Quantitative approach of Asian regional low carbon development within a context of socio-economic development

Low Carbon Asia Research Network (LoCARNet) 3rd Annual Meeting

Venue: ASTON BOGOR HOTEL and RESORT, Bogor, Indonesia

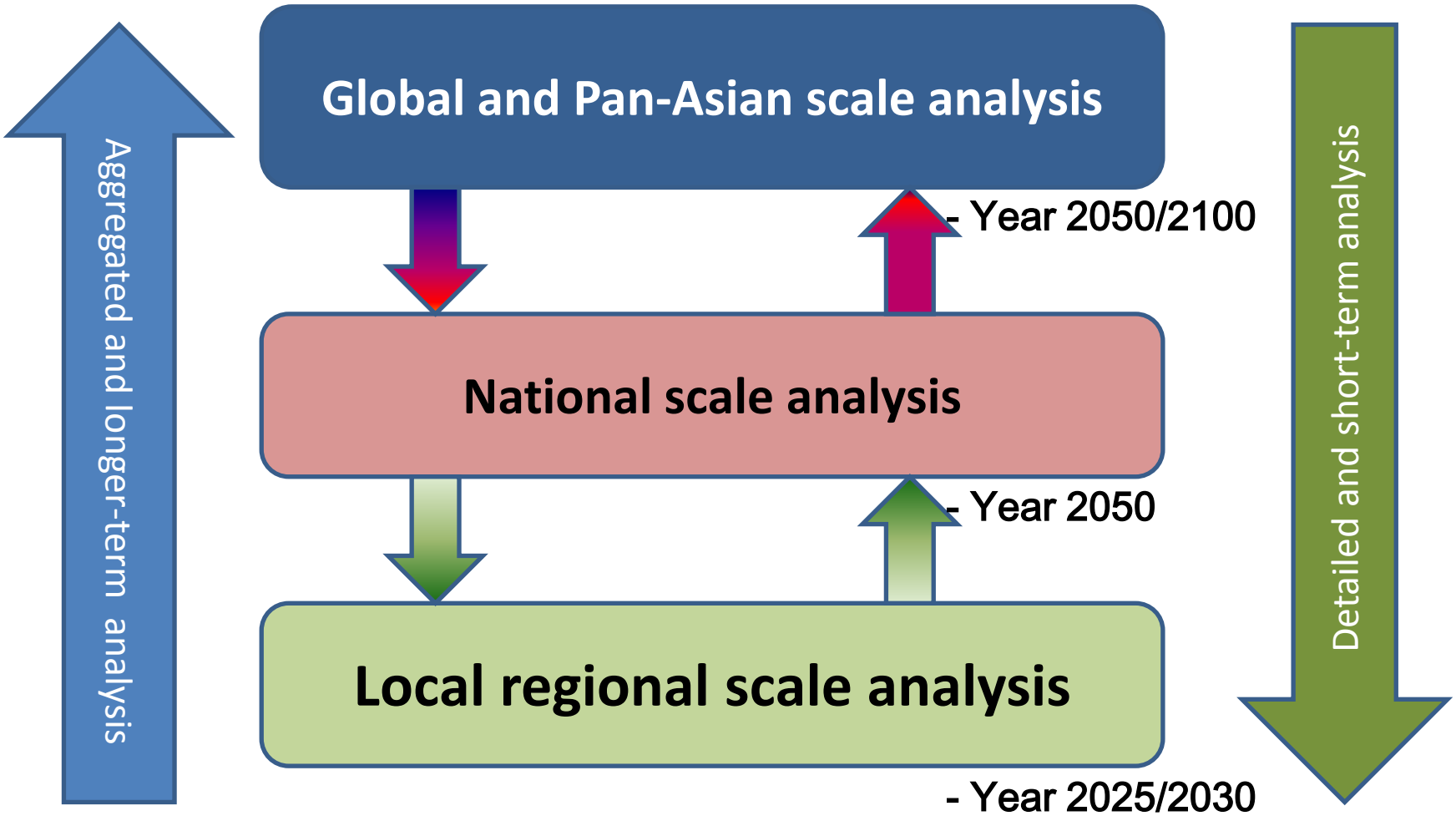
Date: 24 November 2014

Speaker: Yuzuru Matsuoka, Kyoto University, Japan

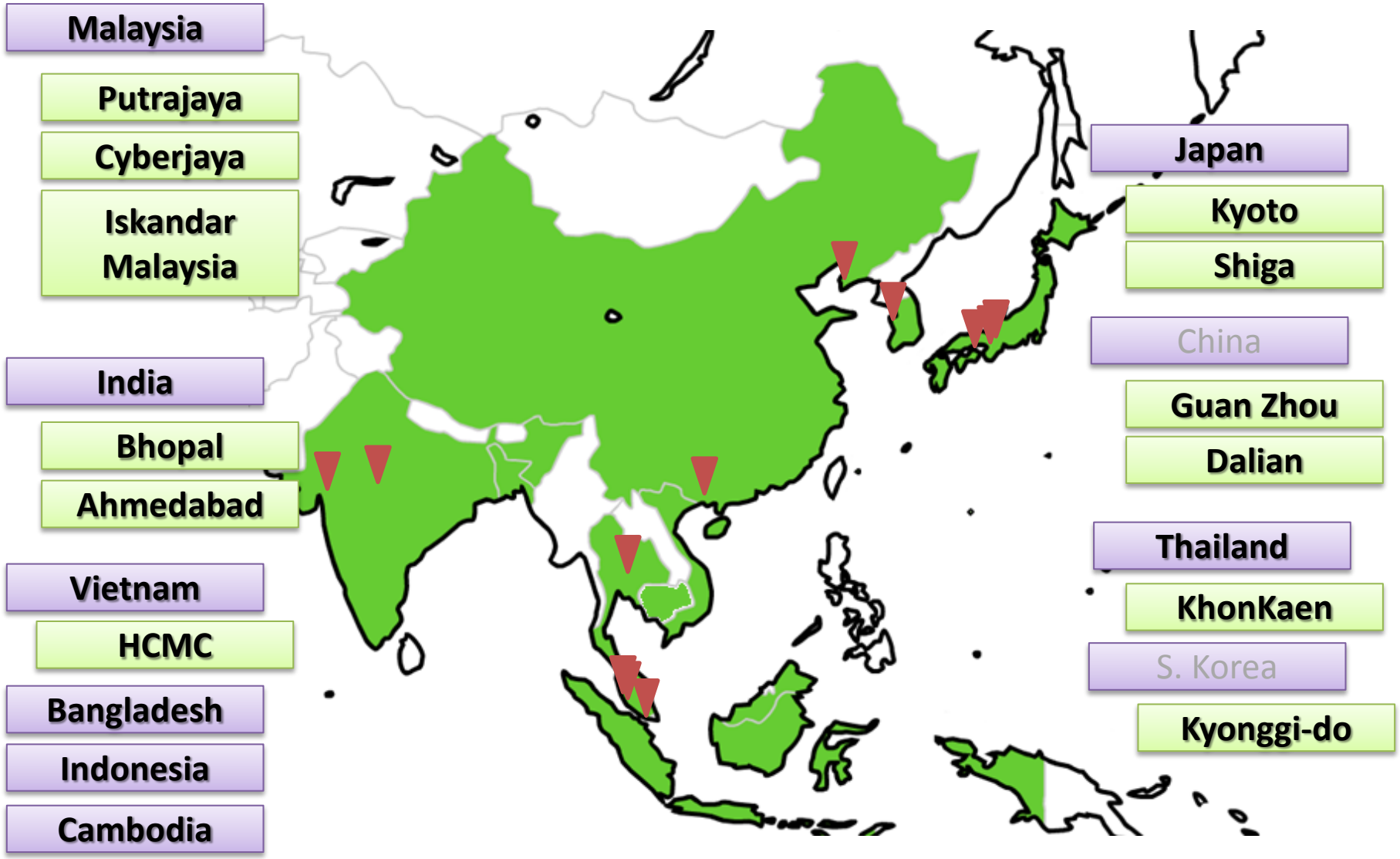
Several points of Asian Low Carbon Development (LCD) study

1. Planning of Low Carbon Society and its realization cannot be conducted without multi-disciplinary, integrated and quantification methodologies.
2. Establishing the methodologies and apply them to the target regions, taking account of regional distinctive diversified characteristics, is indispensable.
3. Design positive Asian Low Carbon Development Actions and roadmaps towards the Visions with back-casting approach.

Under these view points, we are conducting multi-scale and multi-disciplinary analysis for designing Asian Low Carbon Development (LCD)



Up to now, we applied and are applying our LCD study approach to 8 nations and 12 regions in Asia regions



Research procedure of our LC development approach

- Area
- Base year
- Target year
- Covered sectors
- Actors/Players
- LCS target

Setting framework

Qualification of Socio-economic Vision

Quantification of Socio-economic Visions and GHG emission

Coupling of Socio-Economic policies and LCD countermeasures

Analysis of Alternative LCD scenarios and measures

Design LCD Actions and Roadmaps from the analysis

- Demography
- Lifestyle
- Economy
- Transport
- Building
- Resource efficiency
- Energy strategy
- Power supply

Quantifications of parameters:

- Population
- Final demand
- Transport parameters
- Energy service demand generation
- Energy device share
- Power supply assumptions

Evaluation of Scenarios / measures:

- Transportation system
- Energy service demand generation
- Energy device share
- Power supply options
- Renewable energy
- Carbon sink
- etc.

