参考資料３－１

Sustainable development under ambitious medium term target of reducing greenhouse gases

March 22, 2010

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Numerical targets of greenhouse gas reductions in 2020

55 countries or regions submitted the numerical targets to the FCCC secretarial office based on Copenhagen Accord.

	Reference year	Target	Numerical target	Regarding 1995	Regarding 2005
Japan	1990	GHG emissions	−25%	−25%	−30%
EU	1990	GHG emissions	−20%～−30%	−20%～−30%	−13%～−24%
U.S.	2005	GHG emissions	−17%	−3%	−17%
China	2005	GHG/GDP	−40%～−45%	−	4～8%／year
India	2005	GHG/GDP	−20%～−25%	−	3～8%／year

We also note that proposed frameworks such as SCM, sectoral crediting mechanism, NAMA, nationally appropriate mitigation action, REDD, reduced emissions from deforestation and forest degradation, and MRV, measurable, reportable and verifiable, as well as above numerical targets.

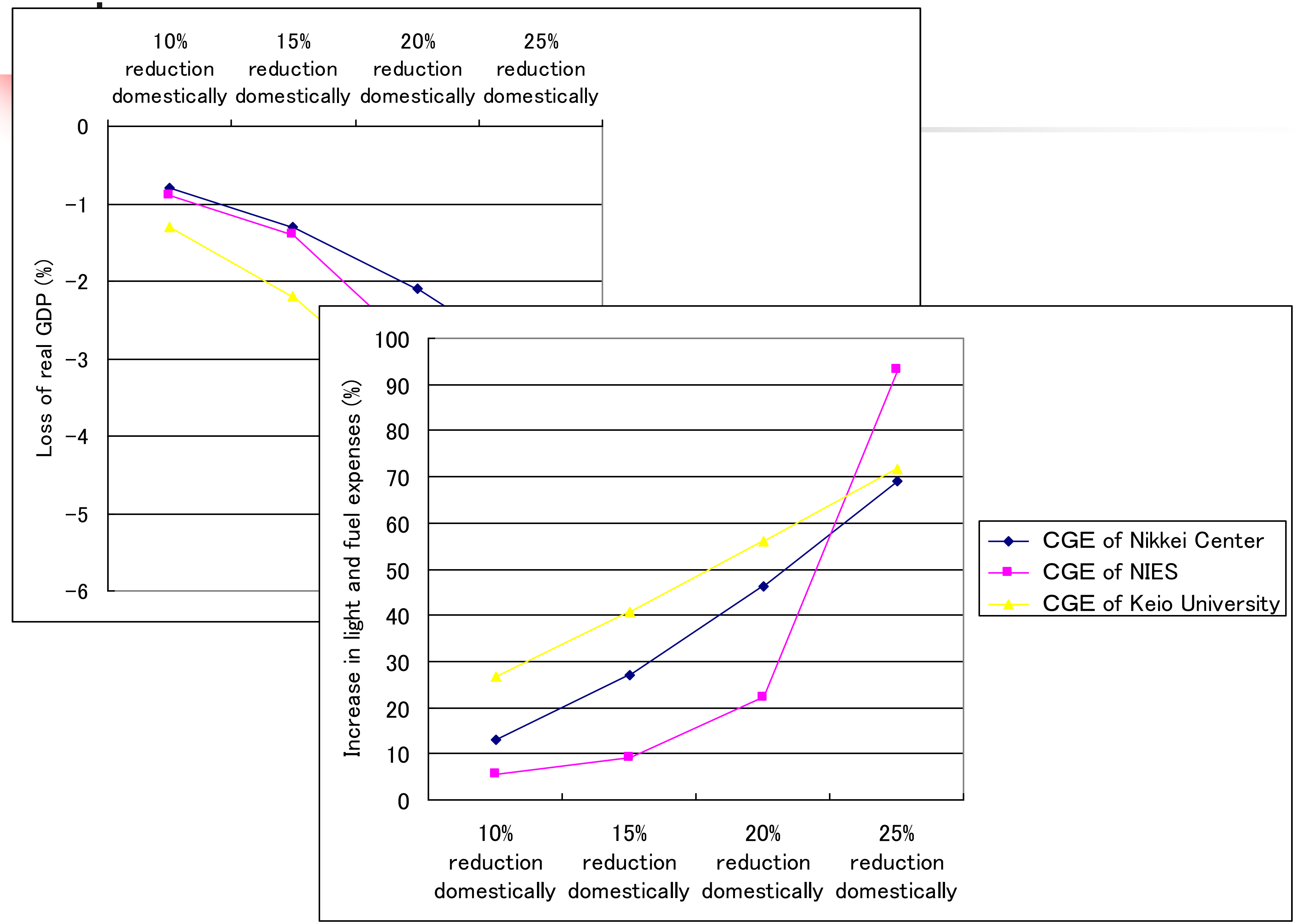
Evaluation of economic impact of Japan's numerical targets (1)

	10% reduction domestically	15% reduction domestically	20% reduction domestically	25% reduction domestically
Loss of real GDP(%)				
CGE of Nikkei Center	−0.8	−1.3	−2.1	−3.1
CGE of NIES	−0.9	−1.4	−2.9	−3.2
CGE of Keio University	−1.3	−2.2	−3.6	−5.6
Increase in electricity price(%)				
CGE of Nikkei Center	20.4	44.2	77	117
CGE of NIES	12.8	19.6	43.6	113.6
CGE of Keio University	37.1	56.2	76.9	97.3
Increase in light and fuel expenses(%)				
CGE of Nikkei Center	12.9	27	46.1	69
CGE of NIES	5.5	9.1	22.3	93.2
CGE of Keio University	26.7	40.6	55.9	71.7
Marginal cost (Yen/t-CO_2)				
CGE of Nikkei Center	10620	21940	39078	63180
CGE of NIES	8678	10252	23869	52438
CGE of Keio University	30303	46764	66093	87667

They evaluate 25% reduction from 1990 level in the above all case studies, in which domestic reduction varies in each case. Nikkei Center: Japan Center for Economic Research, NIES: National Institute for Environmental Studies

Reference: report of the committee to evaluate medium-term targets in Japanese cabinet office

Evaluation of economic impact of Japan's numerical targets (2)



Consumption and production sectors of our CGE models

Decrease by Energy saving (3 Electricity, 4 Gas, 5 Light & Fuel)

Increased cost (7 Durable goods)

Increased cost (14 Automobiles)

Decrease by Energy saving (15 Gasoline)

		1	2	···	18
1	Food				
2	Dwelling				
3	Electricity				
4	Gas				
5	Light & Fuel				
6	Water & Sewage				
7	Durable goods				
8	Heating & Cooling				
9	General furnatures				
10	Other furnatures				
11	Cloths and shoes				
12	Medical & Health				
13	Transport				
14	Automobiles				
15	Gasoline				
16	Communication				
17	Education				
18	Entertainment				
19	Other consumtions				

1	−200
2	200−250
3	250−300
4	300−350
5	350−400
6	400−450
7	450−500
8	500−550
9	550−600
10	600−650
11	650−700
12	700−750
13	750−800
14	800−900
15	900−1000
16	1000−1250
17	1250−1500
18	1500−

