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The Use of Technology Roadmaps to Guide Science and Technology Policy in Japan

Akira YABE(Chairman, JSME Roadmap Committee, JSME)

Our Humankind can not survive without Good Estimation of the Future.

Accurate Estimation of Future Improvement of Technology and Society would be able to be considered only by Our Engineering Societies.

The estimation of future improvement of energy efficiencies and the financial payback period for accelerating the prevention effect for global warming.

JSME Technology Roadmap

(Established from 2006 as 110th Memorial Event of JSME)

Fundamental Principle: The Long Term Improvement Process of Key Physical Parameter would able to Indicate the Future of the Technology Accurately.

One Successful Example would be the Line Width of Semiconductor Memory, which would be shortened to the half at every 1.5 years.(Moore's Principle)

Important Task is to select the Key Physical Parameters, which would control the Future Improvement of the Technology

Purpose: To estimate the Improvement of the Technology and Future Figures of Society, and to give the Future, Clear and Quantitative Targets of Engineering and Academic Researches.

Trend of Academic Research:

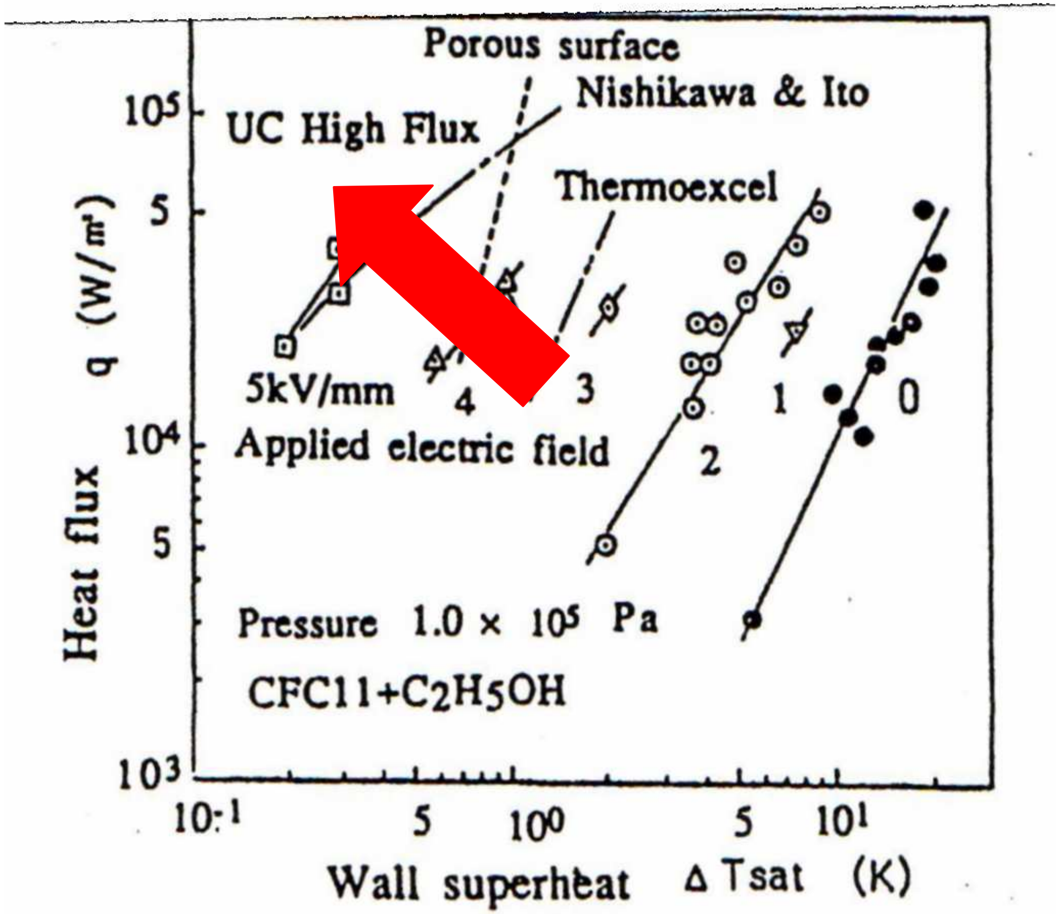
To Realize the Compact and Low Cost Heat Exchangers= Research and Development of Heat Transfer Enhancement

Heat Transfer Enhancement of Boiling

＝High Performance Boiling Surface (To Decrease the Wall Superheat)

or

＝Enhancement of Critical Heat Flux (To remove the Higher Heat Flux)