Tools prepared for conducting Asian LCD studies
Q & A on the tools/models

Purpose		Tools developed	Explanation
What kind of LCD measures are available?	→	LCM-DB	Low-carbon measures database
How to adjust diverse objectives and preferences among LCD Actions ?	→	AHP tool	Analytic hierarchy process tool
How to manage LCD Actions systematically ?	→	LCD-Action Tools	A group of Tools for maintaining logical structure of LCD actions
How to develop quantitative visions, check the feasibility of GHG reduction targets, industrial structure and so on?	→	ExSS	Extended snapshot tool.
What is the optimal technologies invested and how much are their costs?	→	AIM/ Enduse	AIM Enduse-bottom-up model
How much is the impact to macro-economy of LCD actions ?	→	AIM/CGE	AIM Computable general equilibrium model
How to construct the roadmaps of LCD actions?	→	BCT	Backcasting tool

Overall research procedure of our LC development approach

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Design LCD Actions and Roadmaps from the analysis

Analyzing procedure

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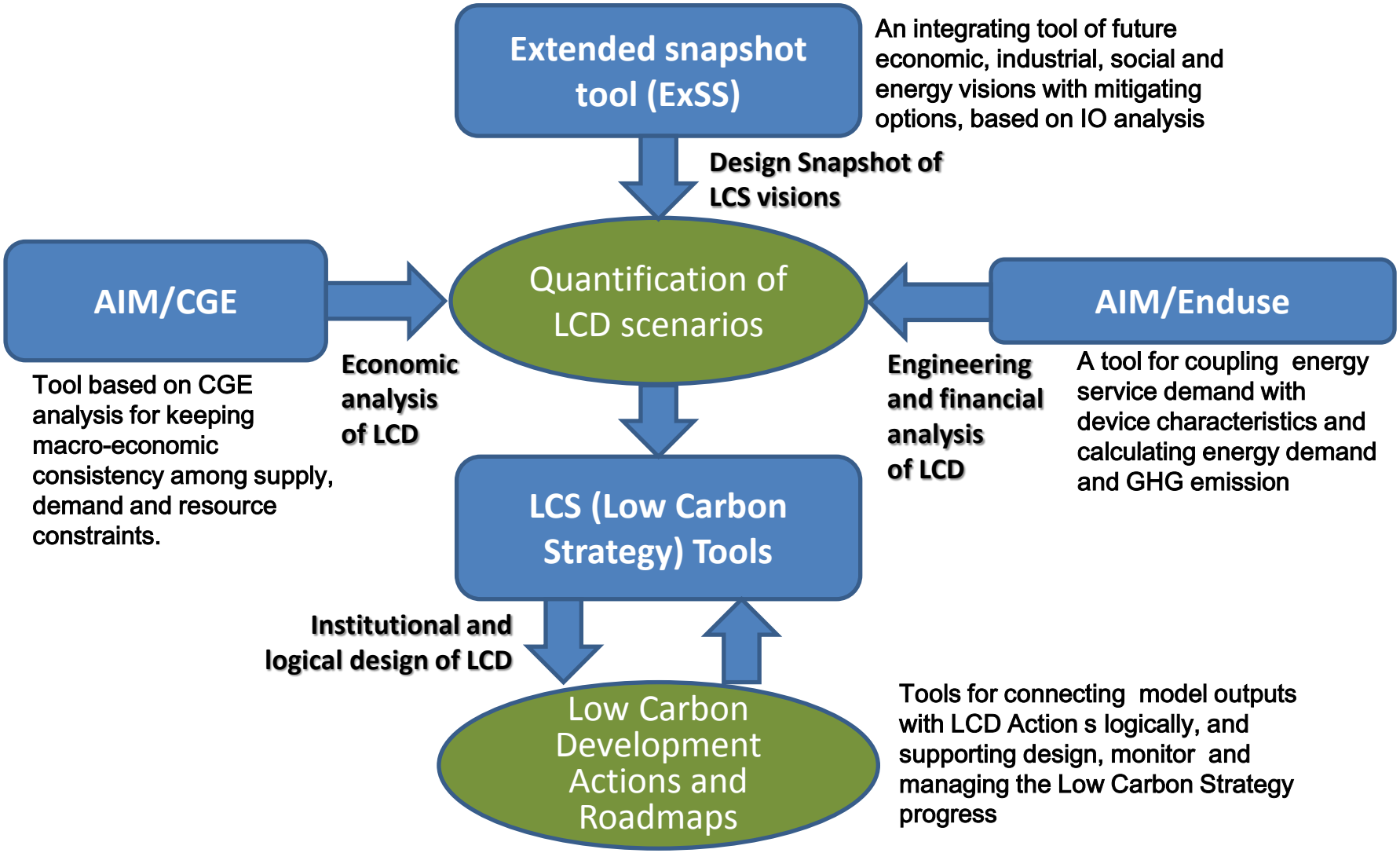
How to combine the tools in order to keep consistency and integrate Socio-Economic policies and LCD actions

2 nd to 3rd step: Quantification of Socio-economic Visions and GHG emission



AIM
ASIA-PACIFIC INTEGRATED MODEL

1st step: and 2nd Step Setting of Socio-economic Vision of the region
An example of Prefecture S

Discussing on future visions of the region

Qualification of the Society vision

Based on narrative description of 2030 Society vision such as;

1. **Powerful cities and industries supported by intra-prefectural and inter-prefectural connections**
2. **Beautiful rural villages, which maintain good nature and landscape**

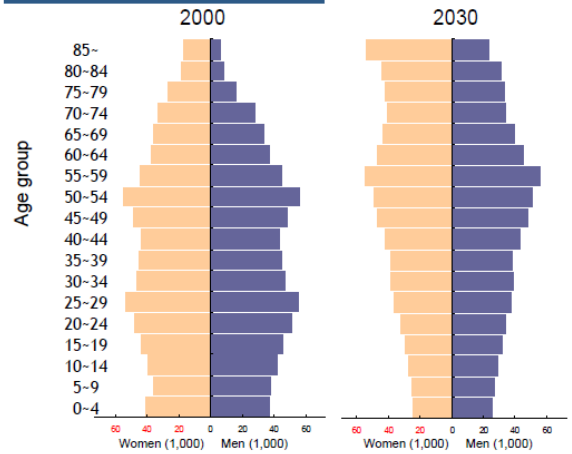
on top of the following prevailing socio-economic trends of this region;

1. **Return of the population to the current level and progress of aging;**
2. **Mature economic growth and steady increase of the tertiary industry; and**
3. **Increase of women and elderly people in employment.**

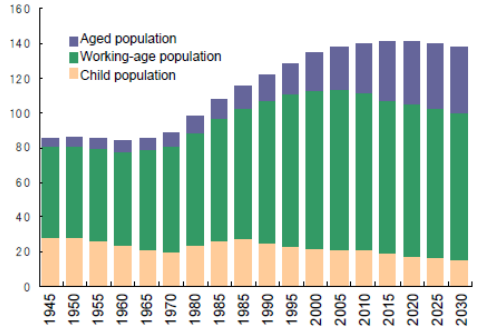
Based on these, we designed quantitatively the regional vision in 2030