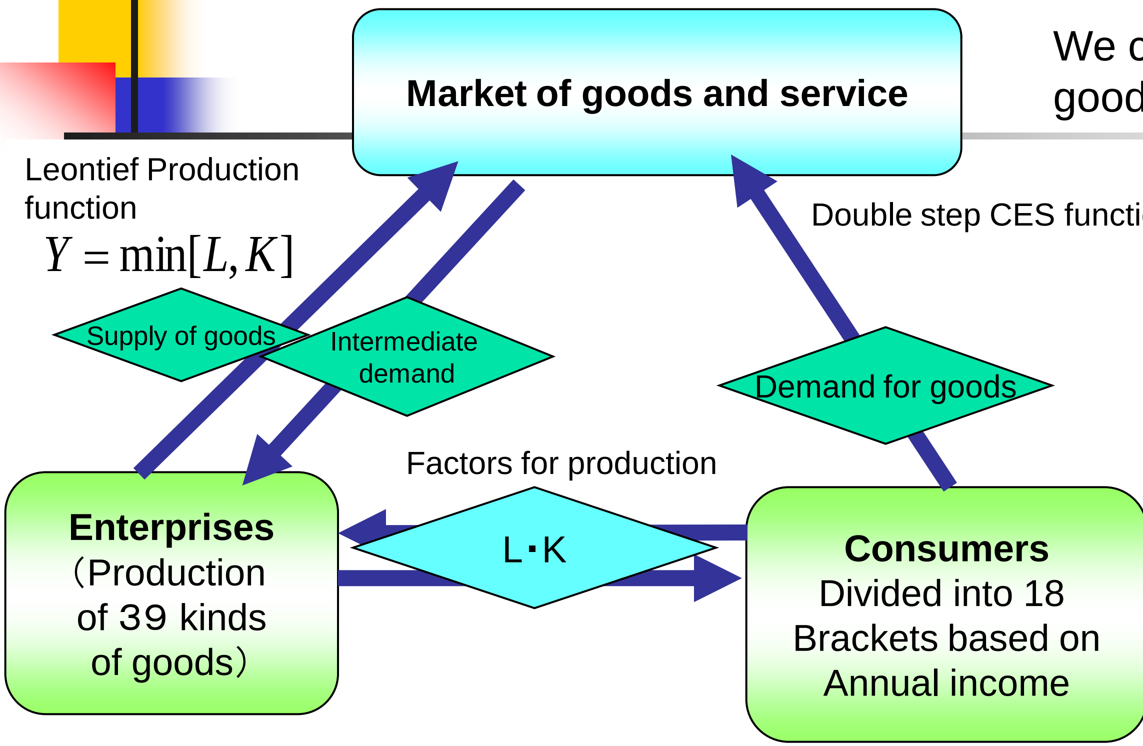
Brackets by income

1	Agriculture, forestry and fishery	20	General machinery
2	Limestone	21	Electric machinery
3	Coal	22	Automobile
4	Oil	23	Transport machinery
5	Natural gas	24	Precision machinery
6	Other minerals	25	Other manufacturing
7	Food	26	Construction
8	Textile	27	Electricity
9	Wood products	28	Gas
10	Pulp & paper	29	Heat
11	Printing	30	Water & Sewage
12	Chemistry	31	Waste disposal
13	Petroleum products	32	Commerce
14	Coal products	33	Finance & Innsurance
15	Ceramic products	34	Real estate
16	Cement	35	Transport
17	Iron & steel	36	Broadcasting
18	Non-ferrous metals	37	Service
19	Metal products	38	Governmental service
		39	service

19 consumption goods ↔ 39 production goods

Structure of our CGE model

We compute the point, in which markets of goods and services are in equilibrium.



U（Utility）
H（Present consumption）
C（Future consumption）,
X (Consumption of goods),
l (Consumption of leisure)

$$U_i = \left[\alpha_i^{1/\sigma_{2i}} H_i^{\nu_i} + (1-\alpha_i)^{1/\sigma_{2i}} C_{Fi}^{\nu_i}\right]^{1/\nu_i}$$

$$H_i = \left[\beta_i^{1/\sigma_{1i}} l_i^{\phi_i} + (1-\beta_i)^{1/\sigma_{1i}} X^{\phi_i}\right]^{1/\phi_i}$$

Consumers are divided into 18 brackets based on annual income.
⇒ Evaluation of economic impact by introducing technologies.
⇒ Evaluation of economic impact in each income bracket.

Mitigation options adopted in our CGE models Year 2020

Newly constructed nuclear power plants → 8 plants
Average operation rate of nuclear plants →90%
Deployment of photovoltaics→28 million kW
Deployment of highly insulated houses→80% of new houses
Deployment of eco-cars→80% of new cars

Furthermore, we assumed to adopt efficiency improvement in home electric appliances, automobiles, industry and promote fuel switching and modal shift in industrial sectors. We also assume to impose carbon tax.

By these options, we domestically realize 15% reduction from 1990 level. With emission reduction credits, we assume to realize 25% reduction from 1990 level.

Modeling deployment of PV (1)

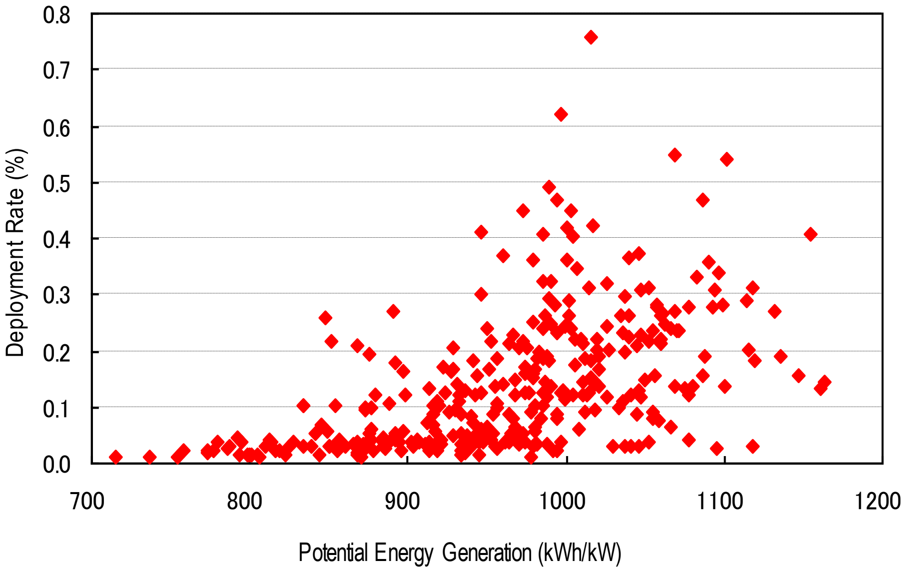


Figure 1: Proliferation Rate – Potential Energy Generation

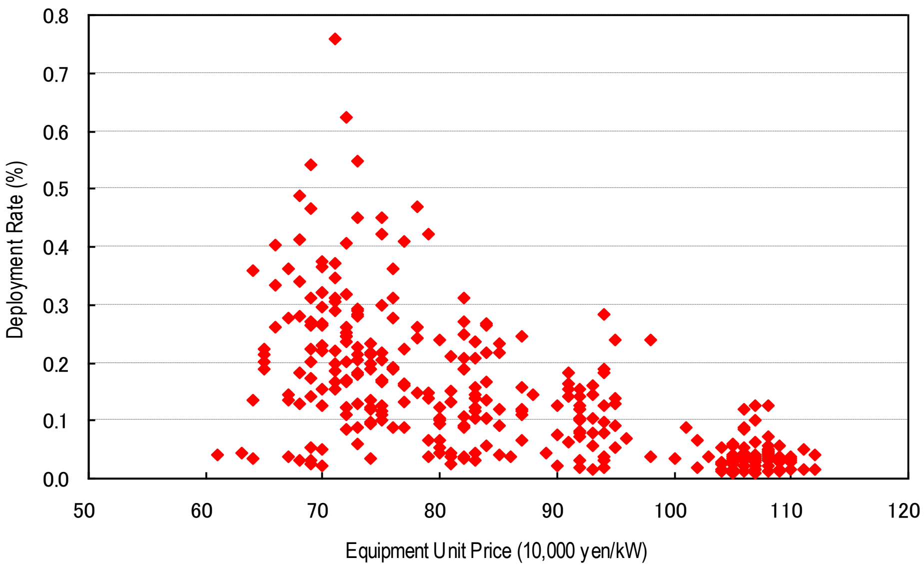


Figure 2: Proliferation Rate – Equipment Unit Price

The lower the equipment unit price for the region, the higher the proliferation rate

The greater the potential energy production for the region, the higher the proliferation rate

Equipment unit price/potential energy generation used as explanatory variables

(Note) Potential energy generation is calculated by multiplying the amount of sunlight x each region's generation efficiency, with consideration for its climate characteristics

Modeling deployment of PV (2)

Definition of deployment rate

$$\frac{\text{Rate of annual deployment}}{} = \frac{\text{Annual houses with PV}}{\text{Stock of houses}}$$

Modeling deployment of PV (3)

Purchase or

Not purchase

→ Discrete choice → Logit model / Probit model

Purchase	$y_i = 1$	$y_i^* > 0$
Not purchase	$y_i = 0$	$y_i^* \leq 0$

$$y_i^* = \beta_0 + \beta_1 x_i + \varepsilon_i$$

Gumbel distribution → **<u>Logit model</u>**

Normal distribution → Probit model

Modeling deployment of PV (3)

We modeled the deployment of PV using Logit model.