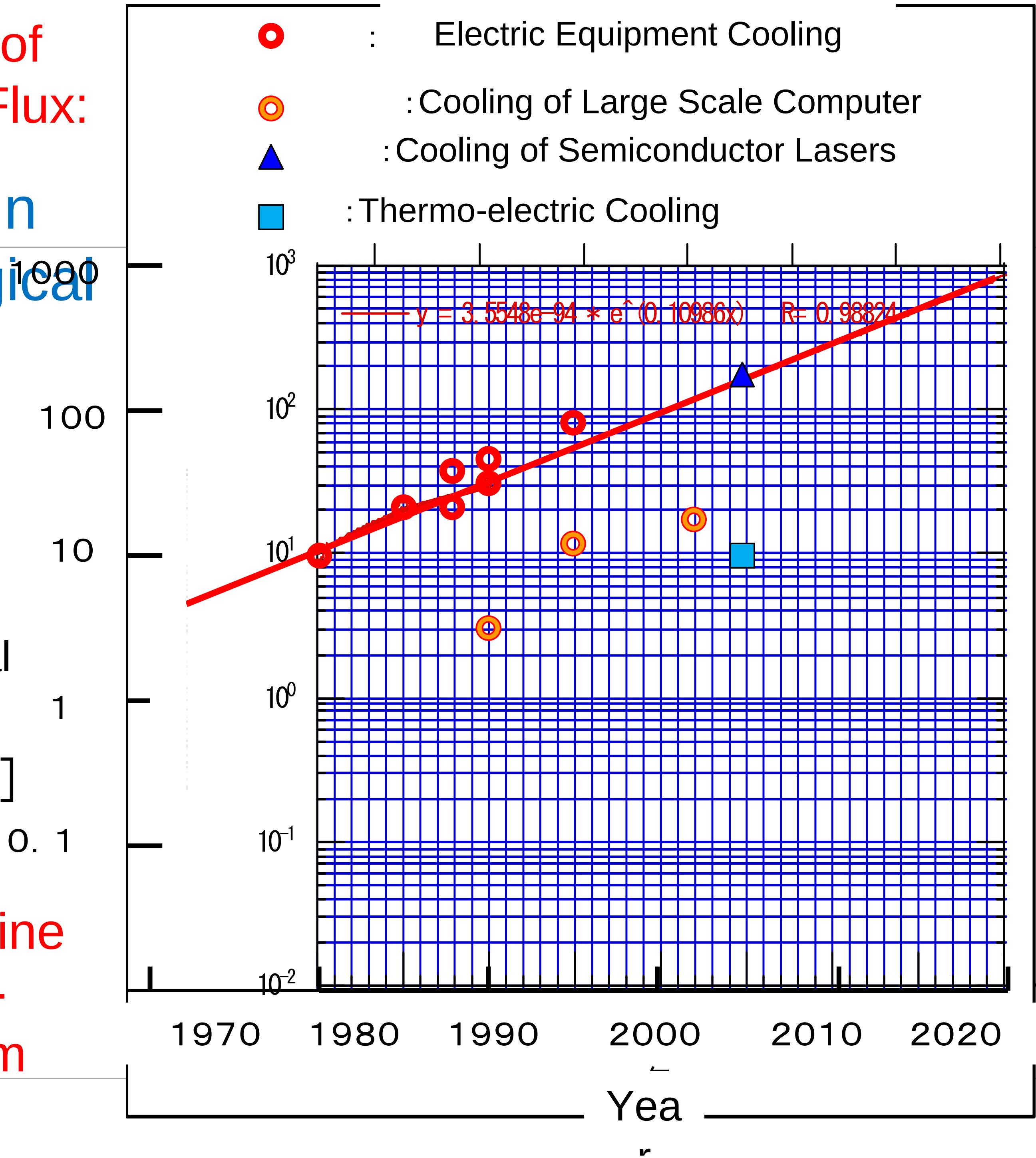


Removal of High Heat Flux:

Plotted in Chronological Order

Possible Heat Flux For Removal

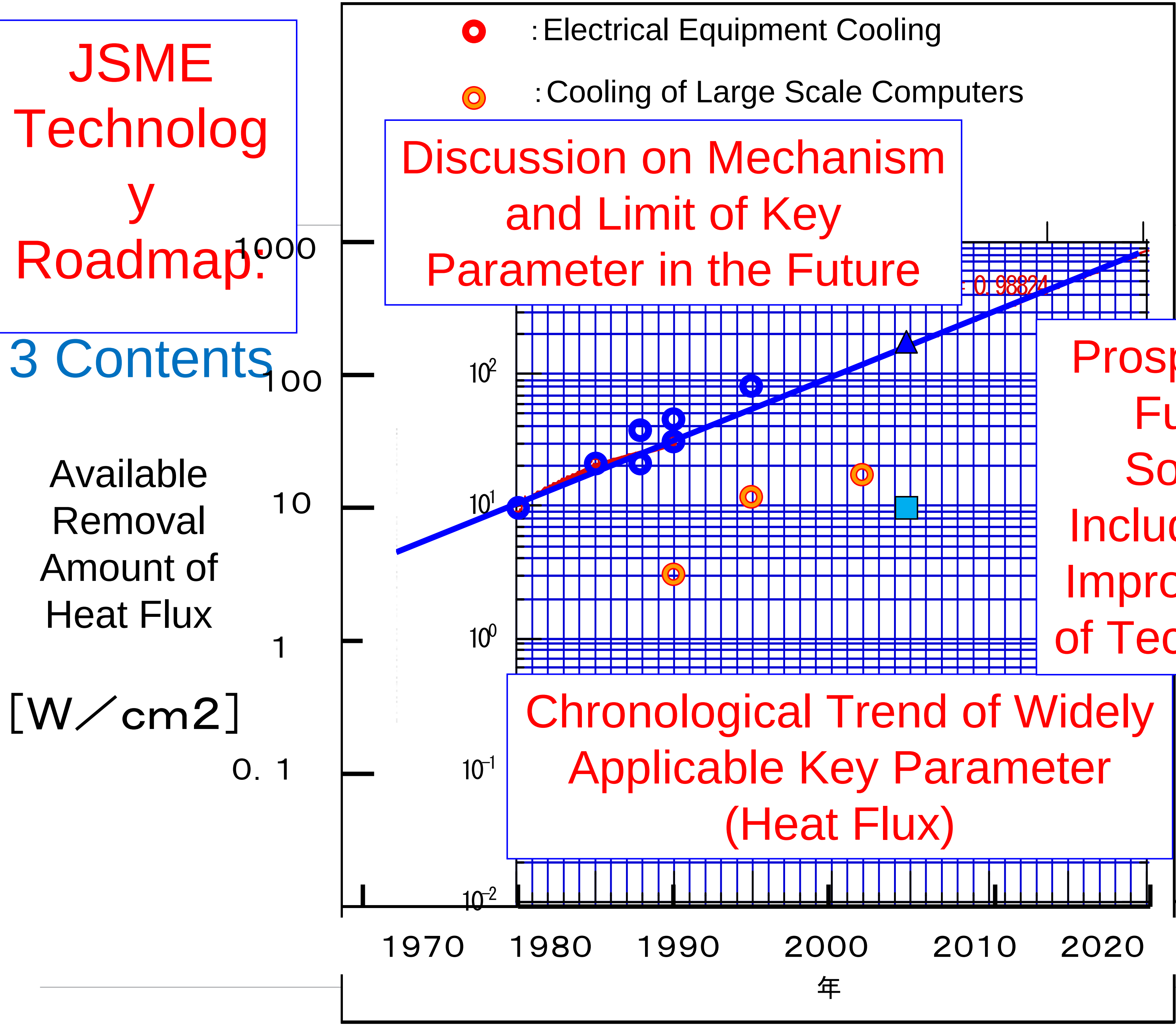
[W／cm2]