Quantification of the vision

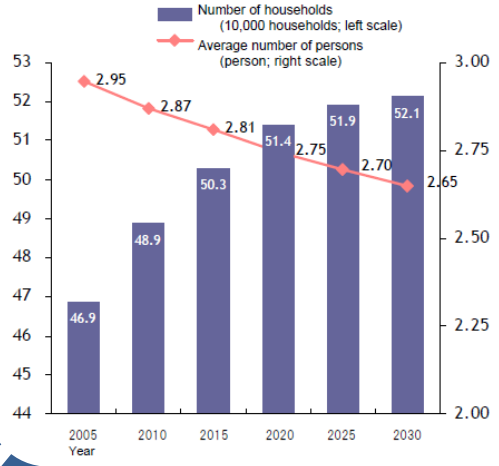
Age pyramid in Shiga Prefecture



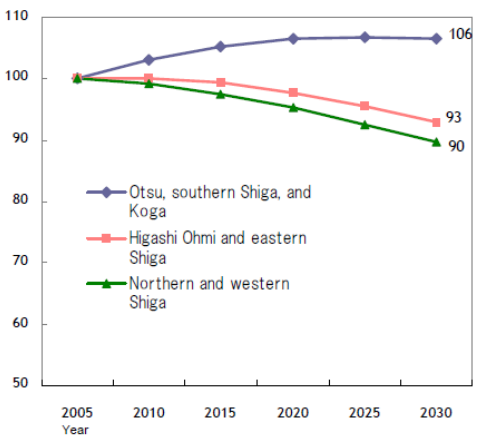
Population of three age groups by year



Number of households and average number of persons per household

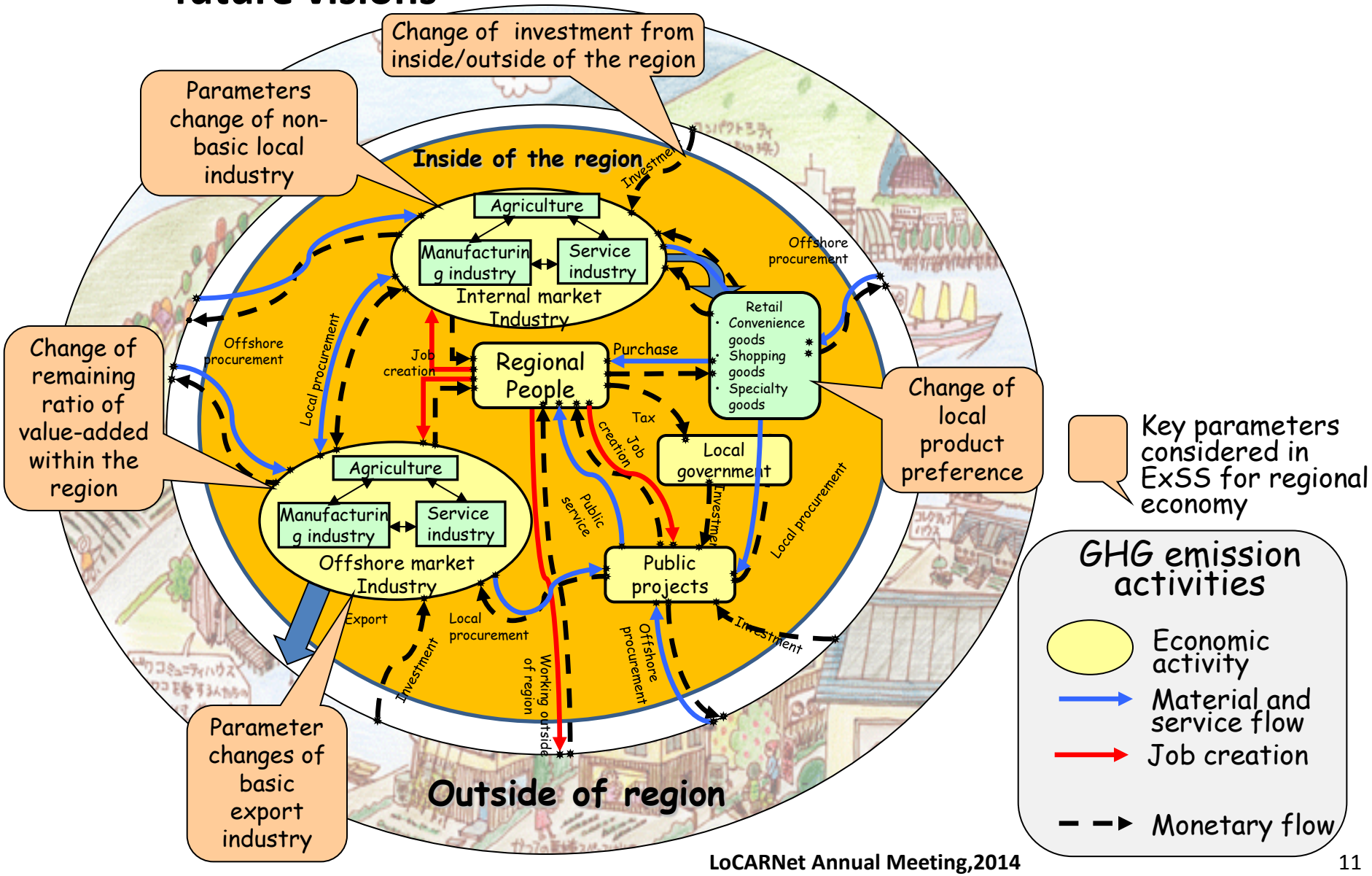


Population index in different regions of the prefecture (Year 2005=100)



Some mechanisms considered in our models/tools for quantifying regional future visions

2nd step: Quantification of Socio-economic Visions and GHG emission



Quantification of economic and industry visions in the region

- The share of the manufacturing industry is large in the industry of this region, the exports account for a high proportion of the final demands. Therefore, the industry largely depends on the economic trend of the nation as a whole.
- Based on the assumption that per capita GDP in this country will grow by 0.87%, annual per capita GDP growth will be assumed as 0.90% in this region.
- Furthermore, we have estimated further detail with an input-output analysis. Based on assumptions that the service sector grows and the food self-sufficiency ratio in the prefecture increases (about 50% in monetary terms including intermediate input, we have estimated that the shares of the primary and tertiary industries will grow and the secondary industry will decline in the production in 2030.

Production by industry

	Production (billion yen)		Share in the total production	
	2000	2030	2000	2030
Primary industry	95	564	0.8%	4.2%
Agriculture and forestry	90	531	0.8%	4.0%
Fishery	6	33	0.0%	0.2%
Secondary industry	7220	6470	62.3%	48.2%
Mining	22	10	0.2%	0.1%
Construction	938	985	8.1%	7.3%
Manufacturing	6260	5475	54.0%	40.7%
Tertiary industry	4269	6401	36.9%	47.6%
Utilities (electricity, gas, heat, and water)	102	116	0.9%	0.9%
Transportation and communications	532	1002	4.6%	7.5%
Wholesale/retail and restaurants	541	637	4.7%	4.7%
Finance and insurance	314	593	2.7%	4.4%
Real estate	657	708	5.7%	5.3%
Service	1739	2612	15.0%	19.4%
Public duties	335	658	2.9%	4.9%
Unclassifiable	50	74	0.4%	0.5%
Total	11584	13435		

Direct Low Carbon Measures

An example of City K

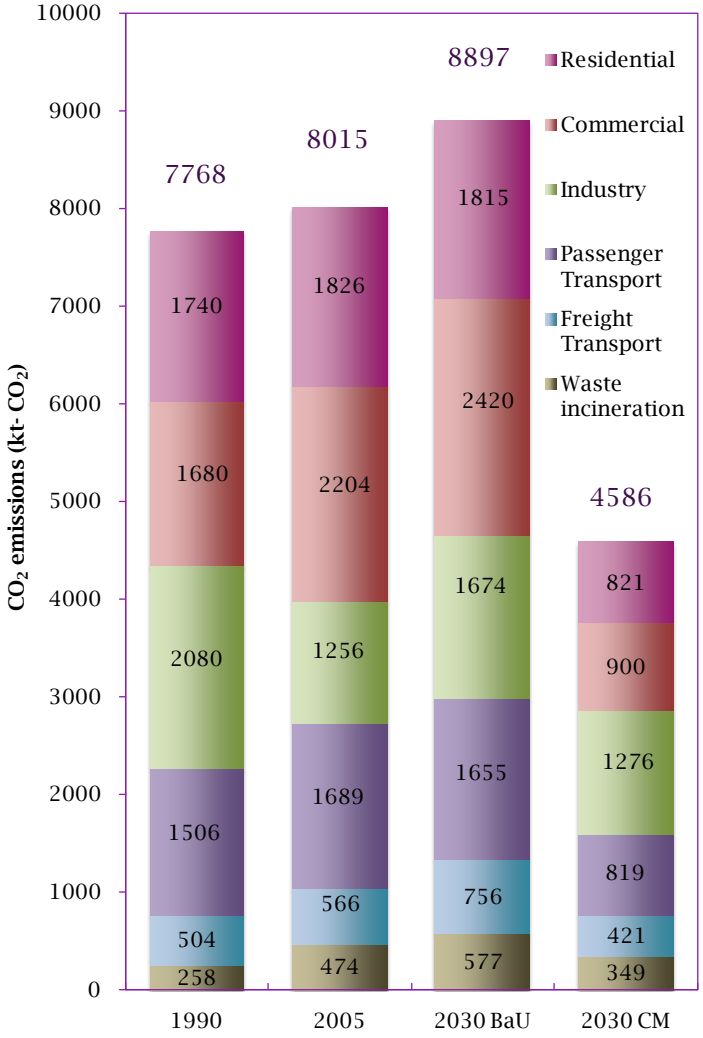
3rd step: Coupling of Socio-Economic policies and LCD countermeasures

