



# JST's activity towards the realization of a dynamic and affluent low carbon society

IEA EGRD workshop

Island energy – status and perspectives

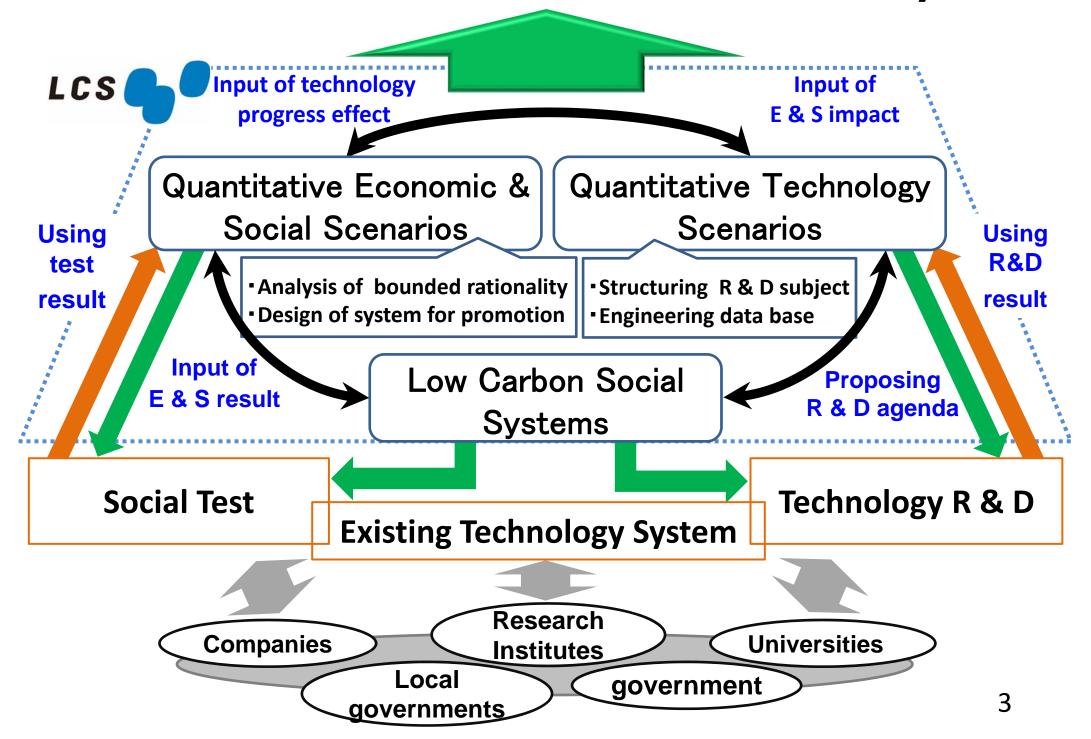
5 – 6 October 2015, Tokyo, Japan

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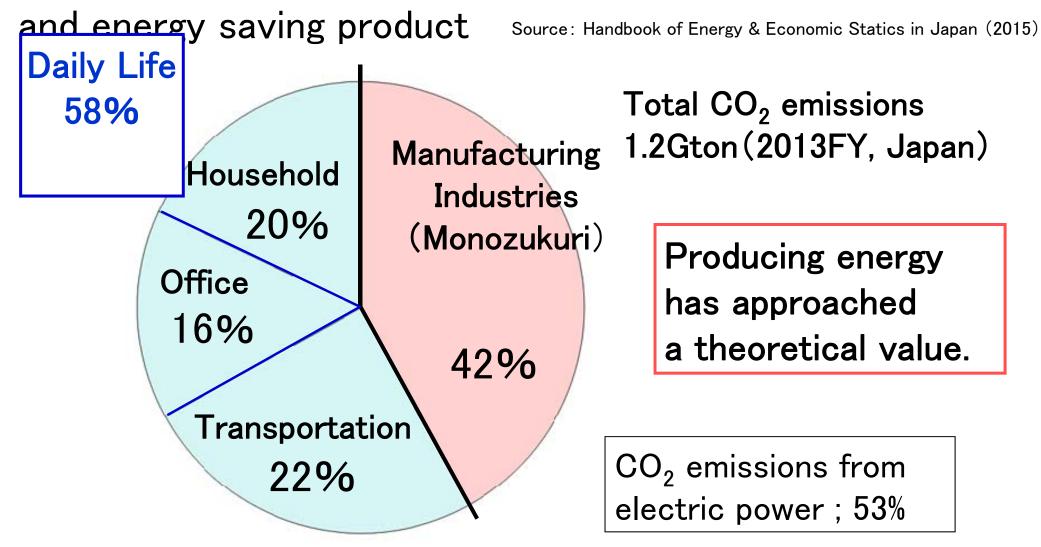
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### Towards affluent low carbon society