Like one Line in Semi-Logarithm

JSME Technology Roadmap:

3 Contents



Discussion on Mechanism and Limit of Key Parameter in the Future

Prospects of Future Society Including the Improvement of Technology

Chronological Trend of Widely Applicable Key Parameter (Heat Flux)

JSME Technology Roadmaps

http://www.jsme.or.jp/English/jsme%20roadmap/index.html

Roadmap of high-temperature heat flux heat reduction technology	Thermal Engineering div.
Roadmap of heat pump hot water supply technology	Environmental Engineering div.
Roadmap of micro- & nano-biomechanics in Tissue Engineering	Bioengineering div.
Roadmap of automobile fuel efficiency technology	Transportation & Logistics div.
Roadmap of industrial robot technology	Robotics & Mechatronics div.
Roadmap of micro- & nano-processing technology	Materials & Processing div.
Roadmap of engine thermal efficiency technology	Engine Systems div.
Roadmap of energy machine efficiency/output technology	Materials & Mechanics div.
Roadmap of design engineering technology	Design & System div.
Roadmap of dynamic phenomenon analysis technology	Dynamics, Measurement & Control div.

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Technology Roadmaps For Realizing the Sustainable Society

1） For evaluating the technological innovation correctly, JSME Technology Roadmaps for Sustainable Society would be used.

2） Quantitative estimations, such as economical payback period of energy technologies, necessary total budget of energy policy would be possible by organizing the JSME Technology Roadmaps of Various Technical Divisions for Sustainable Society

NEW FINDINGS

The systematic organization of JSME Technology Roadmaps for Sustainable Society by various engineering divisions of JSME has been produced over several years.

Two good results have been obtained in the discussions by combining the several technological roadmaps as the new findings.

1) Energy Usage and CO_2 Emission Reduction for the Automobiles
2) Energy Saving for Air-conditioning and Hot Water Supply by Utilizing High Efficiency Heat Pump Systems

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1) Energy Usage and CO2 Emission Reduction for the Automobiles

The specific strength of materials and new materials such as Aramic fiber would be useful for reducing the weight of automobiles.

The thermal efficiency of engines has been increased gradually by many kinds of breakthrough.

The average traveling speed has been increased by the improvement of traffic control technology.

The total amount of CO2 reduction potential would be 100MT/year and the most effective method would be the increase of the traveling speed.

