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for Industrial Sector in the Climate-Energy Interface
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Overview of the Voluntary Action Plan in Japan and Quantitative Analyses on the Emission Reduction Efforts

Keigo Akimoto, Kohko Tokushige, Junichiro Oda
Fuminori Sano, Takashi Homma, Kenichi Wada

Systems Analysis Group
Research Institute of Innovative Technology for the Earth (RITE)

Introduction

- Japan achieved the Kyoto target which was -6% relative to 1990 for the period of 2008-2012, reaching -8.4%.
- The Keidanren Voluntary Action Plan (VAP) on the Environment which was introduced in 1997 made an important contribution to the achievement of Japan's emission target for the KP.
- It will be important to make efforts of the same level to reduce GHG emissions across countries and industrial sectors while they have different condition. For example, the emission reduction efforts cannot be evaluated only by the emission reduction ratios relative to a reference year.
- GHG emission reductions for the first commitment period of the Kyoto Protocol in Japan were quantitatively evaluated by using several indicators focusing particularly on the Keidanren VAP.

History of VAP in Japan

1996 Keidanren Environment Appeal (implementation policy for Action Plan on the Environment) released

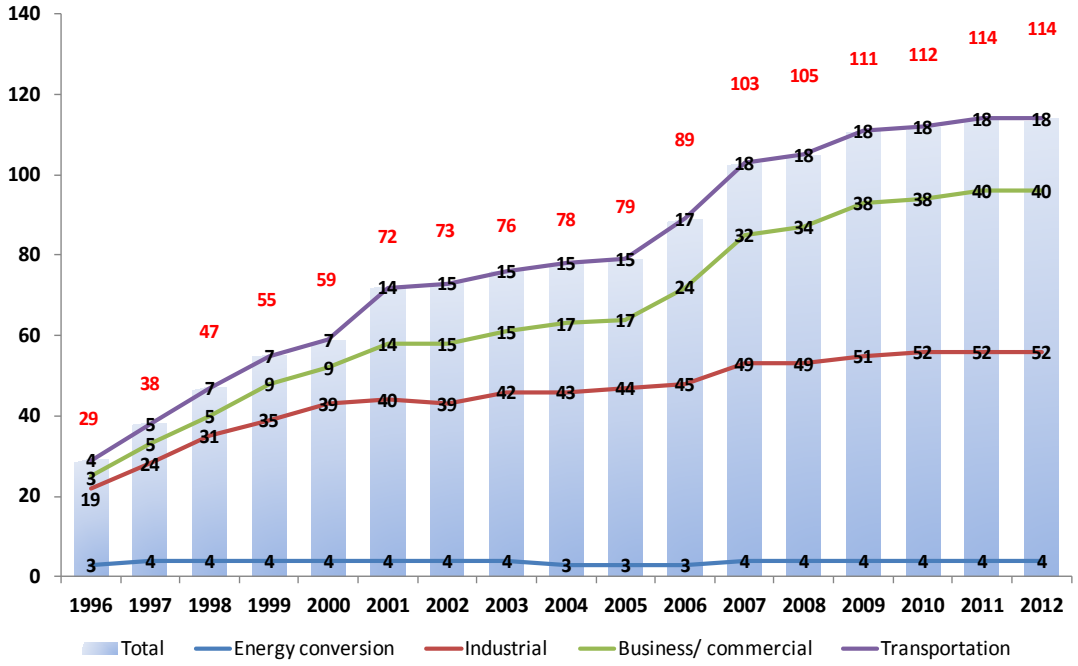
1997 Keidanren Action Plan on the Environment released

1997 Kyoto Protocol adopted

1998 First follow-up on the Keidanren Action Plan both by the Keidanren and Japanese government (annual follow-ups thereafter)

2009 Keidanren Commitment to a Low Carbon Society (pledges of emission reduction efforts toward 2020) formulated and released

2013 Keidanren Commitment to a Low Carbon Society initiated



Source: IEEJ

Establishment of the PDCA Cycle in the VAP of Keidanren

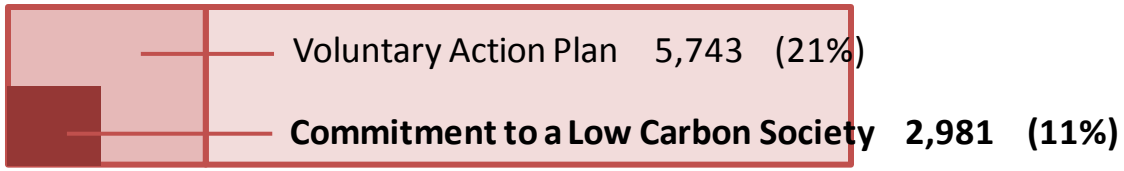
Source: Keidanren

Keidanren and Japanese government established the PDCA cycle in the VAP, which have review processes by the government, Keidanren, and each business association.