Utility of purchasing PV in i prefecture

$$U_i = \theta_1 W_i - \theta_2 I_i + \theta_3 S_i + \theta_4$$

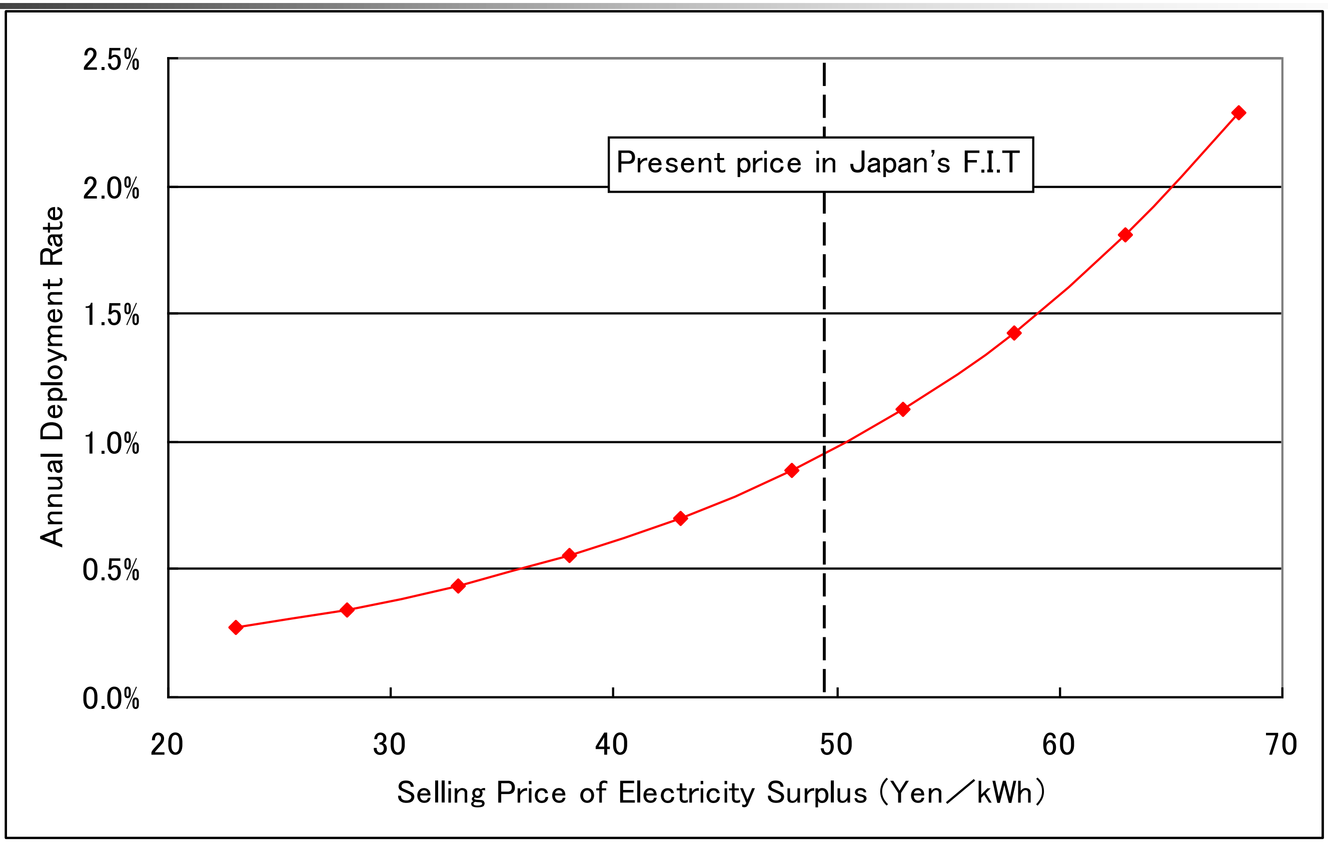
Rate of purchasing PV in i prefecture

$$P_i = \frac{\exp(U_i)}{1 + \exp(U_i)}$$

W_i **: Potential generation（kWh／kW）,** I_i **: Initial investment（10000yen／kW）,**
S_i **: Selling price of electricity surplus（yen／kWh）**

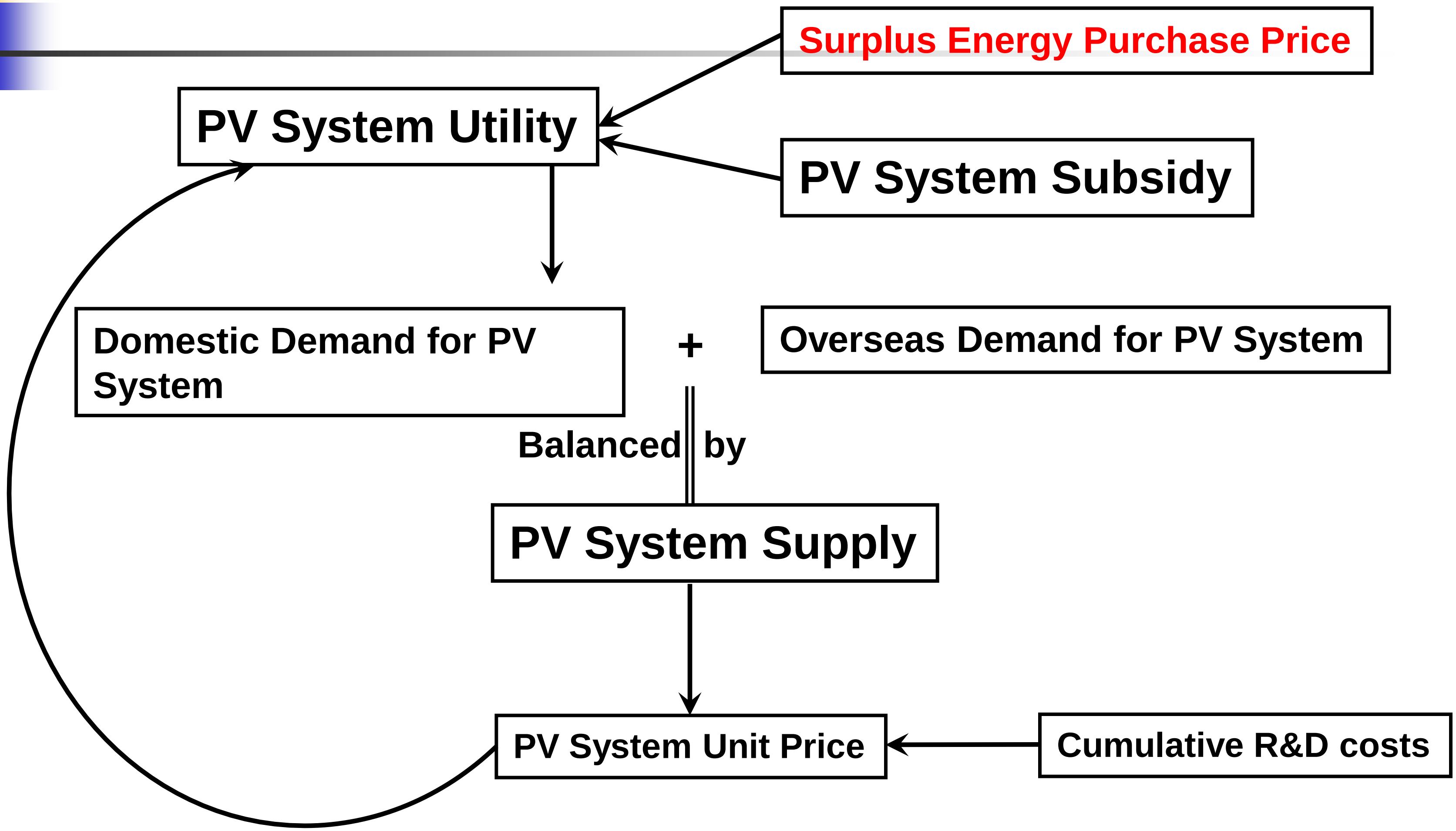
Exploration of a deployment strategy

We evaluated relationships between annual deployment rate and purchasing price of electricity surplus.