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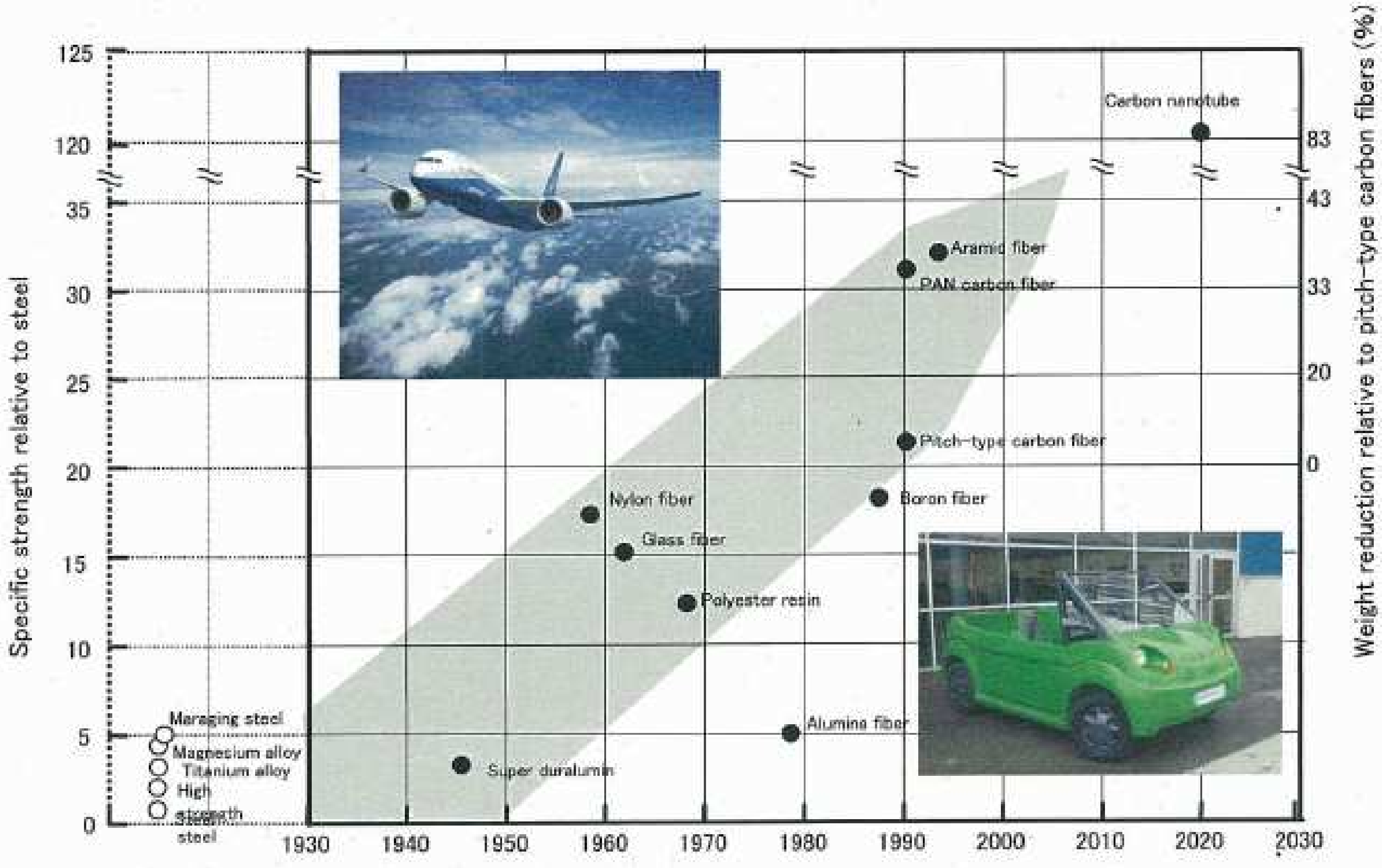