The Ratio of the VAP in the Total Emissions in Japan

Industrial and energy conversion sectors (50,535) based on FY 2012 emissions data (10,000t-CO2)

Business / commercial sector (27,237)



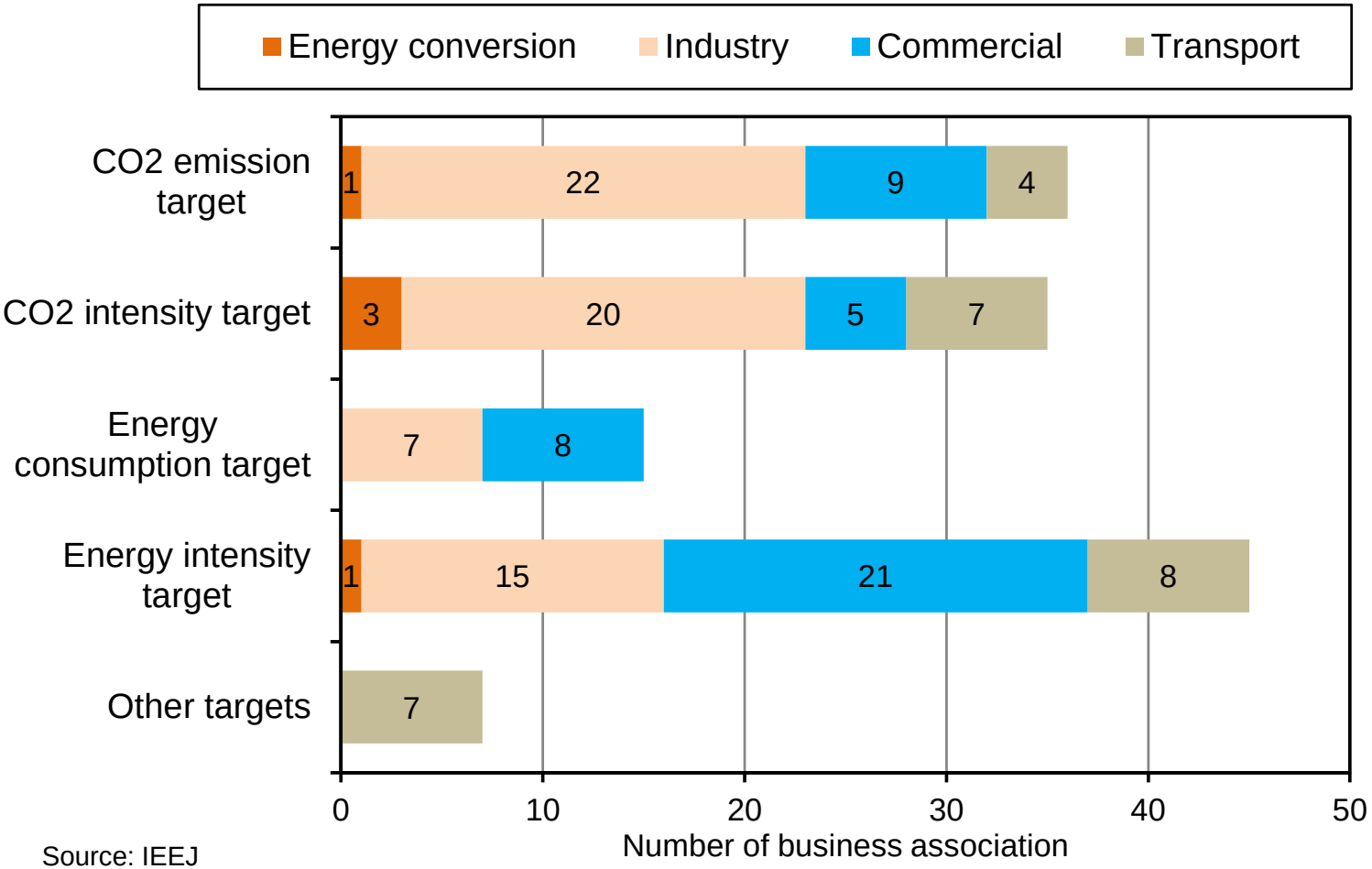
Transportation sector (22,634)

as of June 30, 2014

Source: IEEJ

- The emissions of the industry and energy conversion business associations participating in the Keidanren VAP accounted for about 80% of these sectors' emissions and about 50% of total national emissions in 1990.