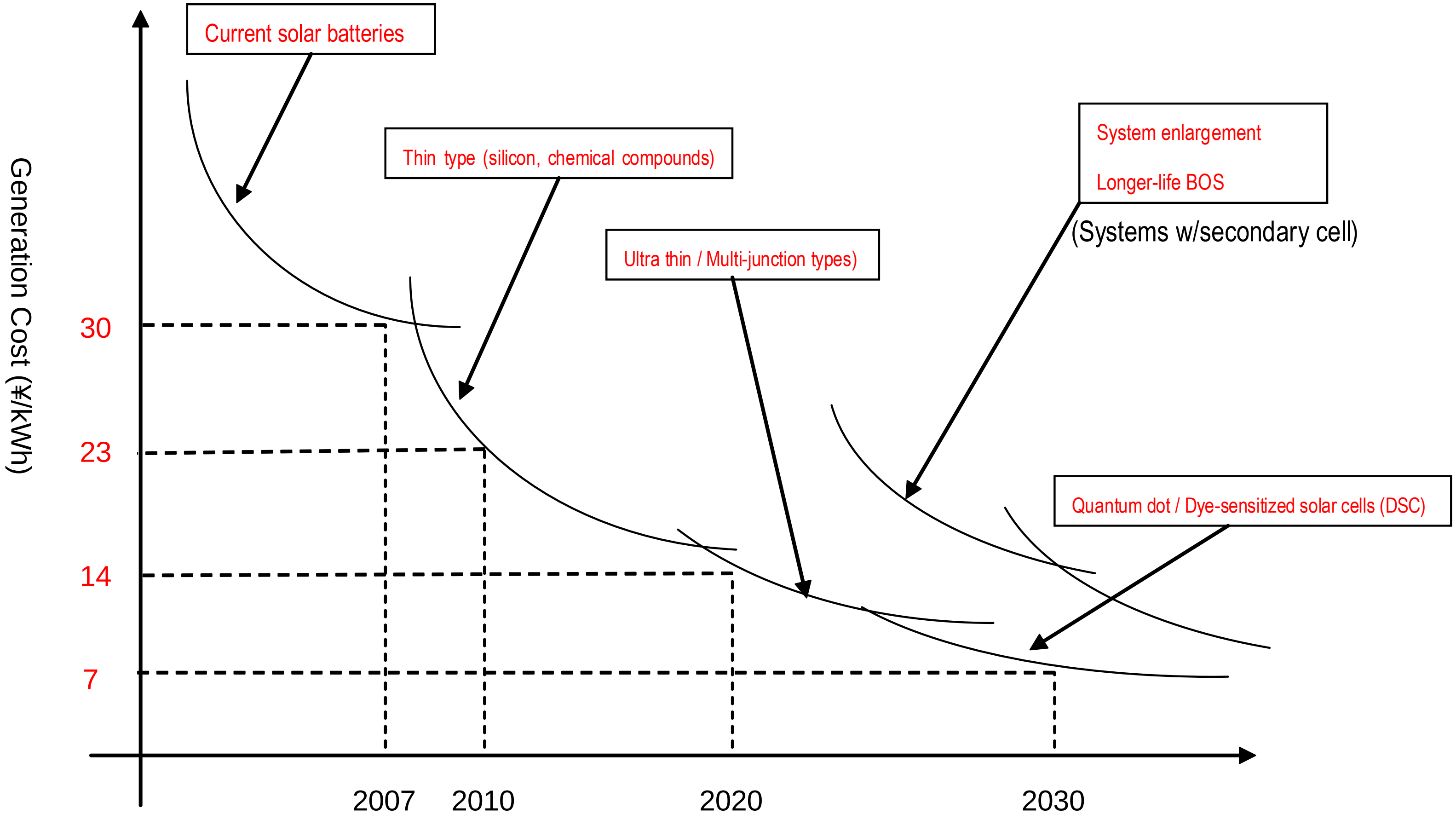
It is difficult to increase PV capacity by 20 times until 2020 only by the present governmental policies.

Examination of PV Proliferation Measures



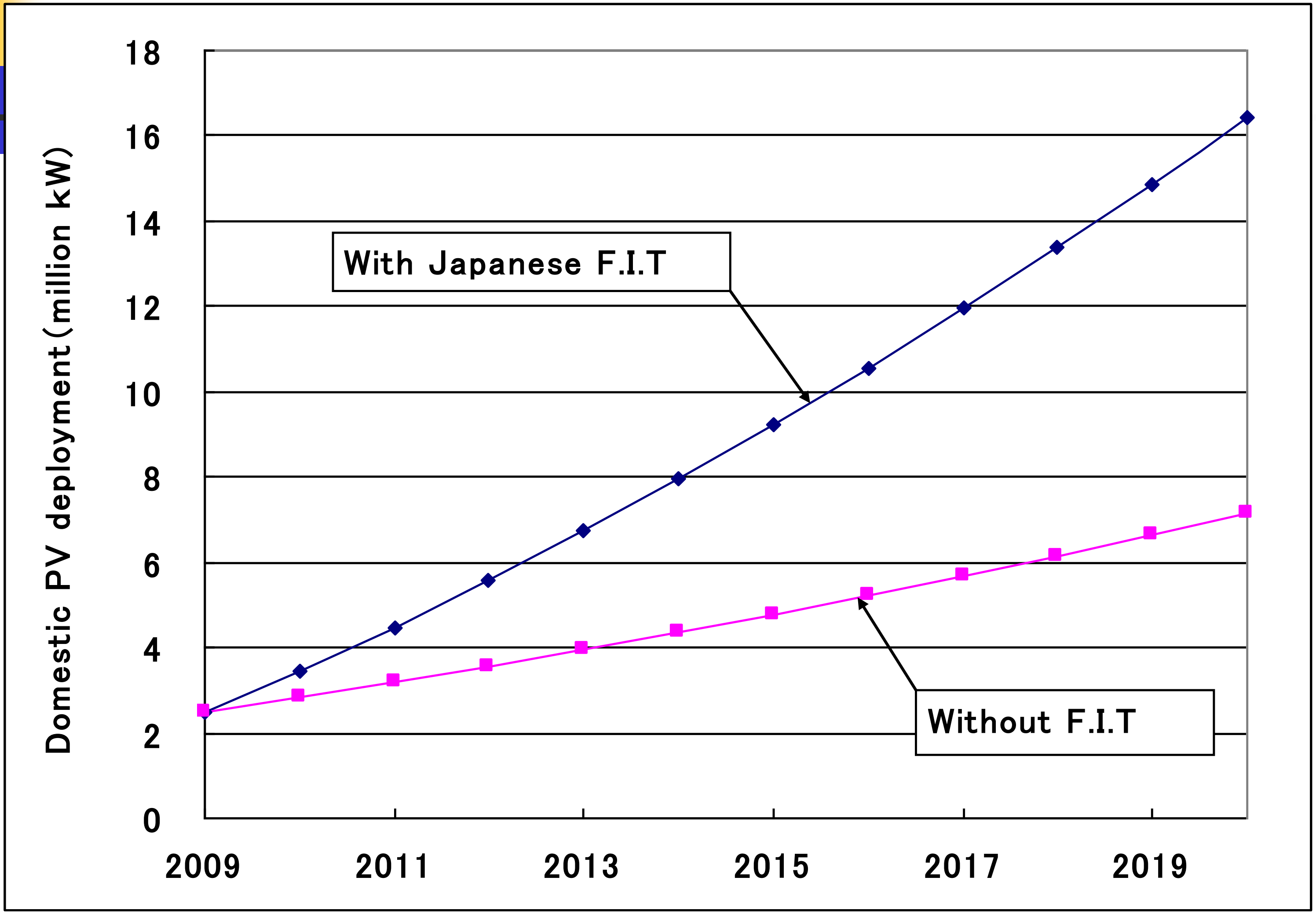
Examination of PV Proliferation Strategy

Cautious R&D and a strategy for deployment are vital in achieving replacement with next-generation PV systems.



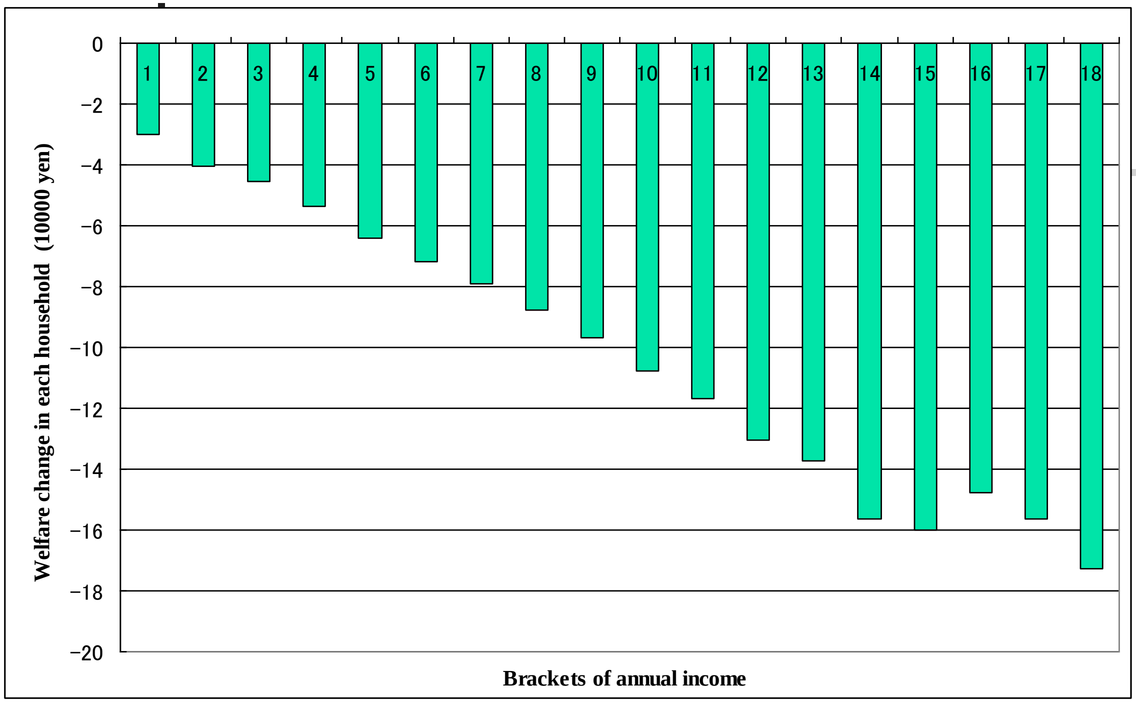
Exploration of a deployment strategy

Relationships between present Japan's F.I.T. and deployment rate



It is difficult to realize the governmental target, 28 million kW in 2020 even with the present F.I.T..