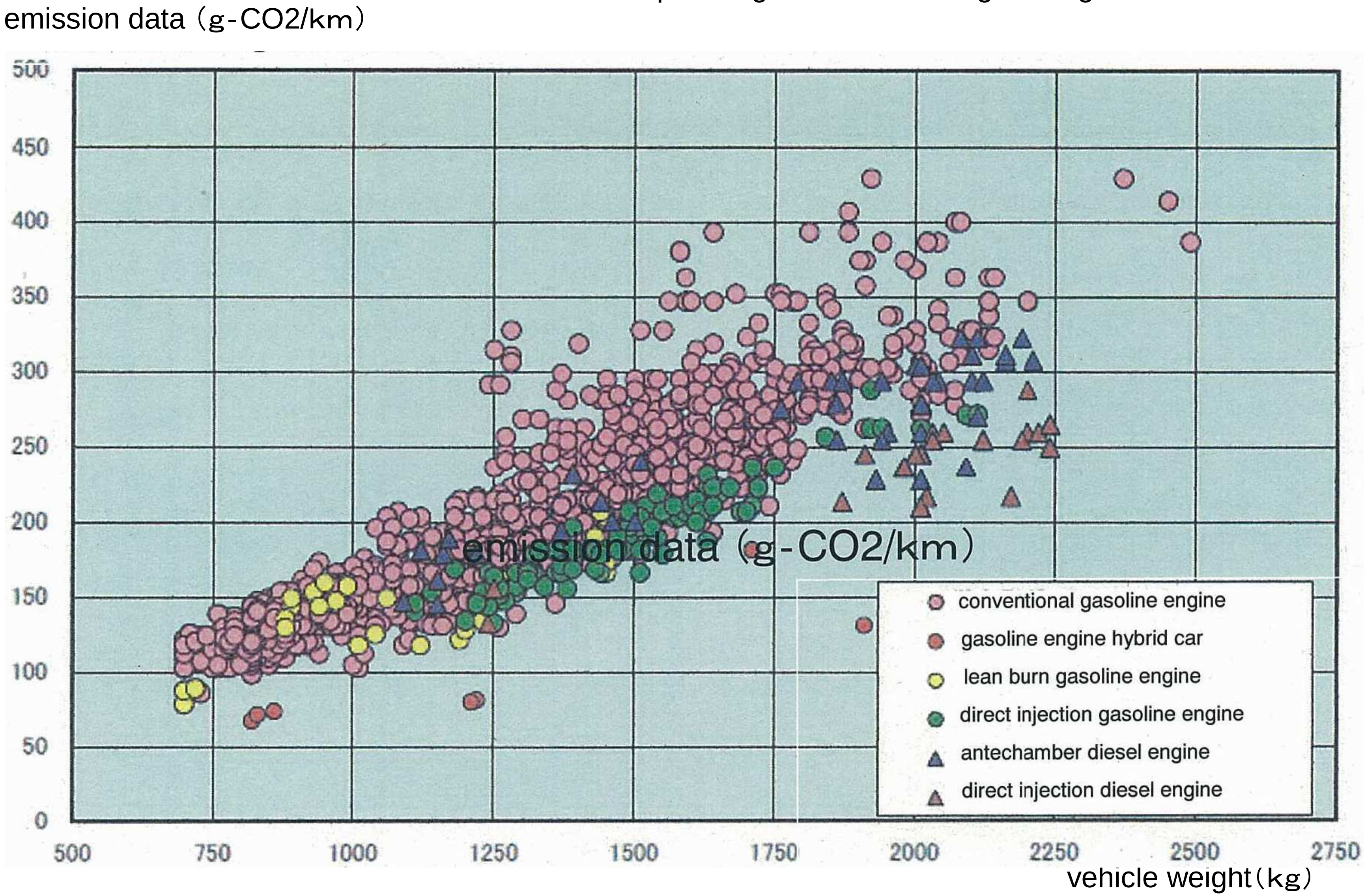
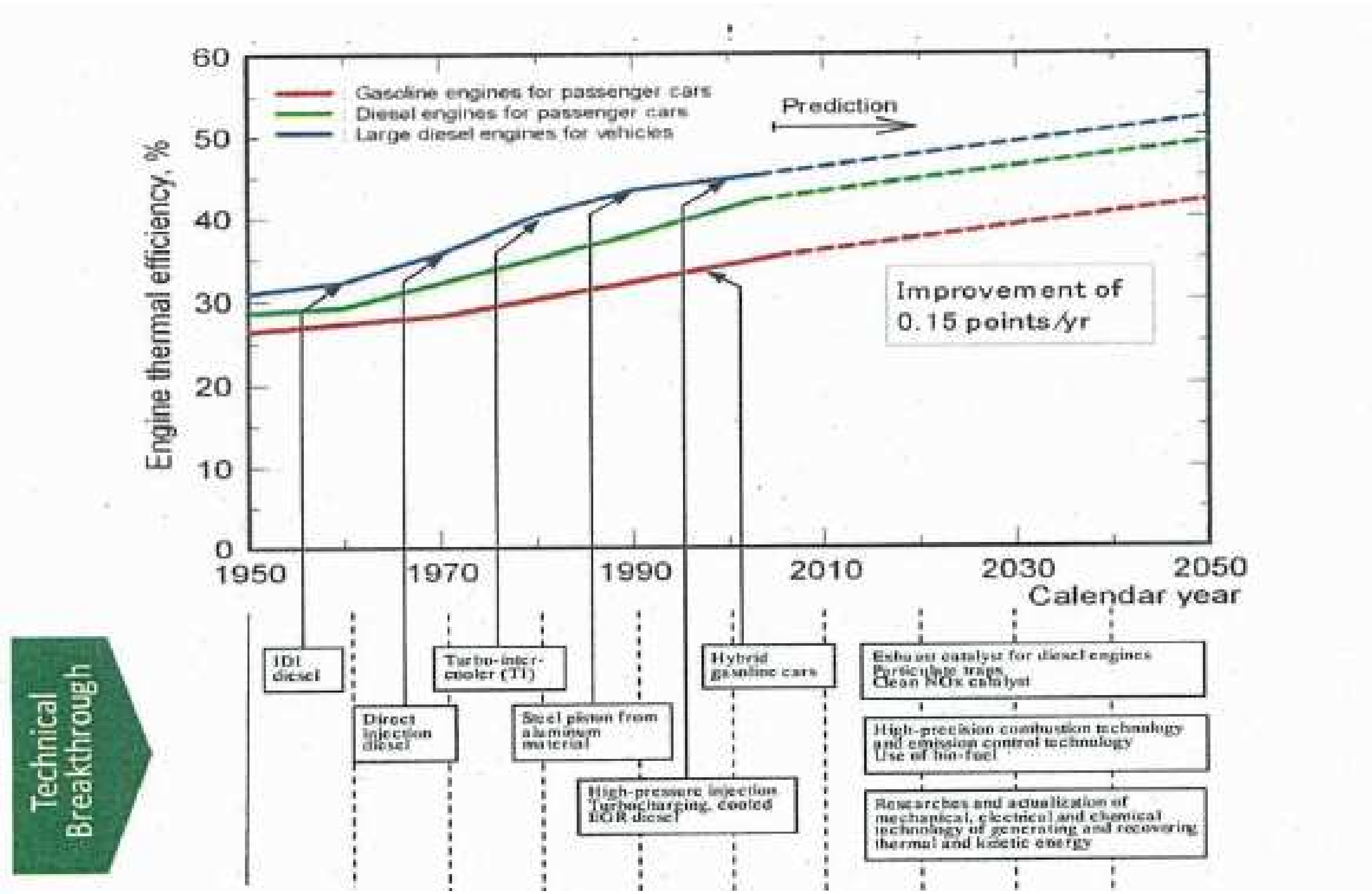