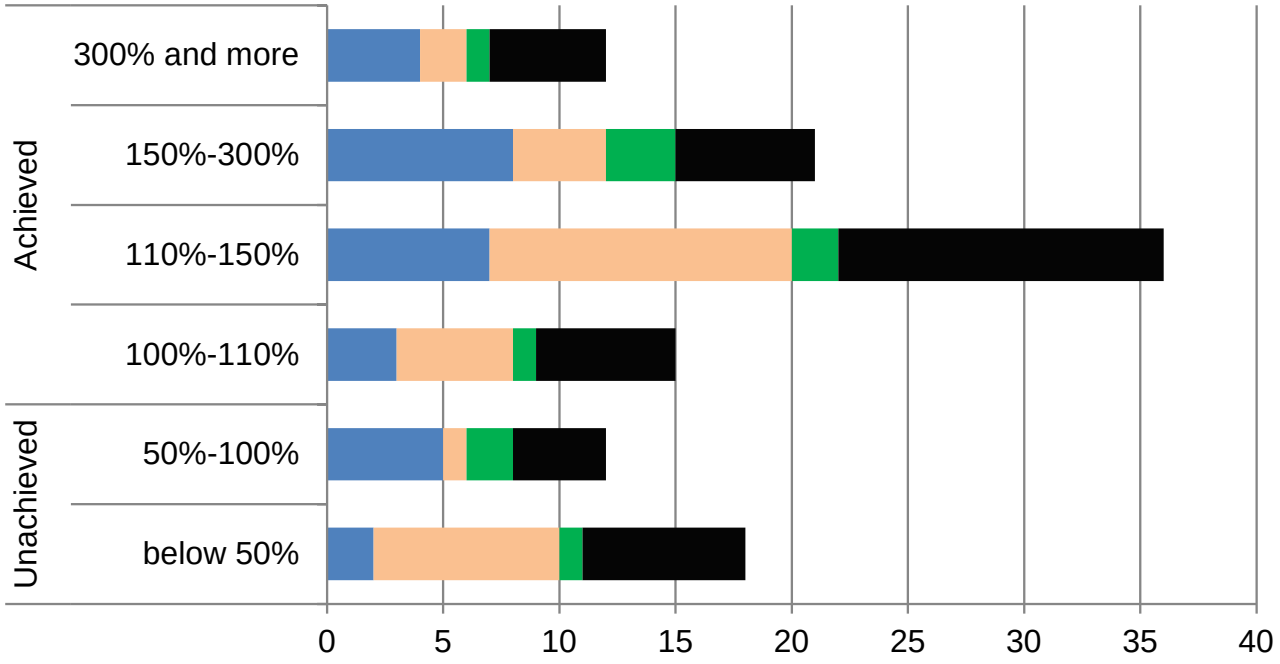
Number of Participant Business Associations and Their Targets of the VAP in Japan



Source: IEEJ

- The VAP in Japan had several kinds of targets reflecting the characteristics of several kinds of business associations.
- CO2 emission and CO2 intensity targets were adopted in relatively many of the industrial sectors, and energy intensity target was adopted in relatively many of the commercial sectors.

Achievement of the Targets of the VAP



	Unachieved		Achieved			
	below 50%	50%-100%	100%-110%	110%-150%	150%-300%	300% and more
CO2 emission target	2	5	3	7	8	4
CO2 intensity target	8	1	5	13	4	2
Energy consumption target	1	2	1	2	3	1
Energy intensity target	7	4	6	14	6	5

Source: IEEJ

- 84 business associations in 114 associations achieved their targets.
- Most of the associations whose results were below 50% of their targets were energy or CO2 intensity targets.