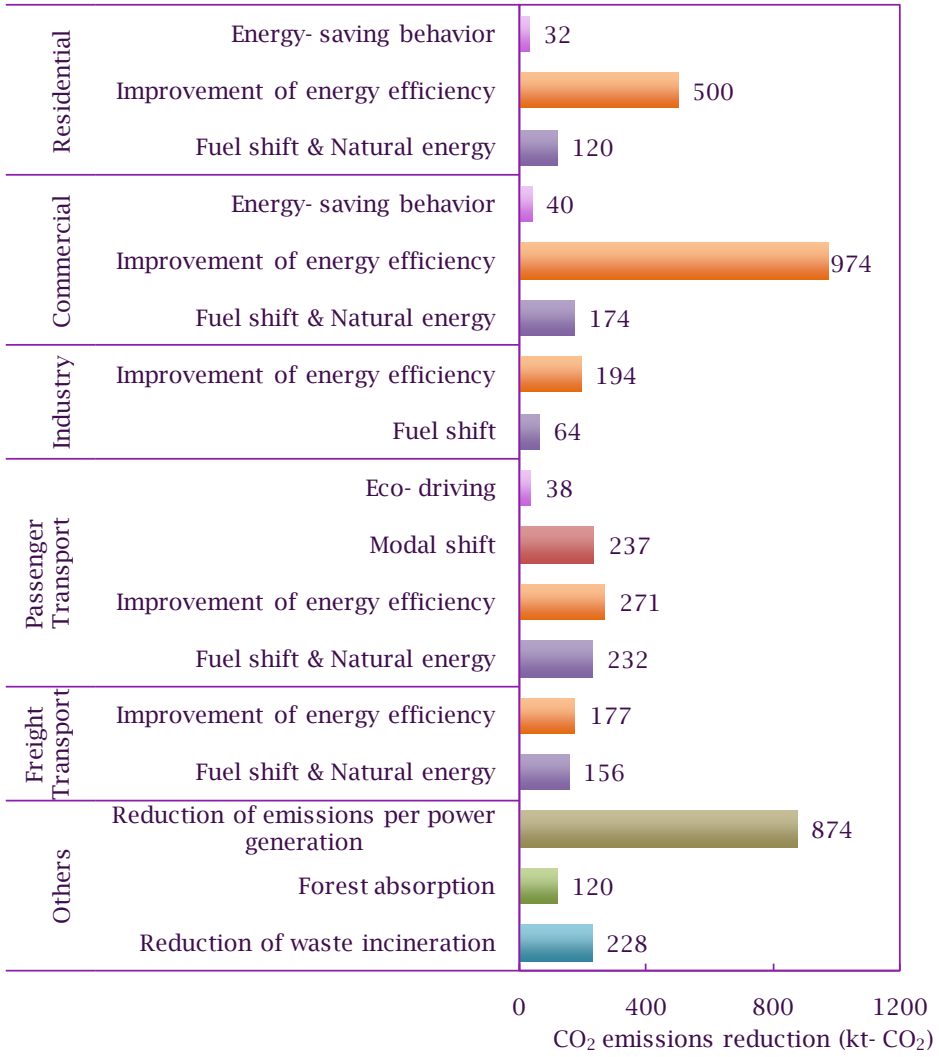
Sector	Low-carbon countermeasure	Quantification measure		Category (*)	Identified implementation intencity		Emissions reduction (kt-CO2)
Household sector	Air conditioner						50.1
	Highest energy efficiency air conditioner	COP	6.60	E	Diffusion ratio (cooling and heating)	50%	
	High energy efficiency air conditioner	COP	2.54	E	Diffusion ratio (cooling and heating)	50%	
	High energy efficiency kerosene heating	COP	0.88	E	Diffusion ratio (heating: kerosene)	80%	12.9
	High energy efficiency gas heating	COP	0.88	E	Diffusion ratio (heating: gas)	80%	25.8
	High energy efficiency oil water heater	COP	0.83	E	Diffusion ratio (hot water: oil)	70%	6.1
	Gas water heater						55.0
	Latent heat recovery-type water heater	COP	0.83	E	Diffusion ratio (hot water: gas)	50%	
	High energy efficiency gas water heater	COP	0.83	E	Diffusion ratio (hot water: gas)	50%	
	Heat pump water heater	COP	4.50	E	Diffusion ratio (hot water: electricity)	70%	48.9
	High energy efficiency gas cooker	Thermal efficiency (base year=1)	0.55	E	Diffusion ratio (cooking: gas)	70%	12.3
	High energy efficiency IH cooker	Thermal efficiency (base year=1)	0.86	E	Diffusion ratio (cooking: electricity)	70%	8.0
	Fluorescent light						
	LED (substitute fluorescent light)	Electricity consumption (conventional type=1)	2.67	E	Diffusion ratio	50%	24.1
	Hf inverter fluorescent light	Electricity consumption (conventional type=1)	1.33	E	Diffusion ratio	50%	
	Incandescent light						51.5
	LED (substitute incandescent light)	Electricity consumption (conventional type=1)	8.70	E	Diffusion ratio	50%	
	Bulb-type fluorescent light	Electricity consumption (conventional type=1)	4.35	E	Diffusion ratio	50%	
	Refrigerator						72.1
	Super high energy efficiency refrigerator	Electricity consumption (conventional type=1)	2.92	E	Diffusion ratio	50%	
	Highest energy efficiency refrigerator	Electricity consumption (conventional type=1)	2.33	E	Diffusion ratio	50%	
	TV						31.9
	LCD TV	Electricity consumption (conventional type=1)	2.27	E	Diffusion ratio	50%	

Projection of CO_2 emissions and Their reductions

An example of City K

3rd step: Coupling of Socio-Economic policies and LCD countermeasures





Analysis of Socio-Macroeconomic assessments of Alternative LCD Scenarios

An example of Prefecture S

4th step: Assessment of Alternative LCD Scenarios

- Comparison among one BaU scenario and three alternative CM scenarios
- CM1:Technocentric scenario, focused on the vitalization of eco-industry in the region
- CM2: Agrocentric scenario, focused on the regional renewable energy production
- CM3: Balanced scenario, balanced mix of Technocentric and Agrocentric scenarios

	Scenario	Unit	Base year	BaU		CM					
						Balanced		Technocentric		Agrocentric	
	year		2000	2030	2030/2000 (%)	2030	2030/2000 (%)	2030	2030/2000 (%)	2030	2030/2000 (%)
Quantified Targets	GHG emission	ktCO2eq	12876.7	14369.5	11.6	6275.8	-51.3	6515.6	-49.4	6425.5	-50.1
	TN load to lake Biwa	kt	6.7	6.6	-1.5	3.3	-50.7	3.3	-50.1	3.3	-50.3
	TP load to lake Biwa	kt	0.38	0.39	2.6	0.09	-76.3	0.10	-74.9	0.10	-75.0
	COD load to lake Biwa	kt	16.2	15.1	-6.8	7.7	-52.5	7.9	-51.4	8.3	-48.8
	Waste final disposal	kt	377.8	400.1	5.9	168.7	-55.4	173.8	-54.0	182.5	-51.7
Social Macro-economic Impacts	Total energy consumption	ktoe	12145.9	13783.2	13.5	6214.4	-48.8	4506.1	-62.9	8477.8	-30.2
	Population	1000	1396.9	1380.8	-1.2	1401.6	0.3	1378.8	-1.3	1405.3	0.6
	Gross Regional Production (GRP)	Bill. JPY/y	5884.0	7677.0	30.5	7737.5	31.5	7708.0	31.0	7655.1	30.1
	Implementation cost (direct financial cost)	Bill. JPY/y		0.0		343.0		370.7		210.5	
	Macro-economic impact (GRP change from BaU)	Bill. JPY/y		0.0		60.5		31.0		-21.9	
	Created Job	1000		0.0		20.1		25.7		15.6	

: Targeted for 75%(-0.75) reduction

: Targeted for 50%(-0.50) reduction

Analyzing procedure

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Try and error to keep consistency and unity among Socio-Economic policies and LCD countermeasures

Analysis of Alternative LCD scenarios and measures

Design LCD Actions and Roadmaps from the analysis

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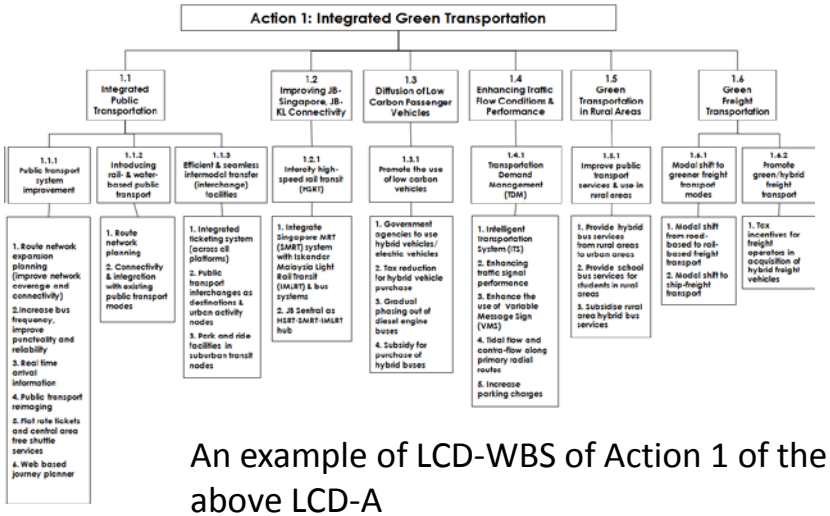
5th step: Design LCD Actions and Roadmaps from the analysis

Low Carbon Development Action (LCD-A)

- LCD-A is a group of measures and programs for realizing Low Carbon Development. It organizes and totals the scope of the LCD measures, from a view points of implementing and managing the related actions.
- Overall structure of LCD-A is shown with its Work Breakdown Structure (LCD-Work Breakdown Structure, LCD-WBS). It is a graphical format of hierarchical display of deliverable measures and programs, which are further broken down into more detailed deliverables.