Fig.1 JSME Technological Roadmap for Specific Strength of Materials

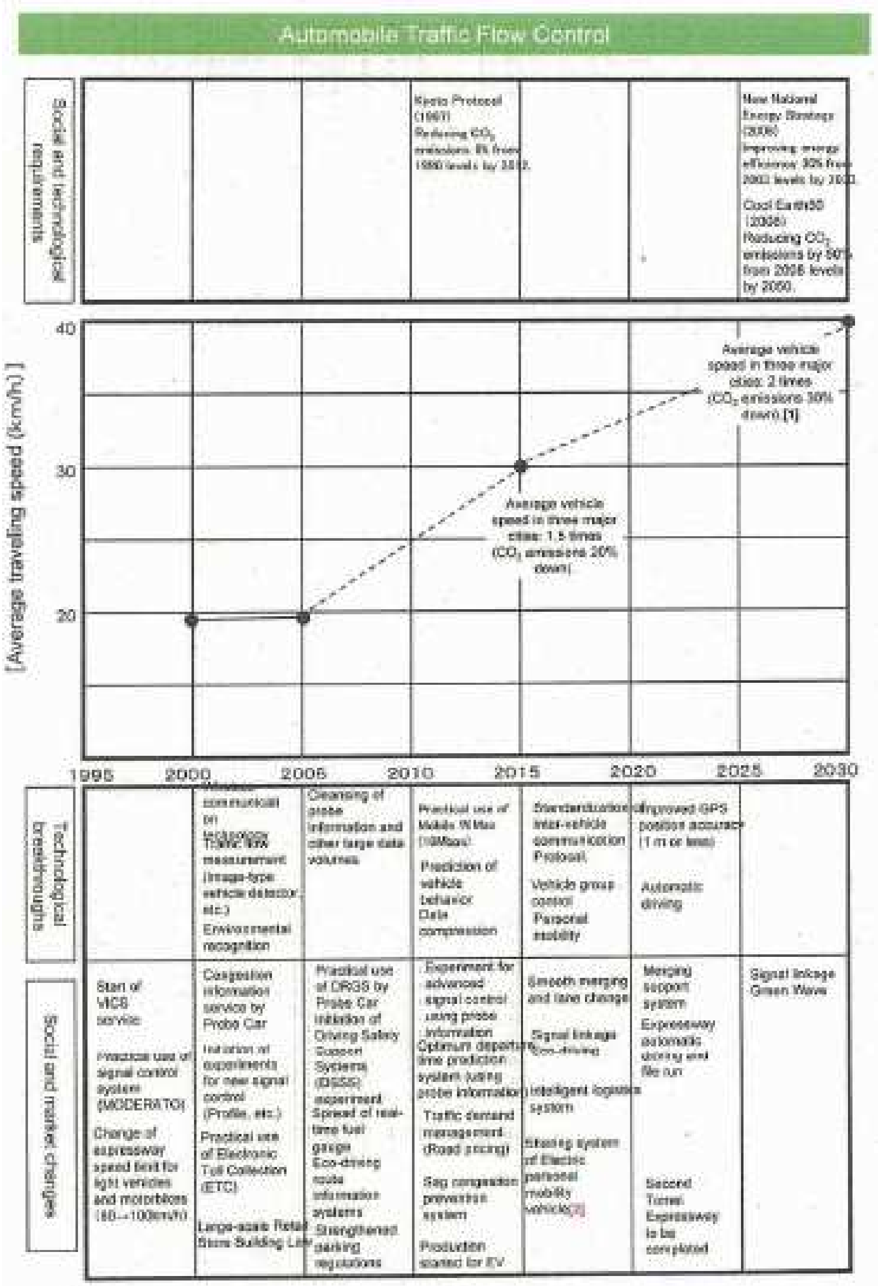
CO2 emission data of passenger cars according to weight