Overview of the Ex-post Evaluation for the VAP (1/2)

1. Evaluations of Japanese efforts including the Voluntary Action Plan based on comparative analysis with major countries

1) Comparative evaluation of energy intensity & CO2 intensity at macro-level
=> influenced by industrial structure

2) Comparative evaluation of improvement ratio of energy intensity at macro-level
=> Improvement rate tends to be low when large improvements had already been made, leaving little room for further improvements. Economies experiencing substantial economic growth tend to have large improvement rates of intensity, vice versa

3) Comparative evaluation of explanations of changes in energy intensity by changes in economic activity in order to see whether improvement measures are taken regardless of economic conditions => However, large uncertainties in evaluations

4) Comparative evaluation of energy efficiency in major sectors (e.g., electricity generation, iron and steel, cement) => Difficulties in evaluating large number of sectors

5) Evaluation of marginal abatement costs and the GDP impacts through model based analyses => Large uncertainties in analysis

Overview of the Ex-post Evaluation for the VAP (2/2)

2. Evaluation of the Voluntary Action Plan

1) Evaluation of rate of reduction from baseline estimated based on a kind of extrapolation => Given large uncertainties in baseline estimates, difficult to determine a common definition

2) Evaluation of improvement rate of energy intensity in each sector committed to Voluntary Action Plan => Improvement rate tends to be low when large improvements had already been made, leaving little room for further improvements. Economies experiencing substantial economic growth tend to have large improvement rates of intensity, vice versa

3) Evaluation of explanations of changes in economic activity by changes in energy intensity for the business associations committed to Voluntary Action Plan in order to evaluate the possibility of improvement measures taken regardless of economic indicators

=> However, large uncertainties in evaluations

4) Comparative analysis between committed and non-committed sectors to Voluntary Action Plan => Difficulties in analysis due to differences in types of data available for analysis.

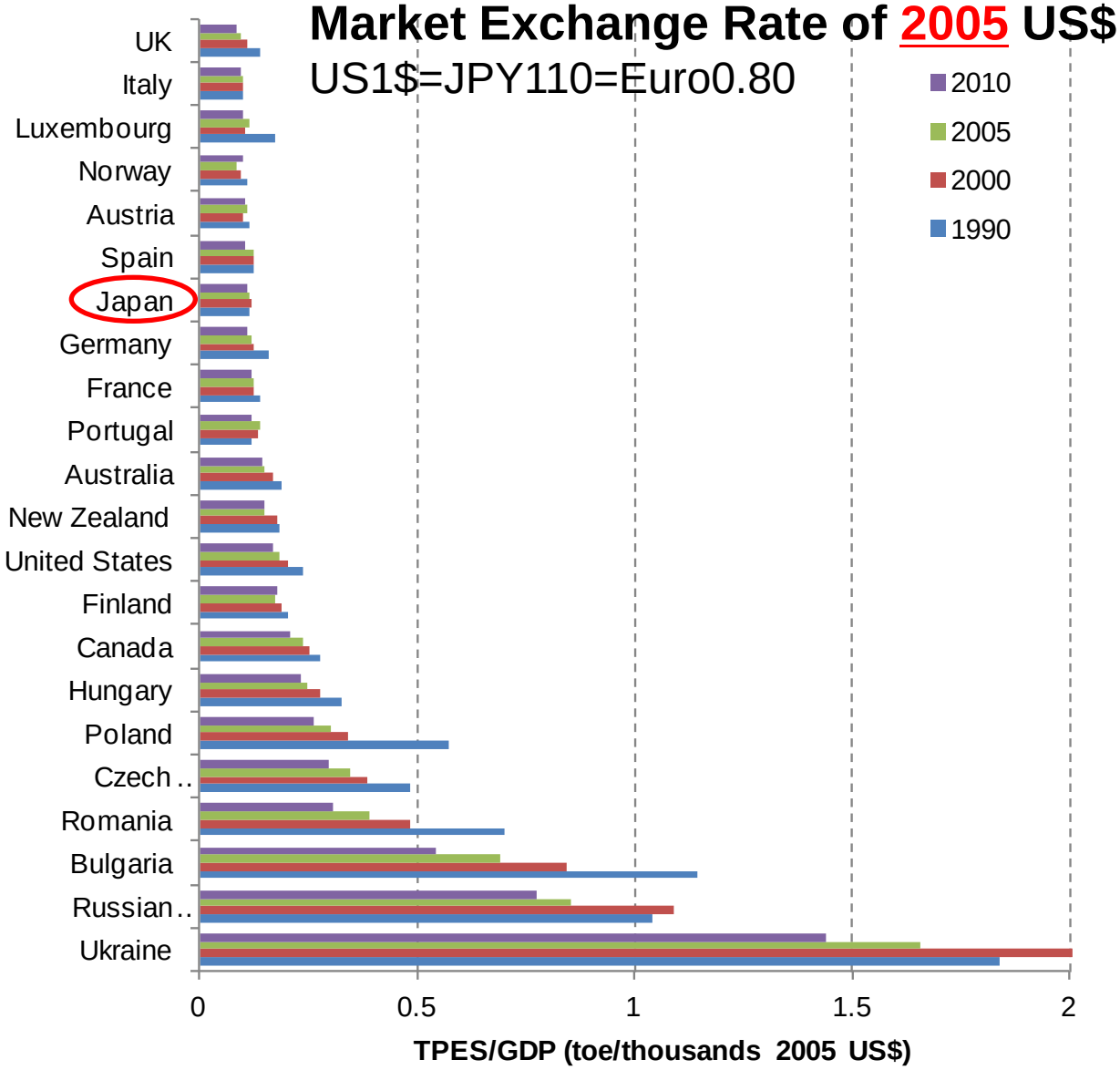
5) Comparative evaluation with Tokyo Metropolitan Government's emission trading scheme => Limitations in analysis as Tokyo scheme also yet to be evaluated and no trading of emissions