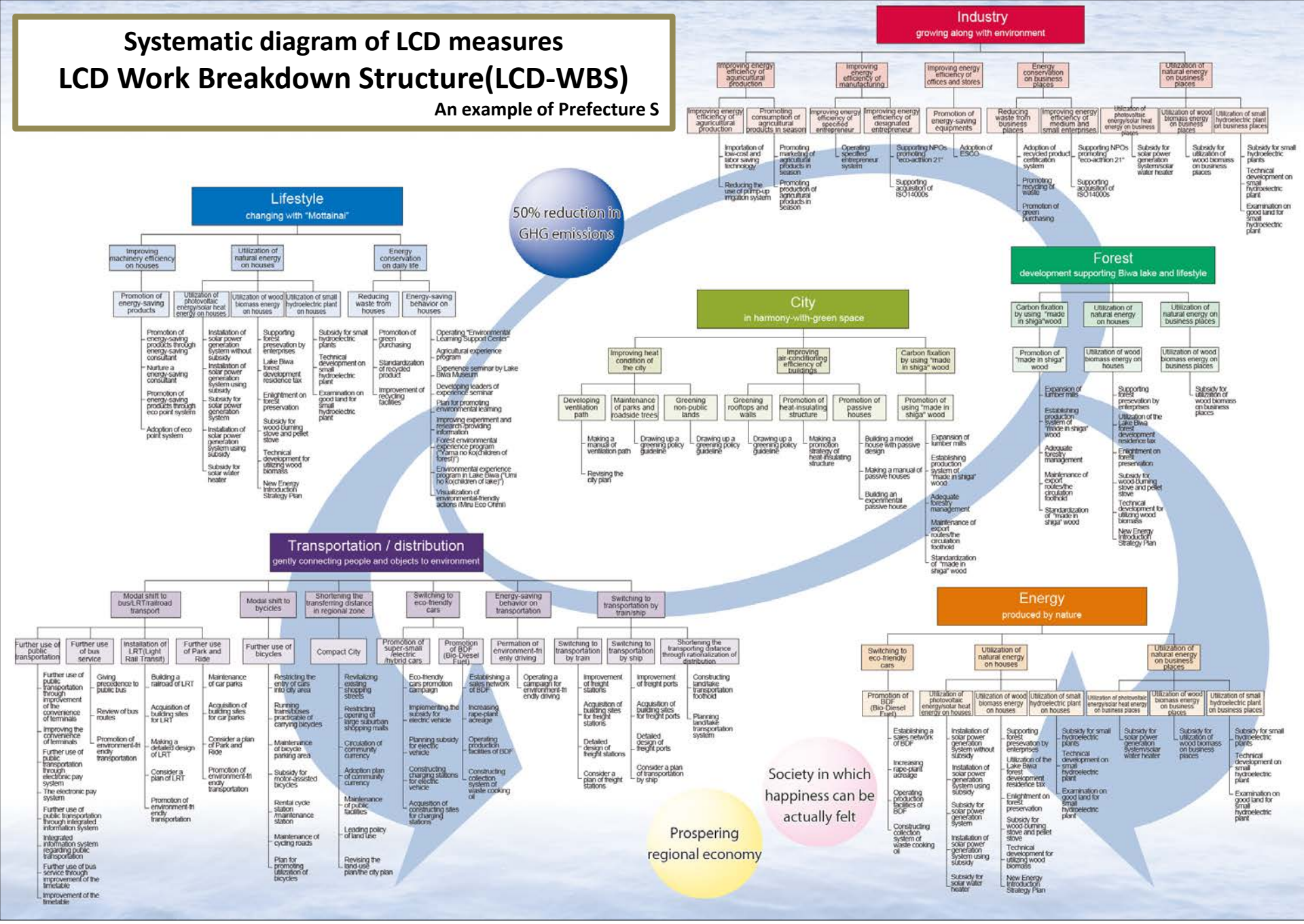
LCD-A for Iskandar Malaysia, grouped into three Themes

	Action Names	Themes
1	Integrated Green Transportation	GREEN ECONOMY
2	Green Industry	
3	Low Carbon Urban Governance	
4	Green Building & Construction	
5	Green Energy System & Renewable Energy	
6	Low Carbon Lifestyle	GREEN COMMUNITY
7	Community Engagement & Consensus Building	
8	Walkable, Safe, Livable City Design	GREEN ENVIRONMENT
9	Smart Growth	
10	Green and Blue Infrastructure & Rural Resources	
11	Sustainable Waste Management	
12	Green and Clean Environment	



An example of LCD-WBS of Action 1 of the above LCD-A

Systematic diagram of LCD measures
LCD Work Breakdown Structure(LCD-WBS)
An example of Prefecture S



Analysis of annual implementation cost for realizing the prescribed GHG reduction target under different cost constraint

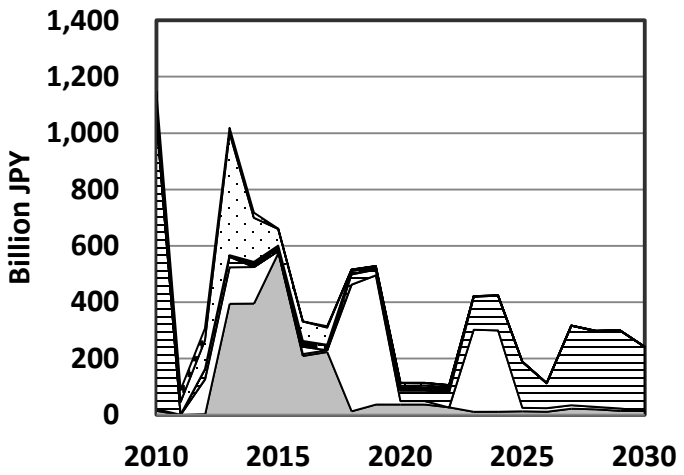
5th step: Design LCD Actions and Roadmaps from the analysis

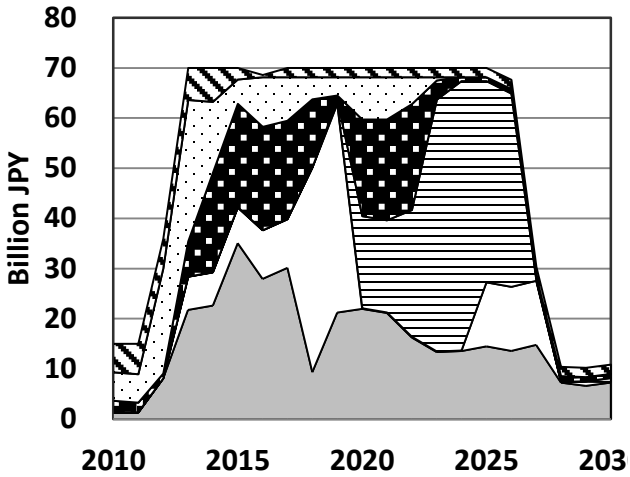
An example of Prefecture S study

Private sectors

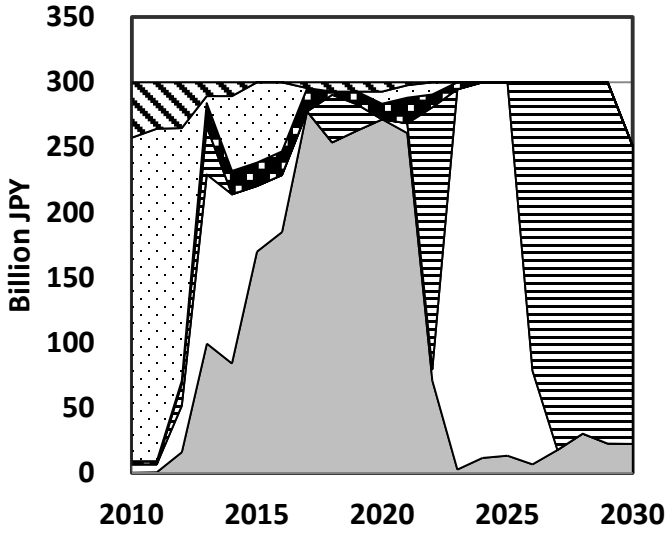
Public sectors

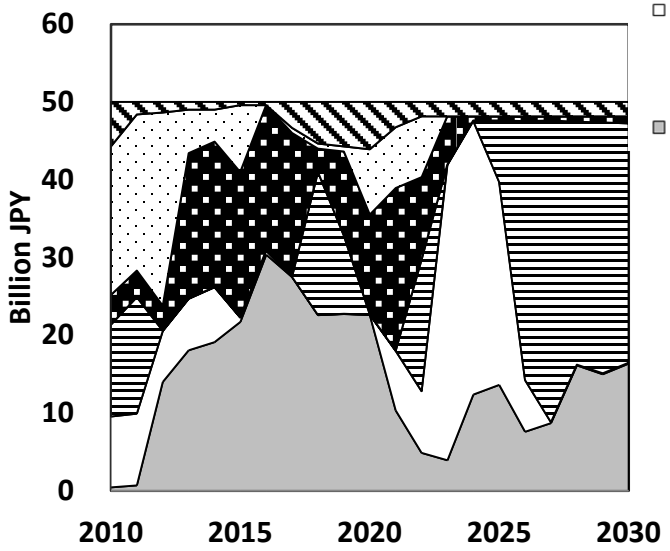
Variable flow case





Constant flow case





Actions

- Forest development
- Energy produced by nature
- Industry growing along with environment
- Lifestyle change
- City in harmony-with-green space
- Transportation

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Roadmap of LCD Actions (1)

An example of Prefecture S study

Action to make the City as harmony-with-green space

Policy-wise reduction effects (figures are reductions in 2030, unit is kt-CO_2)

86 Improving heat condition of the city

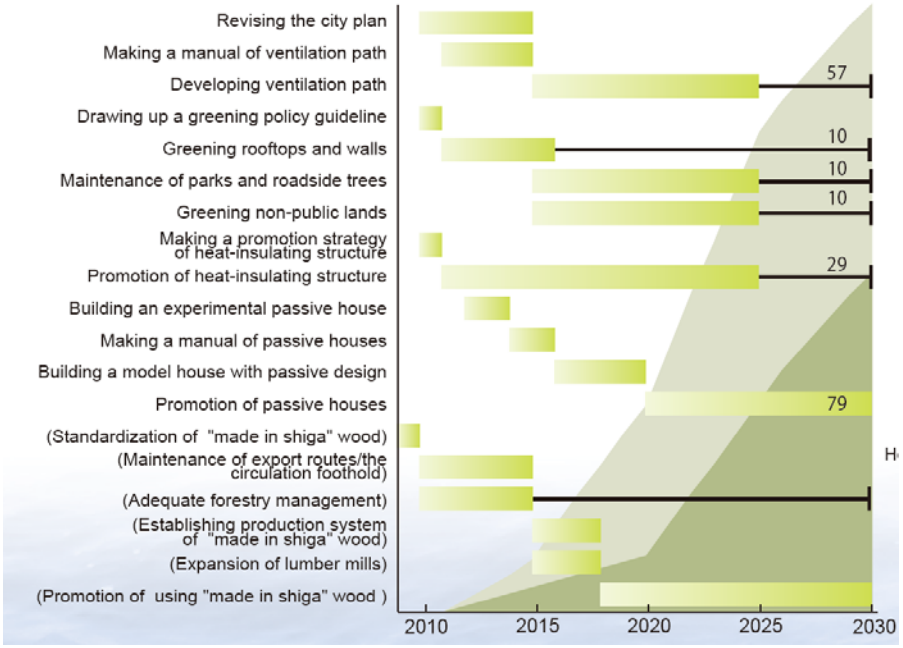
108 Improving air-conditioning efficiency of buildings

Reductions in "carbon fixation by using "Made in Shiga" wood" is recorded in "Forest development supporting Biwa lake and lifestyle."