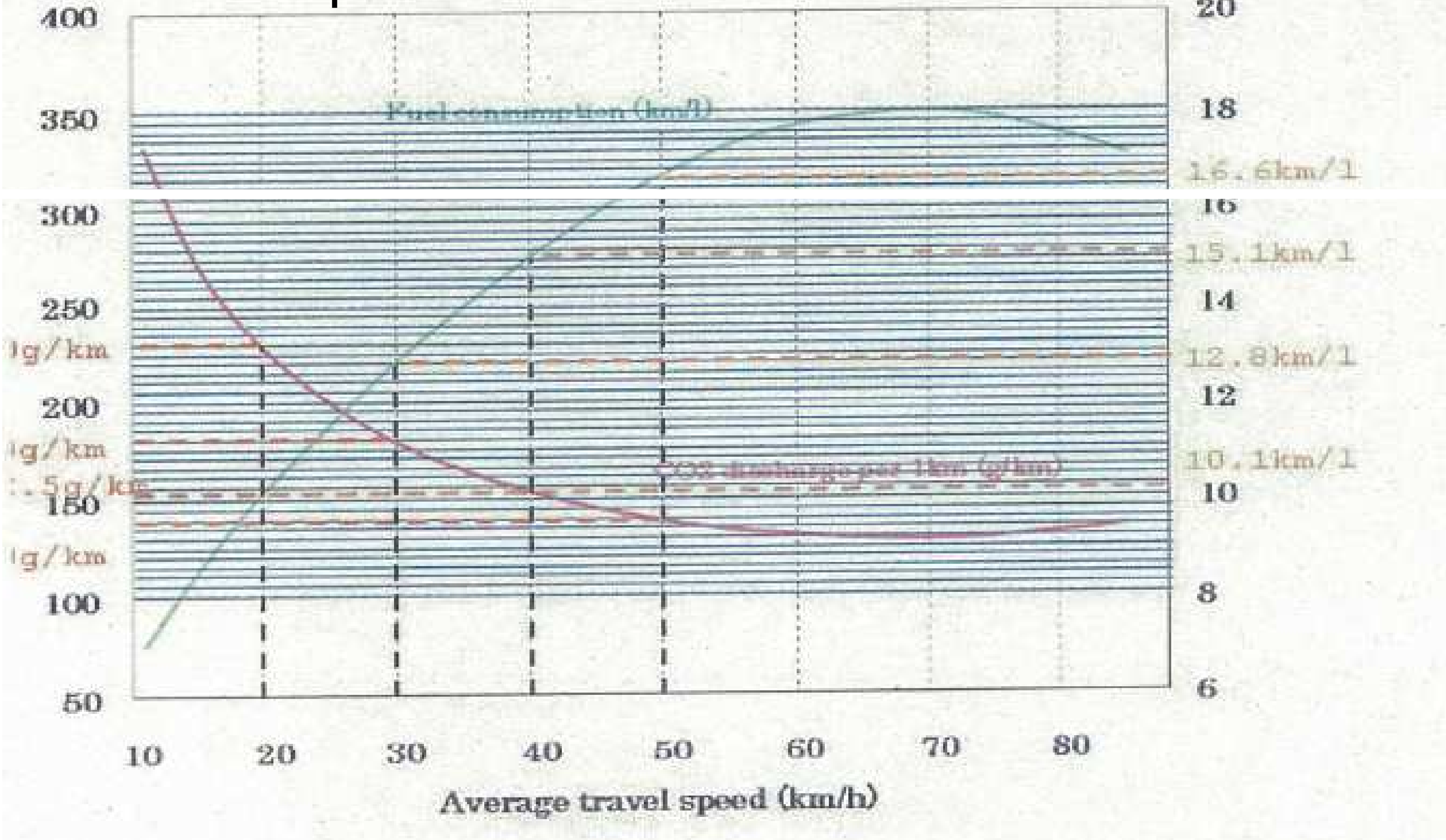


JSME Technology Roadmap of Thermal Efficiency of Engines

JSME Roadmap of the Increase of Average Traffic Speed By Traffic Flow Control and the Reduction of CO2 Emission



Fuel Consumption



Average Traveling Speed and Fuel Consumption

Appendix B: Data sheet for the climate plans

Country:JAPAN Population(2006) 127.8million, Area377,923km2,GDP:4384billion$

			Baseline			
			2007	2015	2030	2050
GHG emissions (tons CO2-eq.)	CO_2					
	Total		1,371MT			
GHG emissions by sector (tons CO2-eq.)	Transportation fuels					
	AUTOMOBILES					
	FIG.1	New Materials: such as Aramic Fiber (Specific Strength Relative to Steel) Weight Reduction(%)	0%	0.35%	1.00%	1.30%
	Fig.2	Engine Thermal Efficiency (Gasoline Engine)	36%	37.20%	39.50%	42.50%
		Average Traveling Speed by Traffic Flow Control Tecnology	20km/h	30km/h (20% Red CO2)	40km/h (30% Red CO2)	50km/h (40% Red of CO2)
		Estimated Total CO2 Emission from Automobiles	222MT	178MT	151MT	122MT
		CO2 Reduction Potential		44MT	71MT	100MT
	Residential, commercial and other sources					
	HEAT PUMP HEATING & HOT WATER SUPPLY	CO2 Reduction Potential		50% Replace	100% Replace	COP=6 100% Replace
	Fig.3	Heat Pump Hot Water Supply (COP...		33MT	66MT	77MT

2) Energy Saving for Air-conditioning and Hot Water Supply by Utilizing High Efficiency Heat Pump Systems

JSME Roadmap of Heat Pump Hot Water Supply

COP of supplying hot water :the value of 5 or higher.

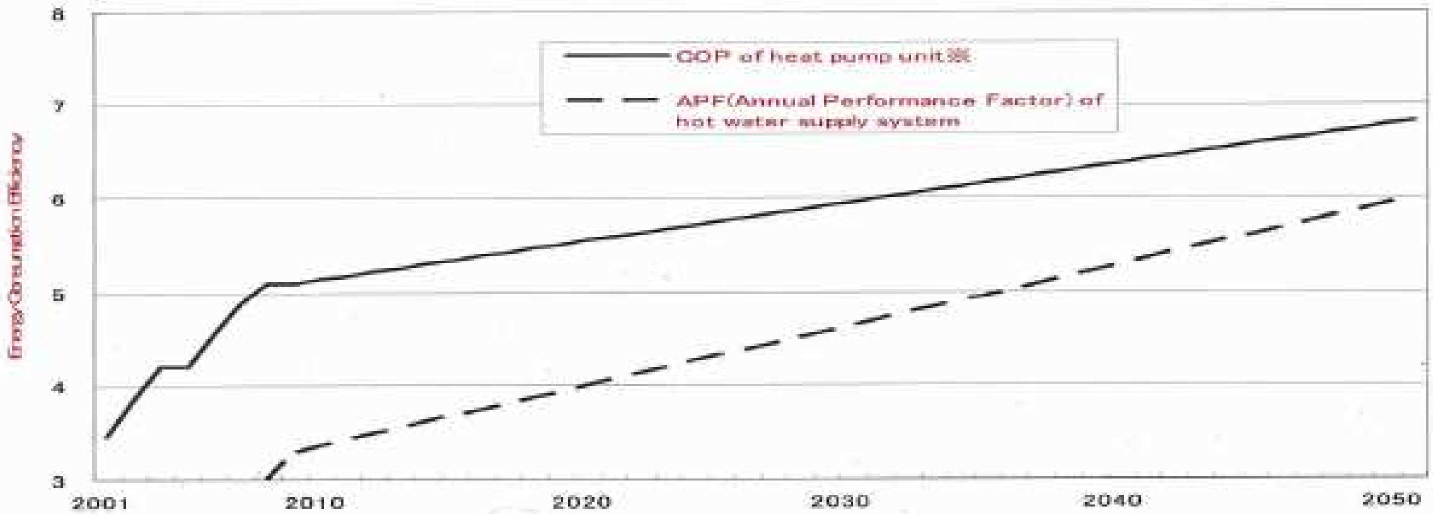
Efficiency of electric power generation of about 40%,

over twice of the total heat release by combustion

by utilizing high efficiency heat pump.