6) Assessment of costs involved with individual measures => few cases with adequate data for cost estimations

Comparison of Energy Intensity among Annex I Countries

- Japan's energy intensity level is very high but not the highest when it is calculated by using market exchange rate of 2005 US$.

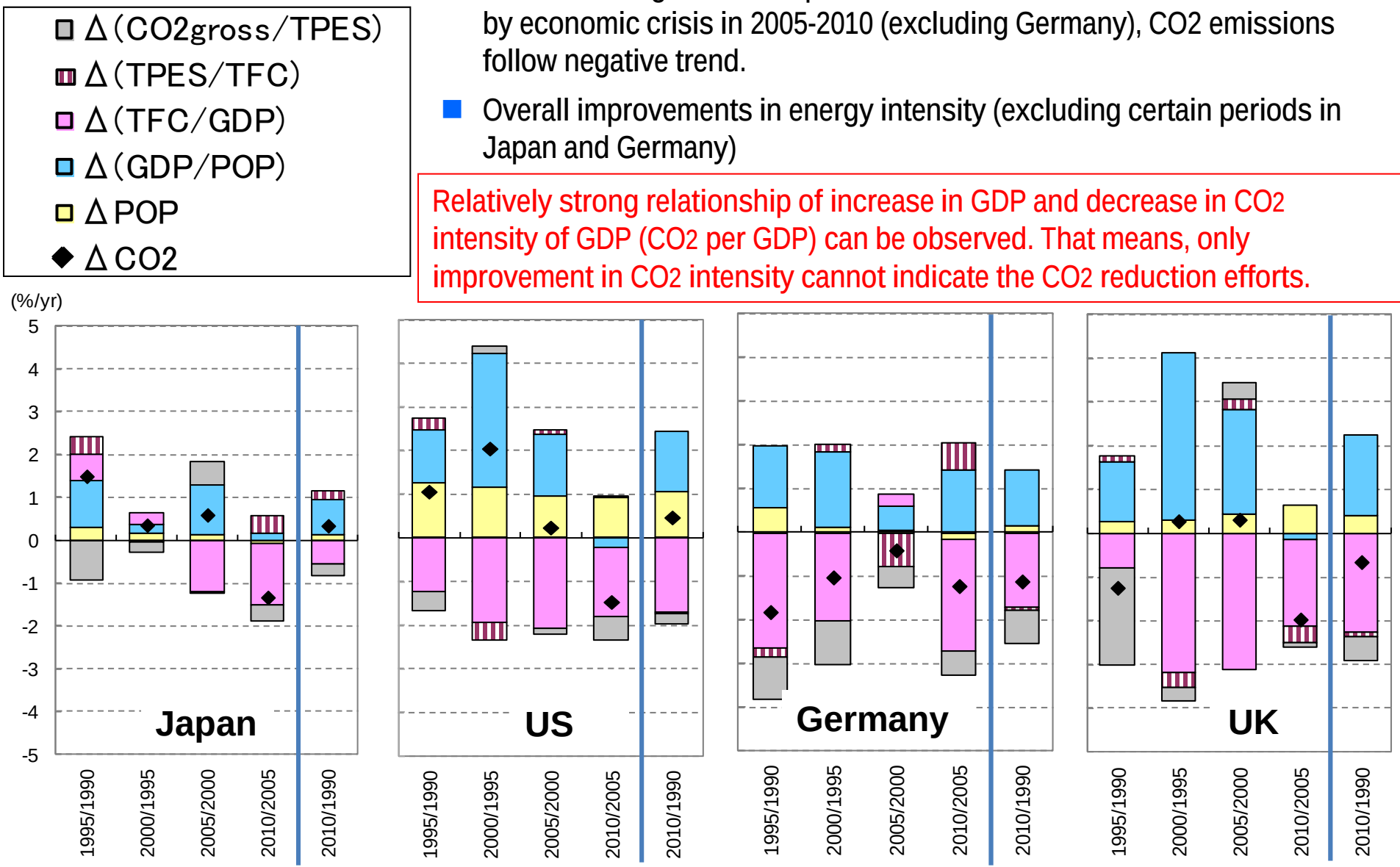
Energy intensity per macroeconomic GDP is largely influenced by currency exchange rates and industrial structure; and therefore, requires careful evaluation.