Simulation results using our CGE model (1)



Equivalent variation：
Utility change is expressed in terms of price in goods before change.

Without efficiency improvement and lowering price in Home electric appliances, automobile and photovoltaics.

Welfare values are decreased in all income brackets.

Welfare values are decreased in all income brackets by realizing 25% reduction of greenhouse gases, unless efficiency improvement and lowering price in home electric appliances, automobile and photovoltaics.

Evaluation of economic impact by deploying energy saving products

Evaluation of aggregate equivalent variation of all consumers

↓

Define this value as total welfare

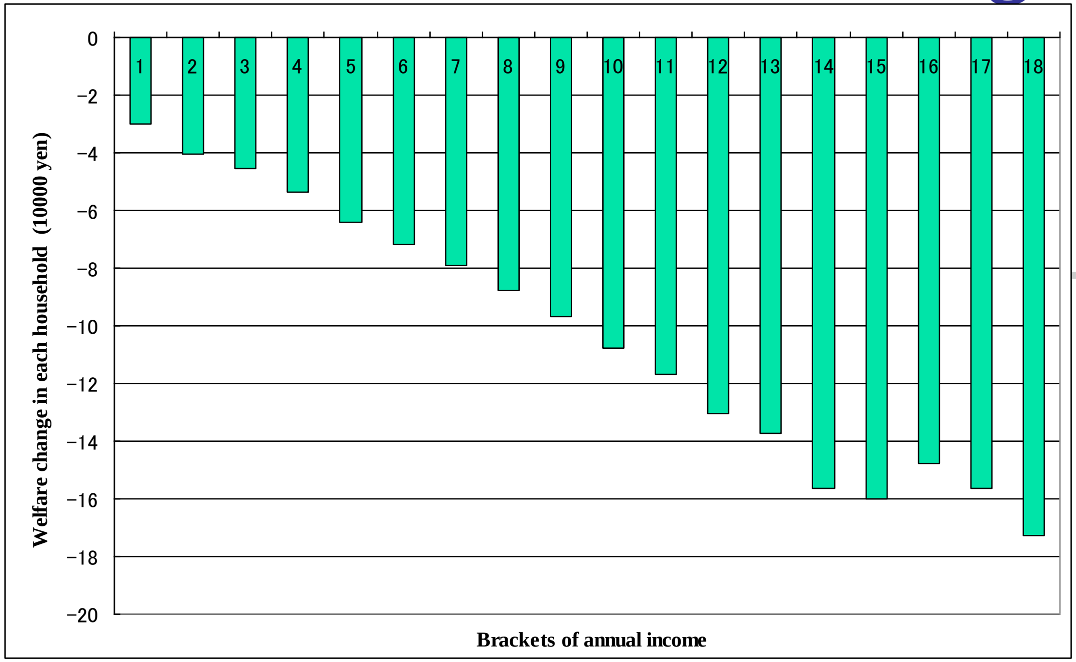
↓

Estimate the welfare change by deploying respective products

↓

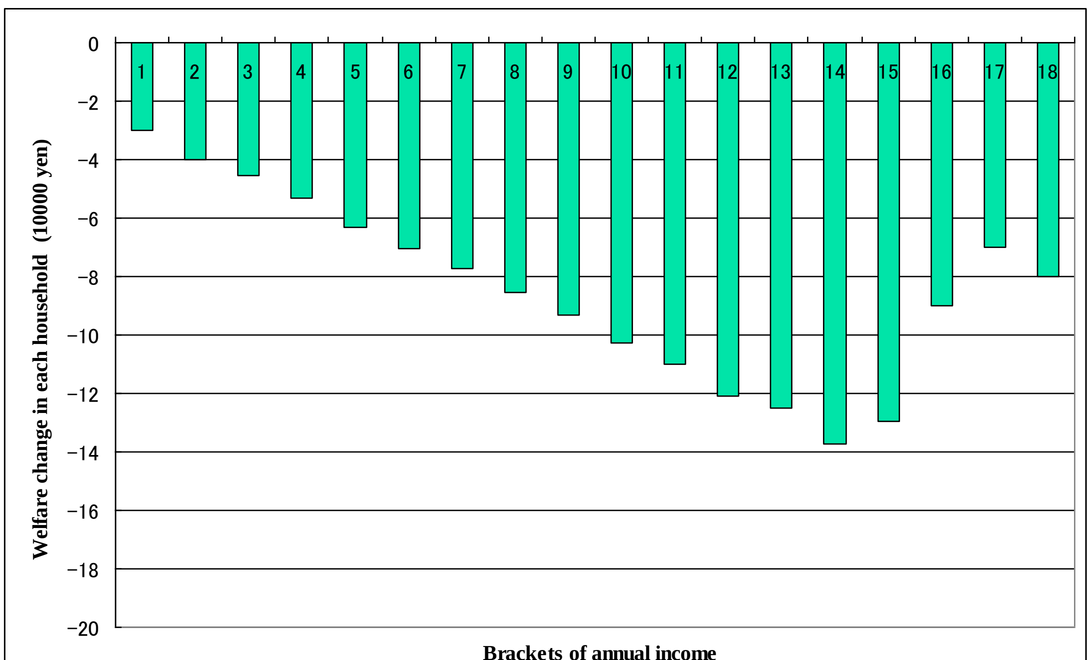
Define the value as economic impact of respective technology

Simulation results using our CGE model (2)



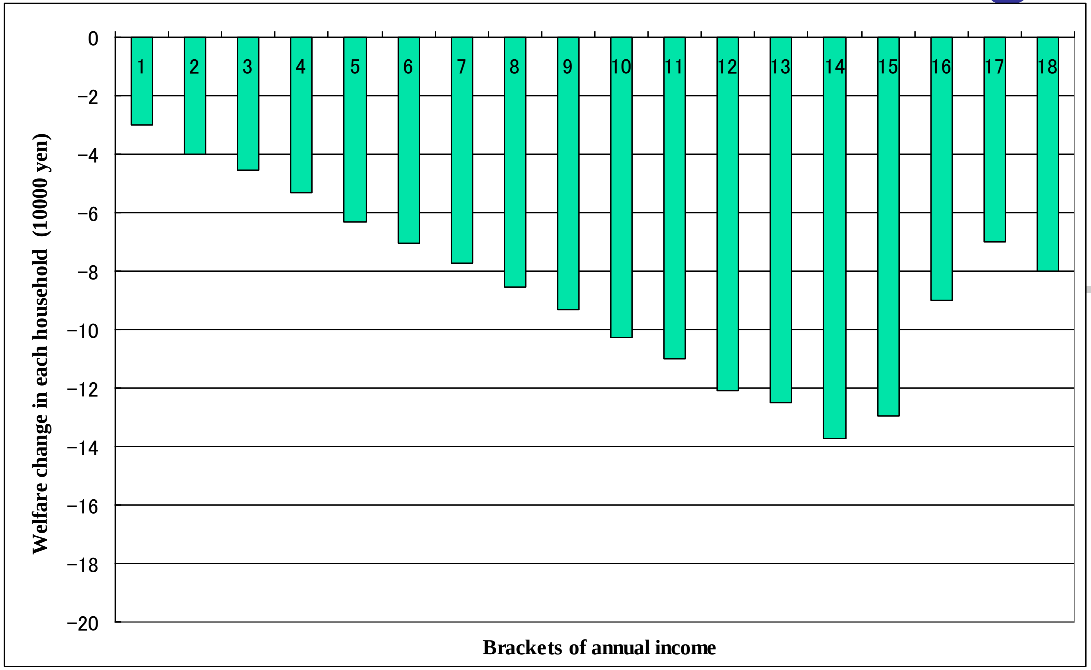
Without efficiency improvement by deploying eco-cars

Welfare values increase especially in higher income brackets by deploying eco-cars. Aggregate welfare change amounts to 829 Billion yen.