CO<sub>2</sub> Low Carbon Society led by CO<sub>2</sub> reduction in daily life



Affluent low carbon society towards 2050

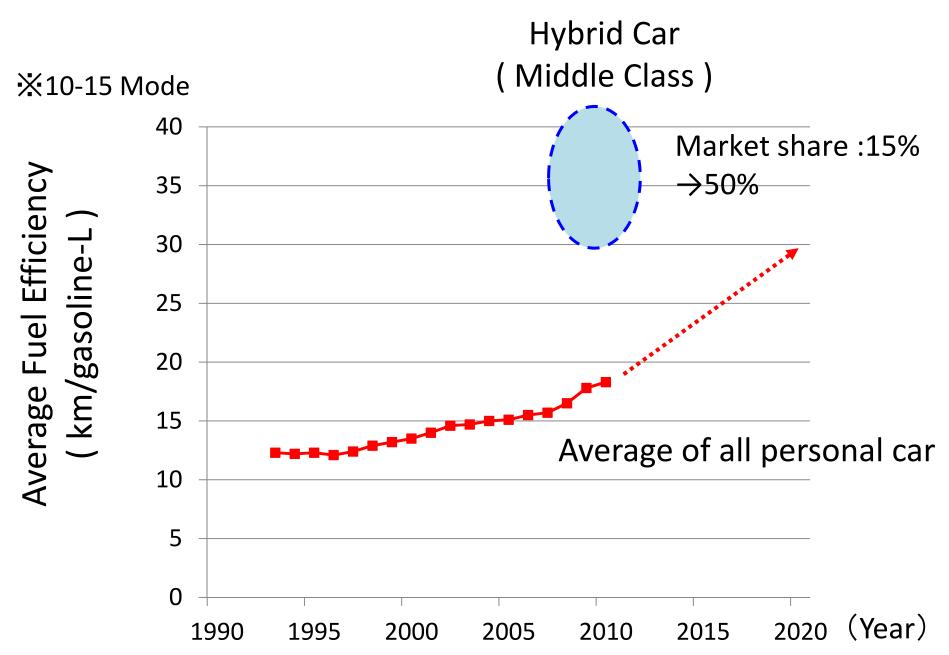
- 1. High energy efficiency
- 2. Renewable energy increase
- 3. Resource recycling system

#### Energy consumption in daily life can be reduced by 75% Energy cost reduction: 1300 US \$/y Energy saving by LED bulb (Standard family) **Electrical** Advanced PV 26% vehicle appliances **15% 15%** 18% 24% PV (2030)Fuel cell and Roof heat pump insulation systems New advanced air conditioner Comfortable life, Fuel cell and Good health heat pump systems Hybrid and electric car Wall insulation Window insulation Energy efficient refrigerator