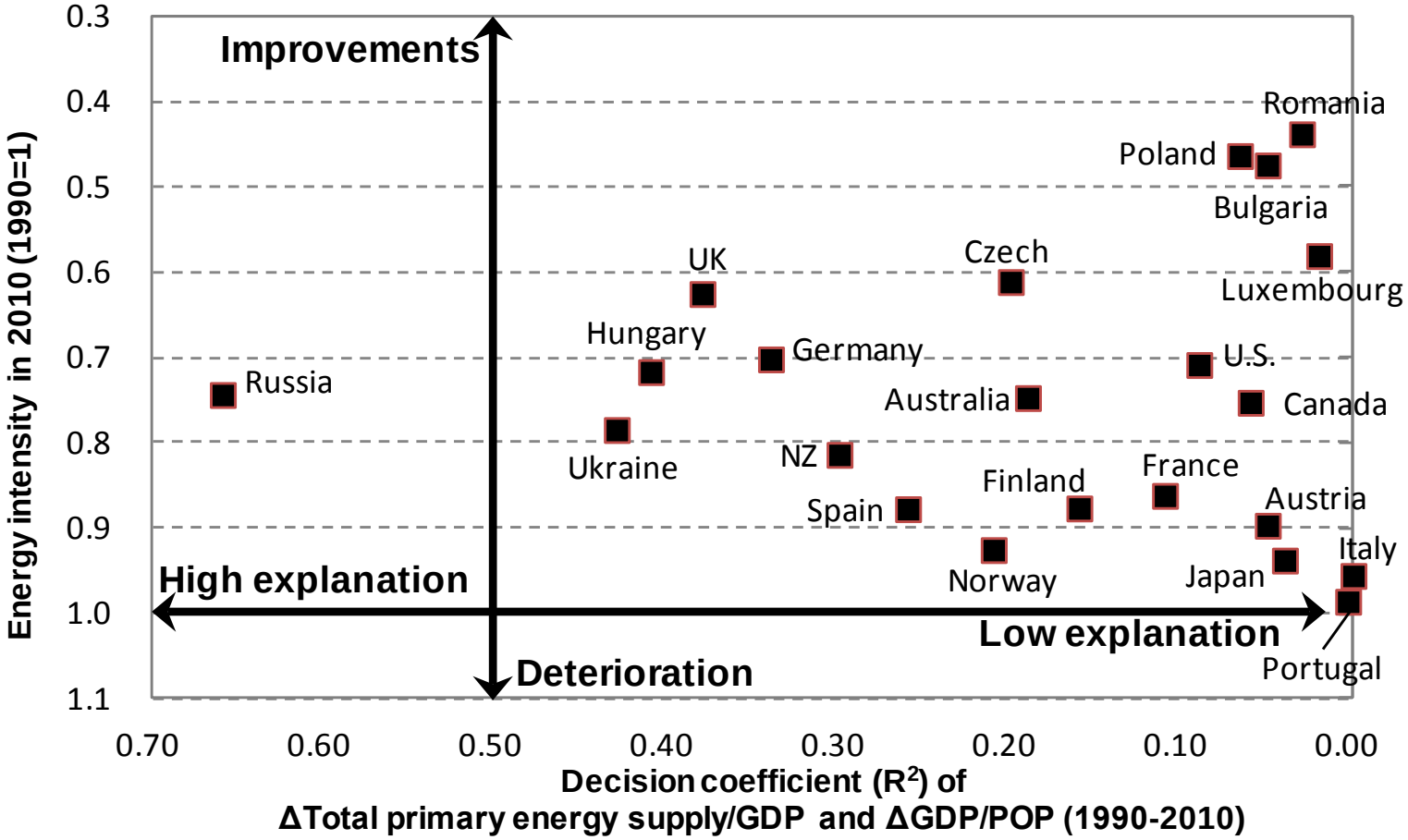
Factor analysis of emissions trends (1990-2010) – Comparison of major economies –

