	85
Forestry conservation	50
Coastal protection	30
Agriculture	44
Forestry	49
Fishery	50
Postal service	18
National forest	47
Water works for industrial use	38

	Delays in infrastructure							
	Early actions	Start in 2020	Start in 2030	Start in 2040	Start in 2050			
Scenario A (compared to the 1990 level)	85.2(-70%)	86.7(-69.5%)	109.5(-61.4%)	134.6(-52.6%)	161.3(-43.2%)			
Scenario B (compared to the 1990 level)	85.2(-70%)	85.2 (-70%)	106.2(-62.6%)	131.7(-53.6%)	158.3(-44.3%)			
<u>2010/02/22</u>		15th AIM Internatio			17			

Point 4: There are uncertainties in technological research, development, and deployment



• Taking action now to achieve a LCS will encourage active technology development, improve efficiency, reduce costs by learning-by-doing effects, spread the portfolio of alternative actions, prepare us for future uncertainties, and thus raise the possibility of achieving a costefficient LCS.

### Summary

What did we do?

 We draw up future roadmaps for technologies, policies, and optimal investment timing toward the achievement of a low-carbon society in Japan by 2050 using an analytical model based on a backcasting methodology.

What did we find?

- Early actions can lead to pathways for minimizing the costs toward an LCS in Japan. However, to take early actions, large investments will be needed at the initial stages. Because:
  - 1. Technologies have learning-by-doing effects: the additional cost of reducing CO2 emissions will fall as the technologies spread.
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# **Further information**

- [Journal] Journal of Renewable and Sustainable Energy, in printing.
- [Journal] Climate Policy modeling long-term scenarios for low-carbon societies Vol.8 Supplement 2008
- [Report] Japan Scenarios and Actions towards Low-Carbon Societies (LCSs)
- [Report] Aligning Climate Change and Sustainability Scenarios, modeling and policy analysis (AIM, 2007), CGER-Report, CGER-I072-2007

# ALL INFORMATION CAN BE ACCESSED THROUGH http://2050.nies.go.jp



Thank you for your attention!