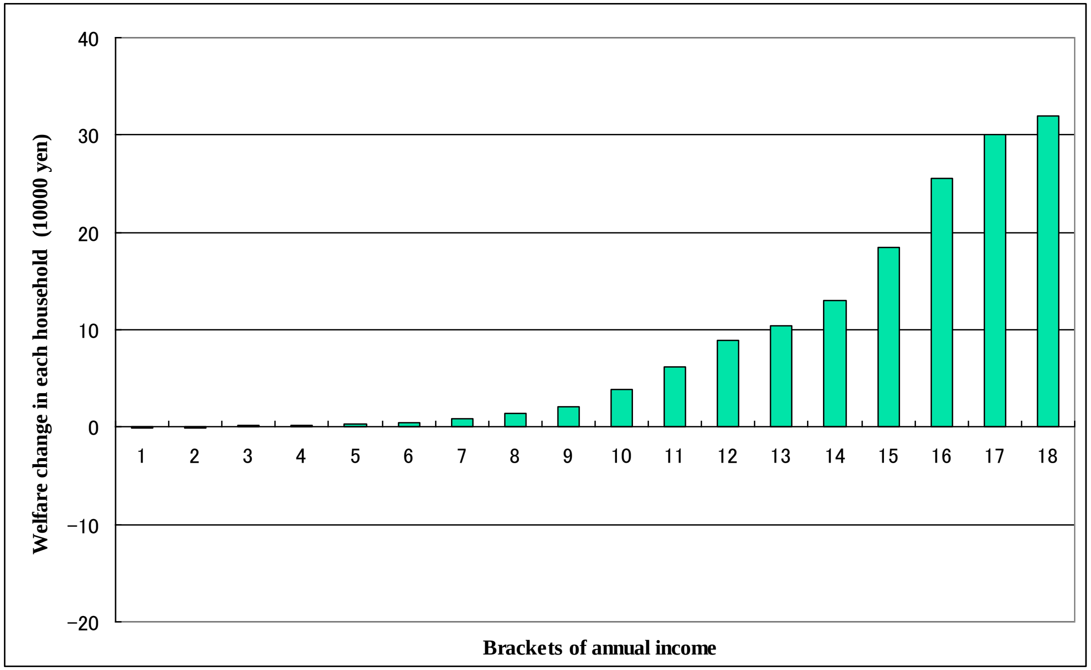
With efficiency improvement by deploying eco-cars

Simulation results using our CGE model (3)



Without efficiency improvement in home electric appliances

Welfare values increase in all income brackets by efficiency improvement in home electric appliances. Aggregate welfare change amounts to 8.04 trillion yen.



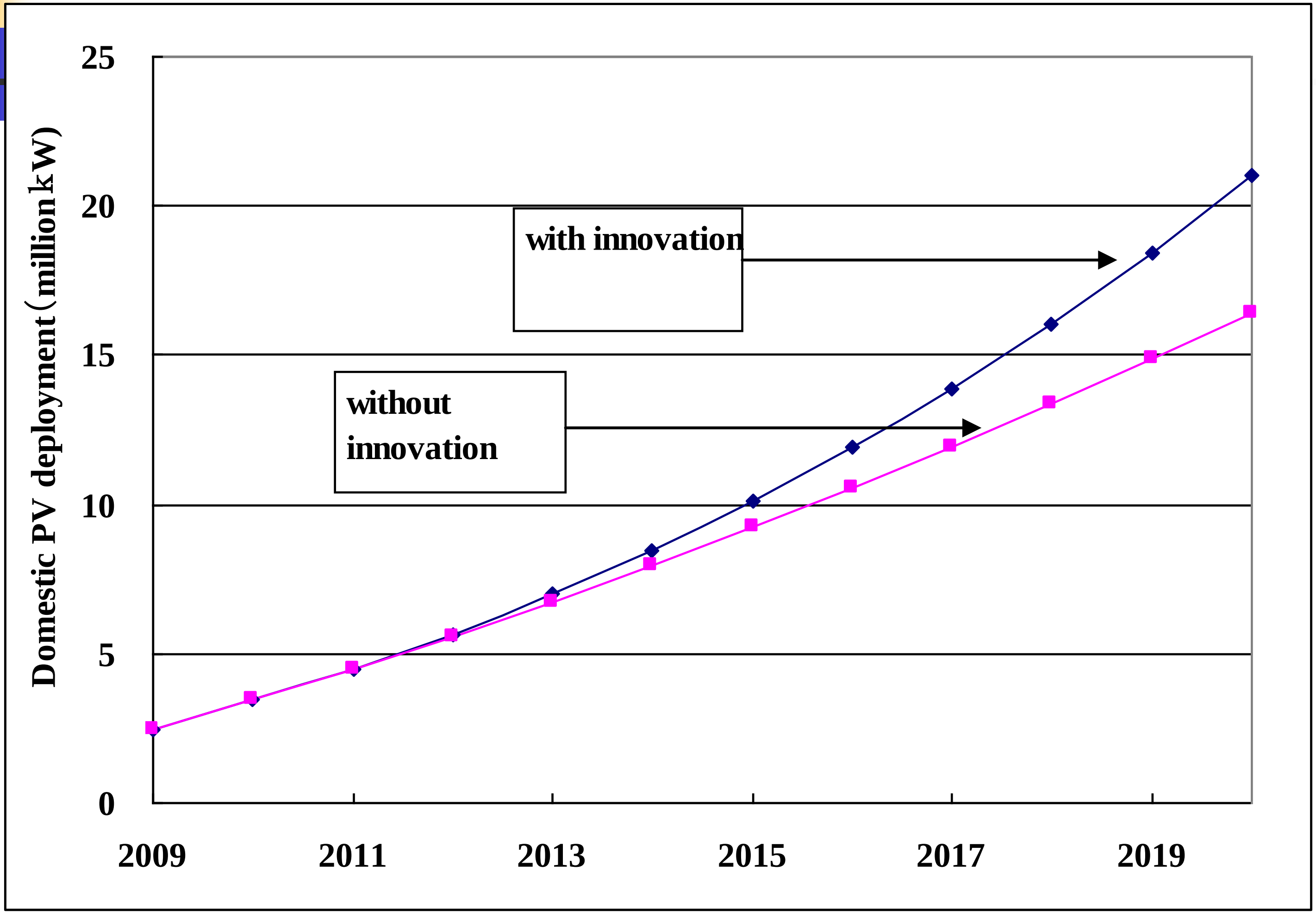
With efficiency improvement in home electric appliances

Examples of costs in photovoltaics and batteries

YEAR	2010	2020	2030
Photovolataics (yen/W)	200	100	50
Efficiency (%)	17	20	35
Setting up (yen/W)	200	100	50
Cost (yen/kWh)	40	20	10
Li-ion batteries (yen/Wh)	10	5	2 (Novel)
Lifetime 5years 20h (yen/kWh)	40	20	4 (10years)
5h (yen/kWh)	10	5	1
Total (5h, yen/kWh)	50	25	11

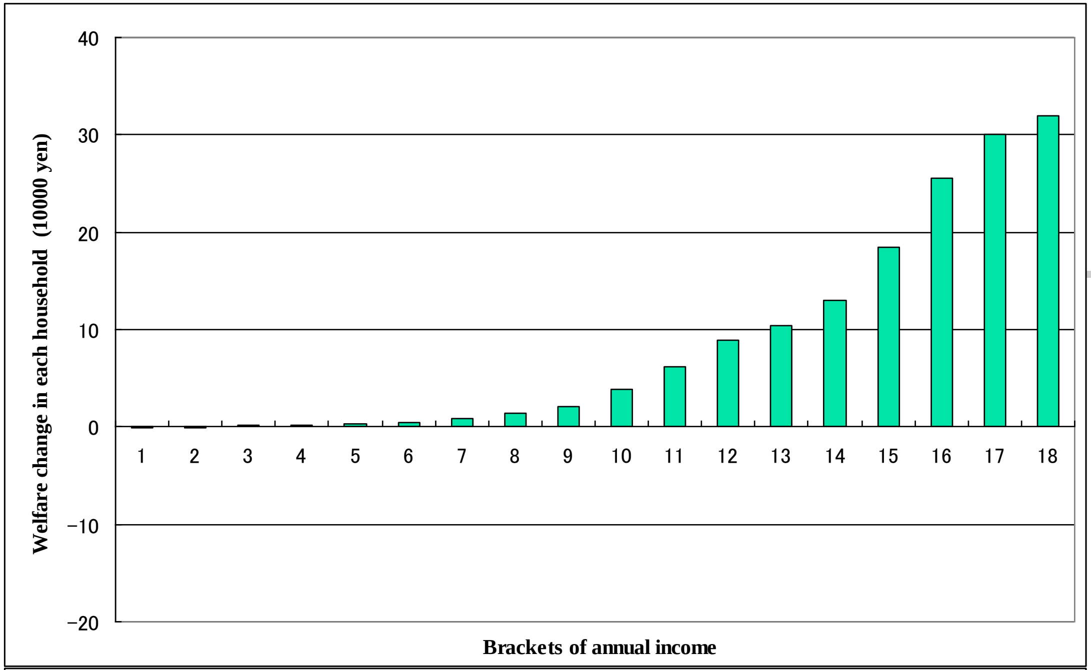
Reference: Koichi Yamada, lectures in Executive Management Programs, February 26, 2010