How to read a chart

Implementation period of actions

period which continue with a finished action



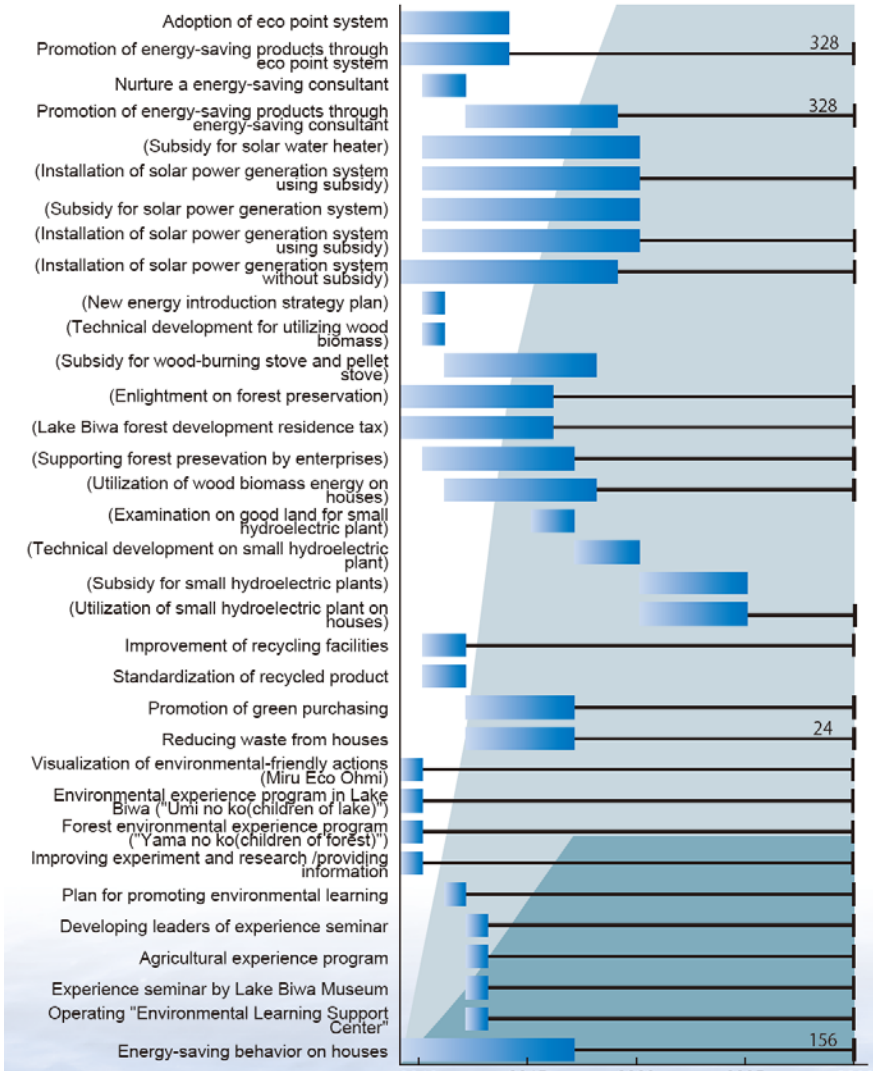
Action to make people's Lifestyle changing with "Mottainai"

Policy-wise reduction effects (figures are reductions in 2030, unit is kt-CO_2)

655 Improving machinery efficiency on houses

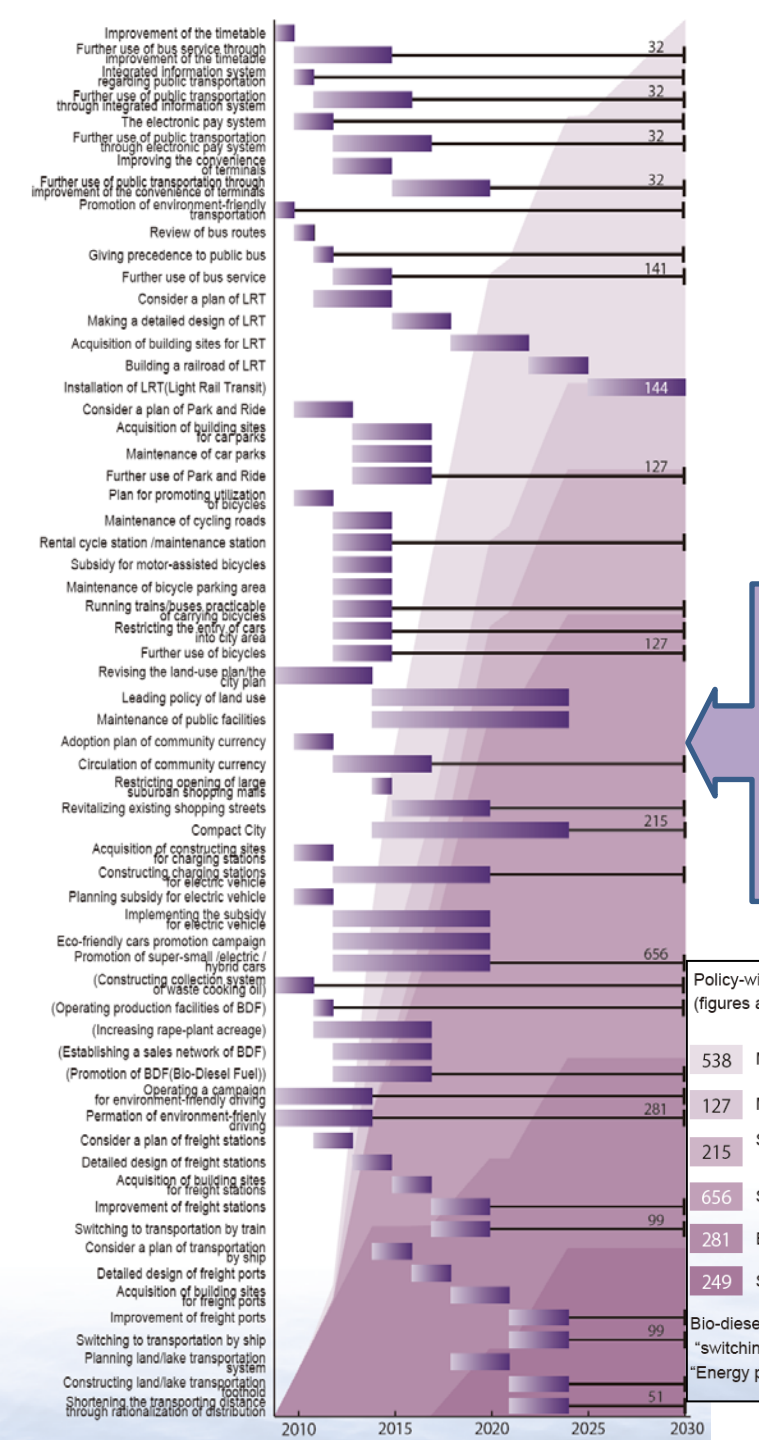
180 Energy conservation on daily life

Reduction effects of "utilization of natural energy on houses" have been recorded in "Forest development supporting Biwa lake and lifestyle" and "Energy produced by nature."



Roadmap of LCD Actions (2)

An example of Prefecture S study



Action to make the **Transportation/ distribution** gently connecting people and objects to environment

Policy-wise reduction effects
(figures are reductions in 2030, unit is kt-CO_2)

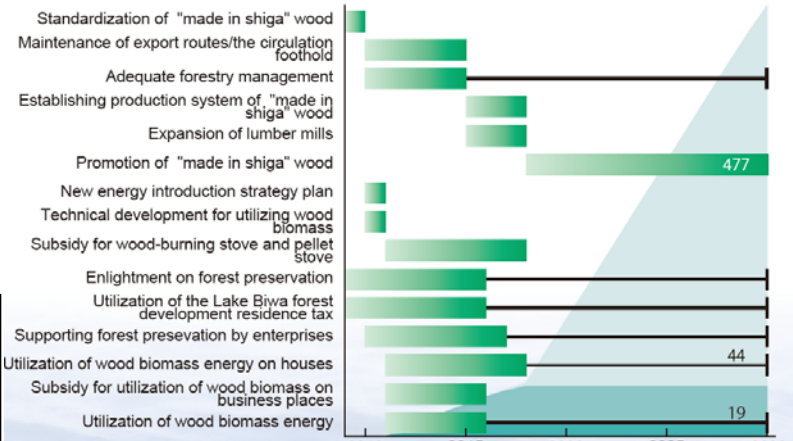
538	Modal shift to bus/LRT/railroad transport
127	Modal shift to bycicles
215	Shortening the transferring distance in regional zone
656	Switching to eco-friendly cars(except as BDF)
281	Energy-saving behavior on transportation
249	Switching to transportation by train/ship

Bio-diesel fuel (BDF) related reductions included in "switching to eco-friendly cars" are recorded in "Energy produced by nature."