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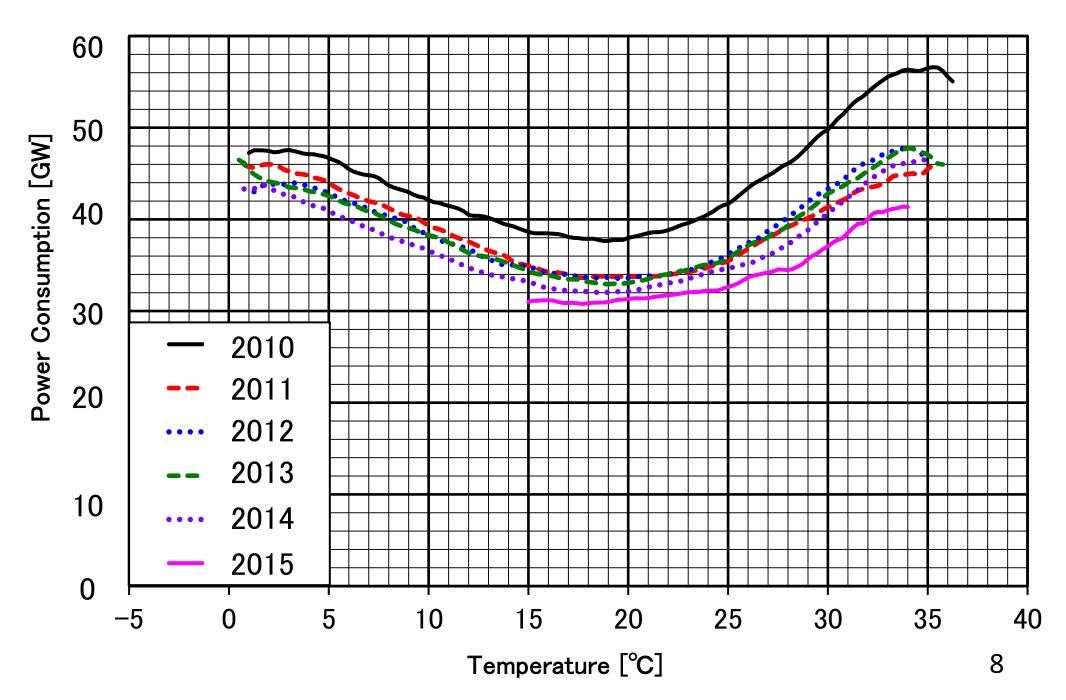
**Energy efficiency Improvement of Home Air Conditioners Promoted by TRP in Japan** Top Runner Program covers 26 products(2013) 7.0 Exhibit performance data in catalogue Home appliances of >70% COP (Coefficient of Performance) 5.9 based on energy 6.0 consumption are covered by TRP. Appropriate combination of 5.0 rule and technology level 4.0 Japan **3.2** 3.0 **2**.6 2.0 Examples of other countries A standard value is determined 1.0 based on products of top performance data In 1999, TRP was taken effect 0.0 2010 2015 2020 (Year) 1990 1980 1985 1995

### Energy Improvement of Vehicles (JAPAN)



### Power Consumption in TEPCO grid

(week day 9:00-21:00)



### Potential of Renewable Energy (Japan)

	Power generation potential (TWh/y)	
Photo voltaic	>400	variable
WP (onshore)	>500	RE
Geothermal	>500	
Hydro(small/medium)	70	stable RE
Biogas	20 **	
Biomass	40	

Biogas<sup> $\times$ </sup>: 20% of Fermentation potential (5 × 10<sup>9</sup> m<sup>3</sup>/y)