Impact of technology innovation on deploying photovoltaics



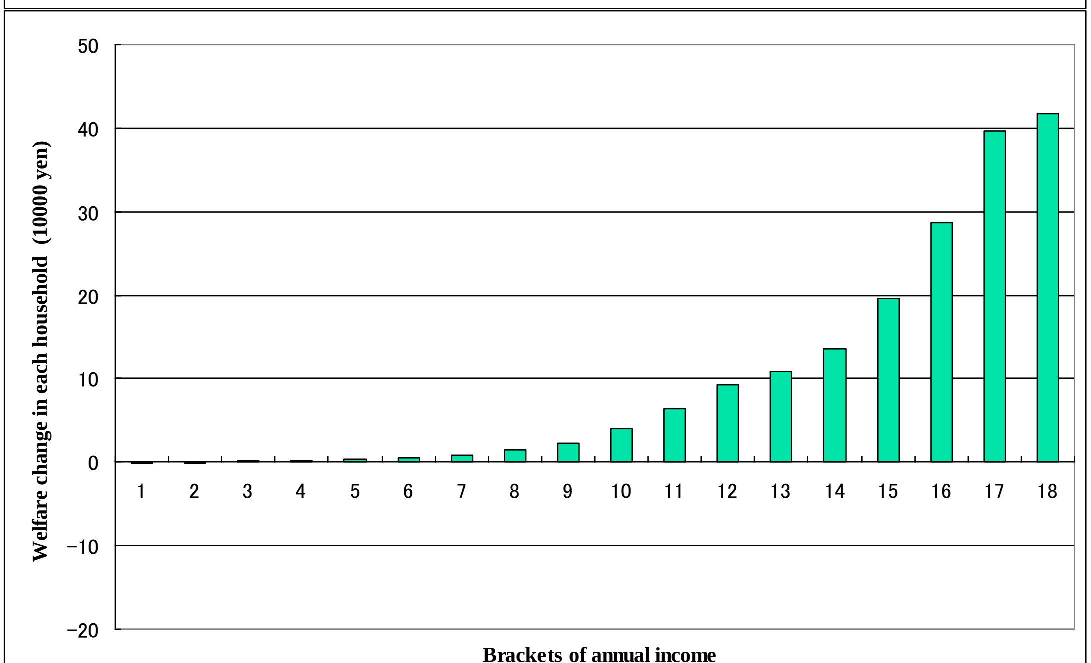
Targets of PV deployment in 2020 is realizable, with technology innovation and Japanese F.I.T..

Simulation results using our CGE model (4)



Without lowering Price of PV

Welfare values increase Especially in higher income brackets by innovation in PV. Aggregate welfare change amounts to 625 Billion yen.



With lowering price by innovation in PV

Why do the welfare values increase?

Most of energy saving and renewable technologies contribute to reduction of lifecycle costs.

		Payback years	CO_2 reduction (10^6 ton)
renewable energy	photovoltaics	15	75
energy saving	insulation of window	10	64
	airconditioning	5	27
	high efficiency water heatin	10	25
	Hybrid vehicles	5	50

Reference: Hiroshi Komiyama's presentation in the meeting of evolution strategy in Japanese cabinet office, 2009.12

Why do the welfare values increase?

The case of introducing PV

Introduction of PV

↓

Reduction of Lifecycle cost

↓

Annual savings in electricity cost ＞ Annual payment on PV

↓

Increased surplus in disposable income

↓

Purchase goods in other sectors

↓

Increase in consumers utility

↓

Increase in welfare value in equivalent variation

Is the scenario with increased welfare value actually realizable?

There are many renewable and energy saving technologies with lower lifecycle costs.

↓

Introduction of these technologies leads to reduction of CO2 with higher welfare.

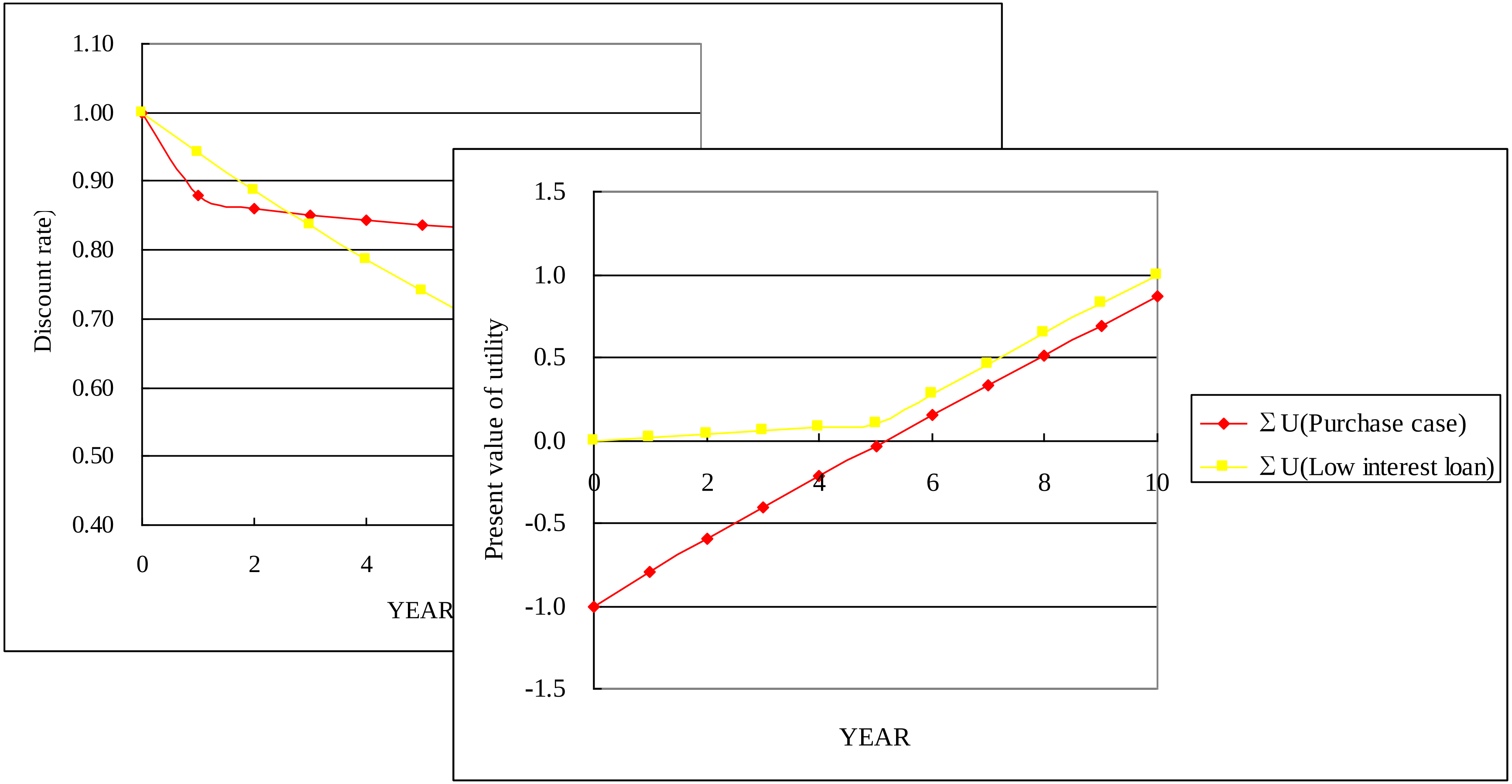
↓

However, even renewable and energy saving technologies with lower lifecycle costs are not necessarily deployed.