Action to make **Forest development** supporting Biwa lake and lifestyle

Policy-wise reduction effects
(figures are reductions in 2030, unit is kt-CO_2)

477	Carbon fixation by using "made in shiga"wood
44	Utilization of natural energy on houses (wood biomass)
19	Utilization of natural energy on business places and agriculture (wood biomass)



Roadmap of LCD Actions (3)

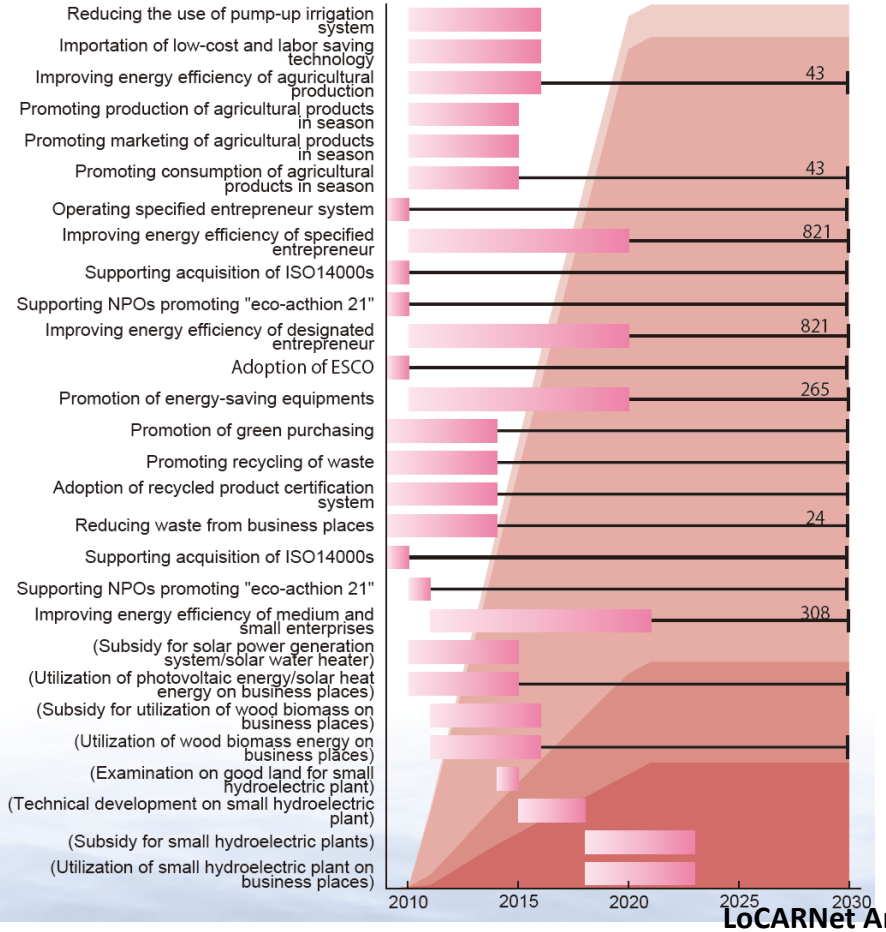
An example of Prefecture S study

Policy-wise reduction effects (figures are reductions in 2030, unit is kt-CO_2)

- 86 Improving energy efficiency of aguricultural production
- 1643 Improving energy efficiency of manufacturing
- 265 Improving energy efficiency of offices and stores
- 332 Energy-saving behavior on business places

Reductions achieved due to "Utilization of natural energy in agriculture and at business places" are recorded in "Energy produced by nature" and "Forest development supporting Lake Biwa and lifestyle."

Action to make Industry growing along with environment

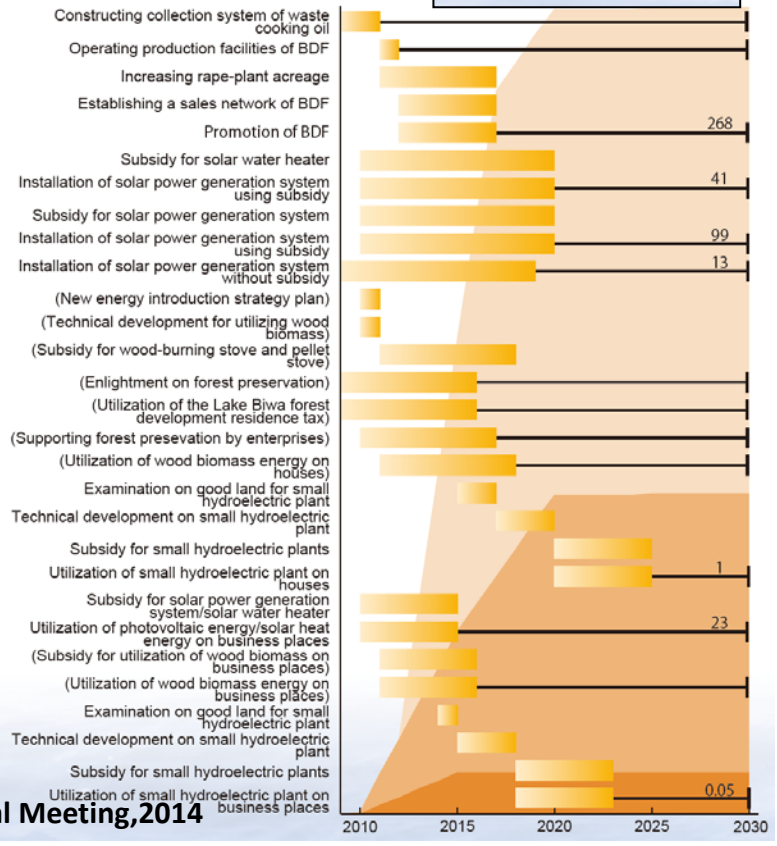


Action to make Energy produced by nature

Policy-wise reduction effects (figures are reductions in 2030, unit is kt-CO_2)

- 268 Switching to eco-friendly cars (promotion of BDF)
- 154 Utilization of natural energy on houses (except wood biomass)
- 23 Utilization of natural energy on business places and agriculture (except wood biomass)

Reductions achieved from wood biomass in "utilization of natural energy in houses" and "Utilization of natural energy in agriculture and at business places" is recorded in "Forest development supporting Lake Biwa and lifestyle."

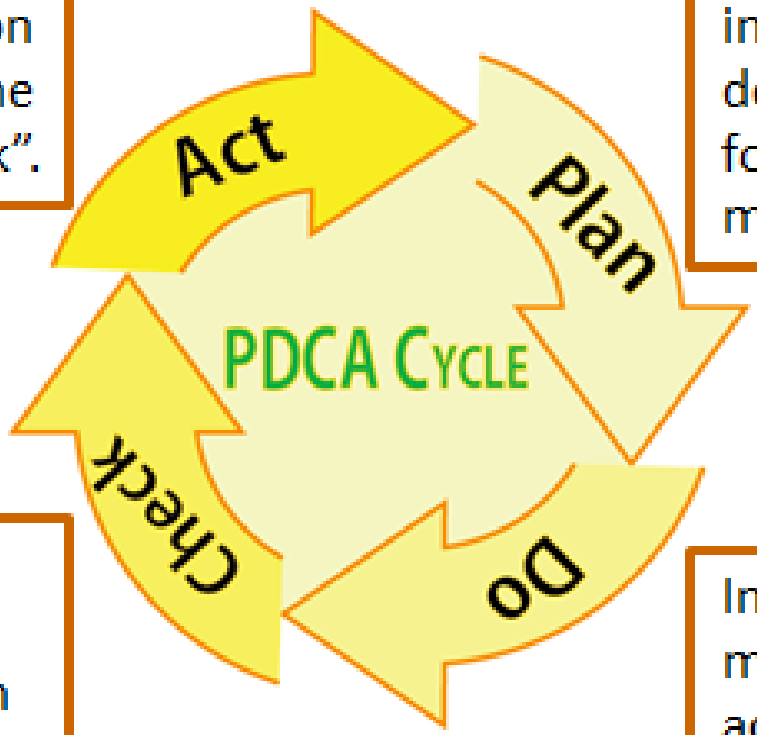


Monitoring the progress of LC Development Actions

PDCA cycle of LCDAs

Review and modify the action plan based on the results of "Check".

Set a goal, select measures to implement and design a scheme for progress management.



Grasp status of progress and outcome of each measure.

Implement the measures by each actor.