#### Prospect of PV System Cost (Yen/W) mono-crystalline Silicon solar cell Important R & D item to break technology (module efficiency 17%, bottlenecks 200 wafer thickness 180μm) Thin Si-wafer of 50µm by cutting CIGS tandem by high speed process New thin film (13%)Organic, Perovskite etc. Organic compound tandem 150 Thin-film PV installed costs (15%) compound **Current status** (20%, 150µm) semiconductor Improved existing tech. Cost **Future product** sola cell (CIGS) (20%,100µm) 100 Module (18%)Si-wafer of $50 \,\mu$ m (20-25%) (22%) S (25%) **Stand** 50 **Compound tandem** Org. mat. tandem **Power conditioner** 0 2020 2010 2015 2025 2030 **Future** 2030 2013 2020 **Future PV** Annual product 1 GW/y 5 GW/y 5 GW/y 1 GW/y or larger lifetime (years) 20 20 30 20 or longer Module cost 79 Yen/W 50 Yen/W 37 Yen/W 24 Yen/W cost nstalled **BOS** cost 84 Yen/W 47 Yen/W 20 Yen/W 20 Yen/W 163 Yen/W 97 Yen/W 57 Yen/W 44 Yen/W Total PV system cost 11 Yen/kWh Cost of electricity 18 Yen/kWh 5 Yen/kWh 4 Yen/kWh Resource: Center for Low Carbon Society Strategy (LCS) 10

	Domestic initial cost for PV installati				
<b>Technology Scenari</b>	0	current status	2020	2030	new PV
-Solar cells-	module	80	50	40	20
	BOS	80	50	20	20
	Total	160	100	60	40
Hierarchy of research projects	Research subjects	•50µm Silico	nt of the existing on compound semic iciency CIGS of sir	onductors	eakthrough technology organic
Scale Performance index	<b>Evaluation of defects</b>	Module efficiency Si 18%	• multila	yer junction	• quantum dots
>10 <sup>0</sup> m  Manufacturing and material processing	<ul><li>and degradation</li><li>Thin film formation</li><li>Reducing resource usage</li></ul>	S.C.C.13% Cutting engineering Layer stack method Synthesis method	High speed film for Synthesis engineerin semiconductor	ng for organic	>40%
Structuring and functionalizing by nano/meso scale control	<ul><li>Formation of quantum dots *superlattice</li><li>Interface control</li></ul>	Control of defects and interface Antireflection engineering	Control of defects an Interface formation of Organic semiconduc Quantum dots-based for Interband structur	control for tor materials	elf-organizing engineering fultilayer organic cell emiconductors-based cell rith high speed crystalization
10 <sup>-9</sup> m Creation of new materials and atomic control	<ul> <li>New compound synthesis for widening the optical absorption</li> </ul>	Synthesis method for less defective compound	S		Ourable Organic semiconductor 20years)
<10 <sup>-9</sup> m	Structural control for quantum materials	Clarifying the degradatio mechanism	Optimization o and quantum d	~	
Simulation	Evaluation of the defects New materials design	nicciianisiii			
New theory and principle	<ul><li>Clarifying new mechanism</li><li>Simulation of new principles for charge</li></ul>			1	11
©JST-LCS	separation -	current 2	2020	2030	future >