The CO2 reduction potential by replacing the boiler, heater and absorption heat pumps would become the order of 200MT/year.

This value would be over 10% of the total CO2 emission in Japan.



Technical Breakthrough

2001～2010	・Development of CO_2 refrigerant Heat Pump Water Heater
	④ High-efficiency ejector cycles
	⑤ Optimum design of high-efficiency, Small-size DC motors
	⑥ SiC power devices
	⑨ Vacum heat insulators
	⑬ Utilization of underground heat
2010～2020	① High-efficiency refrigerant circuit design technology
	⑥ High-efficiency matrix converter
	⑫ Exhaust heat recovery
	⑩ Load forecast control
	⑬ Using solar heat panels together
	① Advanced refrigerant control technology
	② Further size reduction using surface tension
	③ Micro-channel type heat exchangers
	④ Power recovery compressors with integrated expanders
	⑬ Decompressed-boiling solar panel evaporators
2020～2030	① Development of new refrigerant
	⑤ Next-generation sensor-less PM motors
	⑨ High-density thermal storage and latent thermal storage
	① Water refrigerant double-bundle condenser hot water supply systems (heat recovery syst
	⑫ Heat recovery from wastewater

Fig.3 JSME Technological Roadmap for Heat Pump Hot Water Supply System
(Trends of COP & Technical Breakthrough)

commercial and other sources					
HEAT PUMP HEATING & HOT WATER SUPPLY	CO2 Reduction Potential		50% Replace	100% Replace	COP=6 100% Replace
Fig.3	Heat Pump Hot Water Supply (COP=5) for Houses replacing Boiler and Heater		33MT	66MT	77MT
	Heat Pump Heating (COP=5) for Houses replacing Boiler and Heater		25MT	51MT	59MT
	Heat Pump Hot Water Supply (COP=5) for Buildings replacing Boiler and Heater		17MT	34MT	39MT
	Heat Pump Heating & Cooling (COP=5) for Buildings replacing Boiler and Heater, Absorption Heat Pump		20MT	40MT	47MT
	Total CO2 Reduction Potential		95MT	190MT	222MT
Total		270MT	175MT	80MT	58MT

nsity -

Amount of Energy Usage from the Viewpoints of Our Daily Life （Japanese Case)

Contents from Viewpoints of Our Daily Life （Total 5150W, LCA Analysis including Materials）

Clothes：137W （Clothes & Bed 86W, Washing：51W）

Eating ：296W （Green House128W, Cooking59W, Refrigerator 50W, Restaurant59W）

Living ：1576W（House Construction148W, Automobiles for Personal Use 527W、Air-conditioning195W, Bath &Hot Water Supply 198W、Lightening 49W, TV& Electronics 301W）

Business & School：869W（Building & Construction 652W, Public Transportation122W, Hotel 95W）

Society：918W（Carriage324W, Store155W, Hospital81W、Road Construction103W, River92W, Movie27W）

not cleared：1354W

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Energy Cost and Importance of Cheap Energy

Energy Cost ：Japanese Case

Gasoline ： Car for 10km Drive 1 litter $1

Electricity ：One overnight cooling for one room in summer $1

City Gas： Bathing for one family with water usage $1

Kerosene ：One overnight heating for one room in winter season $1

Gasoline $1 for 1 litter in Japan

Kerosene 70 cents for 1 litter in Japan

But in the shopping store

Natural Water & Tea $1.5 for 1 litter container in Japan

Milk $2 for 1 litter in Japan

Gasoline and Kerosene are not valuable compared with Natural water and Milk? NO! Our Society depends on the cheap energy. Energy Production Industry is not easy to survive from the Economical Viewpoints. (example: Biomass Energy Production)

Possibility of Reducing the Energy Consumption based on Daily Life Analysis

15%:Cooling, Heating & Hot Water Supply for Houses & Buildings would be reduced largely by Utilizing High Efficiency Heat Pump System (Instead of Combustion Electricity would be Useful)

10%:Automobiles for Personal Use would be Effective to be reduced by Utilizing Alternatives (Public Transportation System, Trains Bicycles)

10%:Decreasing the Amount of Building Construction would be Effective(Maintenance would be much more important than Construction)

10%: Reducing the Total Amount of Electric Equipments would be Effective(Total Amount of Electricity Consumption should be Reduced)

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RECOMMENDATIONS

1) Produce the reliable technology roadmaps for estimating the future technological performance, for selecting the future energy and environmental policy and for accelerating the prevention effect for global warming.

2) By presenting the comprehensible quantitative engineering data of energy usage and CO_2 emission in public, we should promote the quantitative discussion for accelerating the reduction of the CO_2 emission.

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