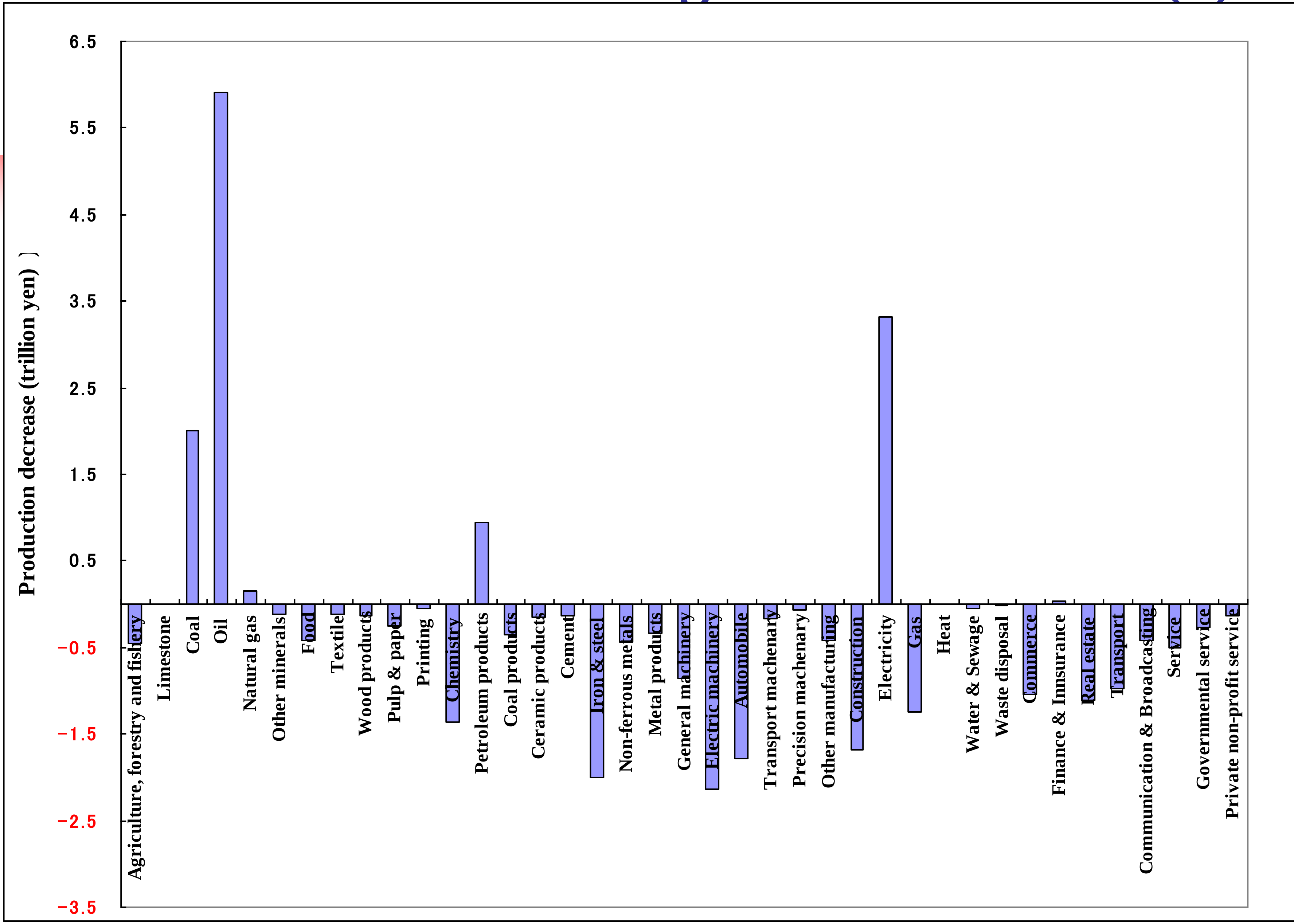
Modern theory on behavioral economics implies that human being is far from 'economic man' with extreme rationality. Ordinary citizens are subject to limited rationality, who are tempted to postpone their work or obligations. Ordinary citizens have higher discount rate than 'economic man', so that they do not necessarily buy products with lower lifecycle costs.

Is the scenario with increased welfare value actually realizable?

We estimate discount functions in time for consumers, so that we could explore the possibility of accelerated deployment under limited rationality.



Simulation results using our CGE model (5)



Transition to Low-carbon society and its economic impact

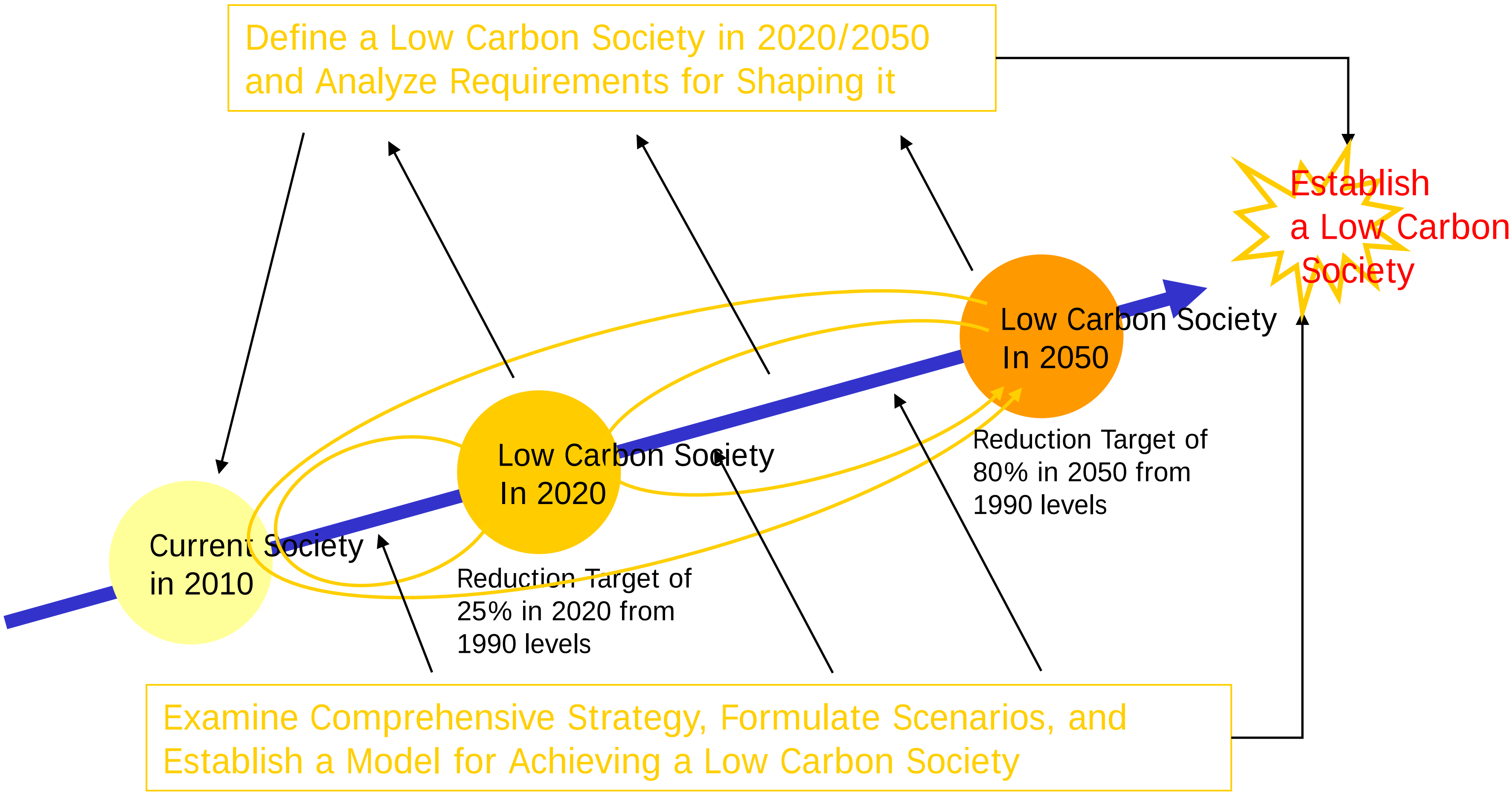
1. Efficiency improvement and renewable technologies have remarkable effect on increasing social welfare values.

2. So as to realize the welfare increase, we should promote accelerated deployment of these technologies as well as R&D on them.

3. If we succeed in accelerated deployment of energy saving and renewable technologies, we could realize low-carbon society with higher welfare.

Center for Low Carbon Society Strategy (LCS)

Established in December 2009
in Japan Science and Technology Agency（JST）



Strategic Scheme for Green Innovation by MEXT

Social System Transformation for Low Carbon Society

Low Carbon Society R&D Strategy Bureau

Control overall strategy (Prioritize R&D Items)

Consulting

Low Carbon Society R&D Strategy Promotion Committee

Mitigation Tech. Diffusion to Society

Realization of Climate Change Adaptation Society

Linkage to Related Ministries, Agencies, Local Governments,

Apply collective R&D efforts from Univ., Agencies, Institutes

Field Experiment Strategy

○Field experimental research of Low Carbon Technology

◆ Society system reform program toward new society corresponding to climate change 5Million Yen(New)

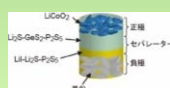
Mitigation Strategy

Innovative technology contributing to Greenhouse Gases Reduction

◆Advanced Low Carbon Related Technologies etc 5,809Million Yen（1,339Million Yen）

High-performance sensitizedsolar cell

Superconducting power transmission cable



Next-generation high-performance storage cell

Super high-temperature resistant alloys

○Promote R & D of Near & Long Term Energy Technology

Utilize full results of *Basic Research Strategy*(JST's CREST etc)

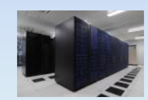
Adaptation Strategy

Research for adaptation of environmental change caused by global warming

◆Climate Change Adaptation Strategy Initiative etc 3,158Million Yen（2,316Million Yen）

○Promote Climate Change Projection and Data Integration as common platform technology

Earth Simulator



Data Integration & Analysis Systemy(DIAS)

Apply full results of *EO Strategy*

Diplomatic Strategy

Int'l Cooperation・S&T Diplomacy

○Contribute to UNFCCC /IPCC/GEOSS etc

○Support to Developing Countries、Capacity Bldg

General Strategy

○Research analysis on realization of new technology

◆Social Scenario Research for Low Carbon Society 300Million Yen（New）

◇JST Low Carbon Social Strategy Center Establishment

○Research Analysis on possibilities of adoption and diffusion of technology considering utility to public and lifestyle change

○Research analysis on influence of new technology to society