## Cost of electricity generation system having a high share of RE in 2050 (Different technology scenarios)

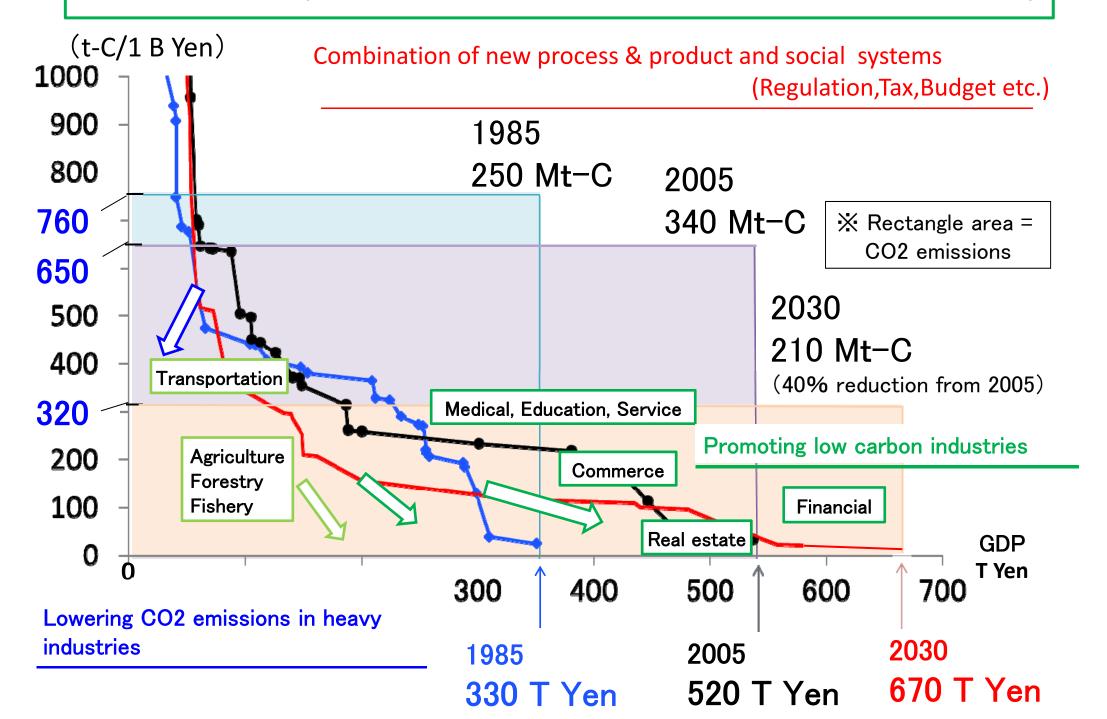
Scenarios		2010 ref.	2012	2030	2050 <sup>2)</sup>	
Total (TWh)		1,163	1,093	1,053	1,080	1,102
Supply Elec. Energy (TWh)	PV	2	7	100	429	297
	Wind	4	6	100	15	171
	Hydro	96	84	100	130	130
	Other RE	1	1	30	231	211
	Nuclear	288	16	100	146	146
	Thermal	772	979	623	128	146
	Hydrogen <sup>1)</sup>	(0)	(0)	(0)	(2)	(17)
Battery (GWh-ST)		0	0	21	474	151
CO <sub>2</sub> Emission(Mt)		<b>536Mt</b>	716Mt	493Mt	107Mt	86Mt
Cost (¥/kWh)		10.9	12.7	11.0	9.7	17.5

CO2 and Cost are estimated by LCS. Technology improvement is included in 2030 and 2050. Cost of Nuclear is 7.5 ¥/kWh in 2012, 14 ¥/kWh in 2030.

<sup>1)</sup> Unused electricity without transmission capacity expansion scenarios

<sup>2)</sup> RE low/high cost scenario in 2050.

### Future industry structure toward affluent low carbon society



### A Base in Asia, Tokyo 🌠

Soul-Incheon Three cities Tokyo representing future **Asia** Shanghai A future City

Base for economy, information, commodity, and logistics
Various and advanced presents
Centripetal force as attractive city
Safety

### Top ranking cities\*1

London, New York, Paris, Tokyo (the 4th in world)

### Specific ranking ...

Tokyo is the 1<sup>st</sup> place in economy and the 2<sup>nd</sup> place in R&D capabilities. Tokyo is only the well-balanced city, above 6<sup>th</sup> places in all fields. \*\* 2

※1 The Mori memorial foundation "Global Power City Index 2014"

**%2** Economy, Research & Development, Culture & Exchange, Habitation, Environment, Traffic access

### Conclusion

- Low Carbon Society led by CO2 reduction in daily life in Japan was explained
- 2. It is important to quantitatively define the efficiency, economic and environmental sustainability of low carbon technologies, and to understand potential of Renewable Energy.
- 3. Cost competitiveness of Renewable Energy is growing, so it is possible for us to consider scenarios with electricity generation system having a high share of RE in 2050.