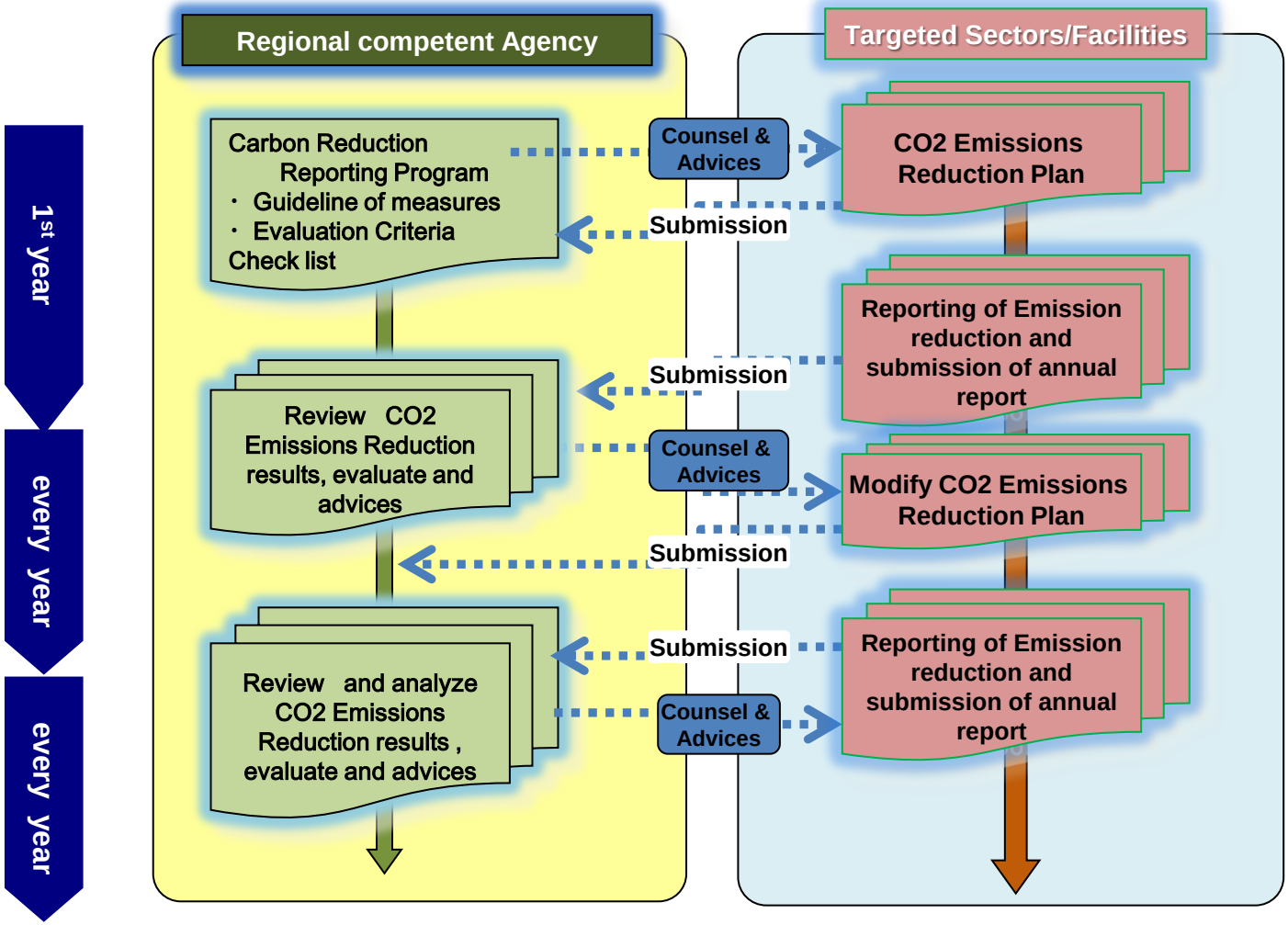
Program of Reporting GHG reduction plan for Large (specified) Facilities

City K, Japan

Reporting of GHG emission reduction plan and its result for Specified Facilities, mandatory, annual, of witch either of the following conditions is satisfied

1) Energy consumption more than 1,500 klOE/y
2) Transport company operating more than a certain numbers of carriers
3) GHG emission more than 3ktCO2/y

149 facilities are listed in 2012



Some extract of outputs from our recent Asian LCD studies

Per capita emission: 0.6 to 13.4 tCO_2, Percent reduction from BaU: 22% to 85%, Percent change from Base year: -73% to 657%

Coutry /Region	Region code	Scenario code	Covered sectors	Base year information						Target year information						Year of study
				Year	Population (1000)	GDP (GRP) total	GDP (GRP) per cap (USD)	GHG emission total	GHG emission per cap (tCO2)	Year	GHG emission in BaU (% change from base year)		GHG emission with Actions (% change from base year)		(% change from BaU)	Number of Actions	
Shiga prefecture	JPN-SIG	JPN-SIG2030	Energy, Waste, Forestry, Water pollution, Industrial process	2000	1397	5884 Bill. JPY	40811	12877 ktCO2eq	9.2	2030	14369	(11.6)	6276	(-51.3)	(-56.3)	6 Actions	2007
Kyoto city	JPN-KYT	JPN-KYT2030	Energy, Waste, Forestry	2005	1470	6124 Bill. JPY	40365	8015 ktCO2eq	5.5	2030	8897	(11.0)	4586	(-42.8)	(-48.5)	6 Actions	2009
Dalian province	CHN-DLN	CHN-DLN2020	Energy	2007	5721	294 Bill. CNY	6201	46010 ktCO2eq	8.0	2020	177760	(286.4)	123490	(168.4)	(-30.5)	-	2010
Dalian province	CHN-DLN	CHN-DLN2050	Energy	2007	5721	294 Bill. CNY	6201	46010 ktCO2eq	8.0	2050	651460	(1315.9)	256250	(456.9)	(-60.7)	-	2010
Guang Zhou city	CHN-GZ	CHN-GZ2030	Energy	2005	9600	506 Bill. CNY	6368	98 MtCO2eq	10.2	2030	336	(242.9)	165	(68.4)	(-50.9)	5 Actions	2013
Khon Kaen province	THA-KK	THA-KK2050	Energy, Waste, AFOLU	2005	1750	2933 Mill. USD	1676	2372 ktCO2eq	1.4	2050	7525	(217.2)	5173	(118.1)	(-31.3)	3 Strategies	2013
Khon Kaen province	THA-KK	THA-KK2030	Energy, Waste, AFOLU	2005	1750	2933 Mill. USD	1676	2372 ktCO2eq	1.4	2030	5256	(121.6)	3585	(51.1)	(-31.8)	3 Strategies	2013
Gyeonggi province	KOR-GYG	KOR-GYG2030	Energy, Land use	2005	10600	169 Tril. KRW	15348	76 MtCO2eq	7.1	2030	162	(114.7)	126	(67.2)	(-22.1)	-	2012
Putrajaya district	MYS-PTJ	MYS-PTJ2030	Energy, Waste, Forestry	2007	49	1062 Mill. MYR	5653	664 ktCO2eq	13.4	2030	4186	(530.4)	1780	(168.1)	(-57.5)	12 Actions	2012
Iskandar Malaysia	MYS-ISK	MYS-ISK2025	Energy, Waste, Forestry	2005	1353	36 Bill. MYR	6944	11 MtCO2eq	8.4	2025	31	(174.6)	19	(65.8)	(-39.6)	12 Actions	2013
India	IND	IND2050	Energy	2005	1103000	33 Tril. INR	680	1292 MtCO2eq	1.2	2050	7241	(460.4)	3114	(141.0)	(-57.0)	10 Actions	2009
Bhopal city	IND-BPL	IND-BPL2035	Energy	2005	1844	70 Bill. INR	868	3 MtCO2eq	1.4	2035	12	(380.0)	7	(180.0)	(-41.7)	7 Actions	2011
Ahamedabad city	IND-AMD	IND-AMD2035	Energy	2005	4700	305 Bill. INR	1483	10 MtCO2eq	2.2	2035	44	(332.4)	25	(140.4)	(-44.4)	8 Actions	2010
Ahamedabad city	IND-AMD	IND-AMD2050	Energy	2005	4700	305 Bill. INR	1483	10 MtCO2eq	2.2	2050	86	(746.1)	25	(140.8)	(-71.5)	8 Actions	2010
Vietnam	VNM	VNM2030	Energy, AFOLU	2005	83100	818 Tril. VND	615	151 MtCO2eq	1.8	2030	601	(298.0)	379	(151.0)	(-36.9)	11 Actions	2012
Bangladesh	BGD	BGD2035	Energy, AFOLU	2005	140000	4 Tril. BDT	446	88 MtCO2eq	0.6	2035	310	(252.4)	179	(104.1)	(-42.1)	-	2010
Indonesia	IDN	IDN2050CM1	Energy	2005	219000	1787 Tril. IDR	887	299 MtCO2eq	1.4	2050	4341	(1351.8)	2263	(656.9)	(-47.9)	-	2010
Indonesia	IDN	IDN2050CM2	Energy	2005	219000	1787 Tril. IDR	887	299 MtCO2eq	1.4	2050	4341	(1351.8)	670	(124.1)	(-84.6)	-	2010
Thailand	THA	THA2030	Energy	2005	60991	8017 Mill. THB	3391	185983 ktCO2eq	3.0	2030	563730	(203.1)	324170	(74.3)	(-42.5)	9Actions	2010
Malaysia	MYS	MYS2020EXT	Energy, Waste, AFOLU	2005	26128	509 Bill. MYR	5129	270710 ktCO2eq	10.4	2020	533575	(97.1)	418709	(54.7)	(-21.5)	-	2013
Malaysia	MYS	MYS2020APS	Energy, Waste, AFOLU	2005	26128	509 Bill. MYR	5129	270710 ktCO2eq	10.4	2020	533575	(97.1)	318567	(17.7)	(-40.3)	-	2013
Malaysia	MYS	MYS2030EXT	Energy, Waste, AFOLU	2005	26128	509 Bill. MYR	5129	270710 ktCO2eq	10.4	2030	741247	(173.8)	429007	(58.5)	(-42.1)	-	2013
Malaysia	MYS	MYS2030APS	Energy, Waste, AFOLU	2005	26128	509 Bill. MYR	5129	270710 ktCO2eq	10.4	2030	741247	(173.8)	359837	(32.9)	(-51.5)	-	2013
Japan	JPN	JPN2050A	Energy, Waste, Forestry, Water pollution, Industrial process	2000	126926	520 Trill. JPY	39690	1144 MtCO2eq	9.0	2050	—	(—)	312	(-72.8)	(—)	12 Actions	2008
Japan	JPN	JPN2050B	Energy, Waste, Forestry, Water pollution, Industrial process	2000	126926	520 Trill. JPY	39690	1144 MtCO2eq	9.0	2050	—	(—)	312	(-72.8)	(—)	12 Actions	2008