- Positive GDP growth over past two decades in all 4 countries. Influenced by economic crisis in 2005-2010 (excluding Germany), CO2 emissions follow negative trend.
- Overall improvements in energy intensity (excluding certain periods in Japan and Germany)

Relatively strong relationship of increase in GDP and decrease in CO_2 intensity of GDP (CO_2 per GDP) can be observed. That means, only improvement in CO_2 intensity cannot indicate the CO_2 reduction efforts.

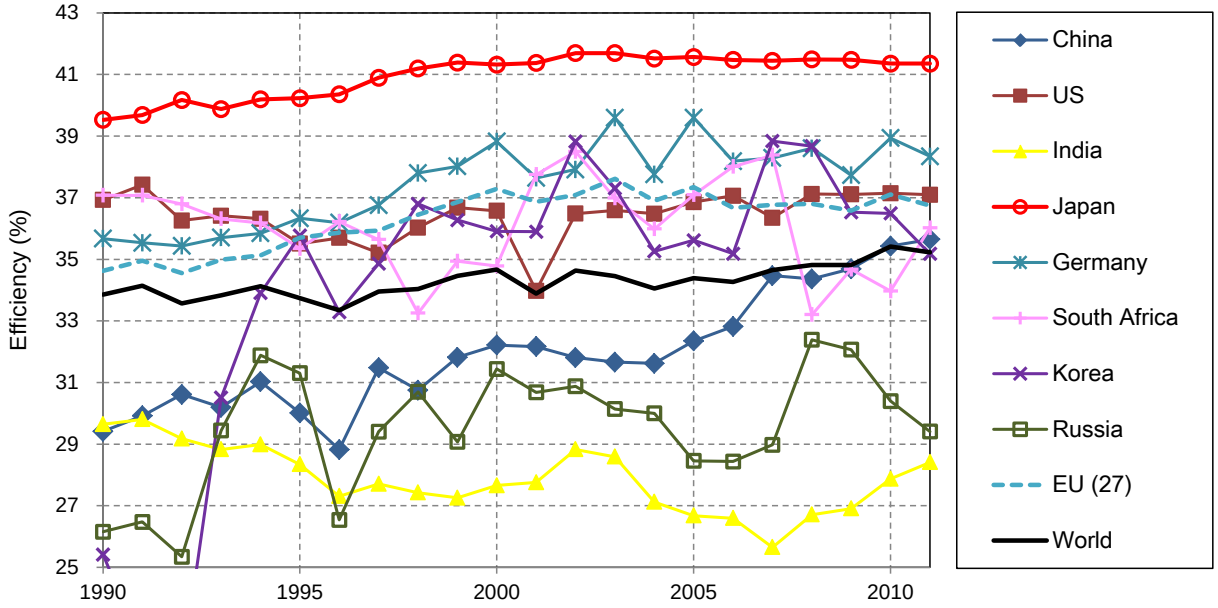


Energy intensity improvement, and the explanations (R2) for annual improvement in energy intensity by annual increase in economic growth between 1990 and 2010



- Countries whose energy intensity changes are explained well by changes of per-capita GDP seem to have achieved their intensity improvements without a large efforts.
- The amount of energy intensity improvement ratio alone cannot be an indicator of the efforts of energy intensity improvement.

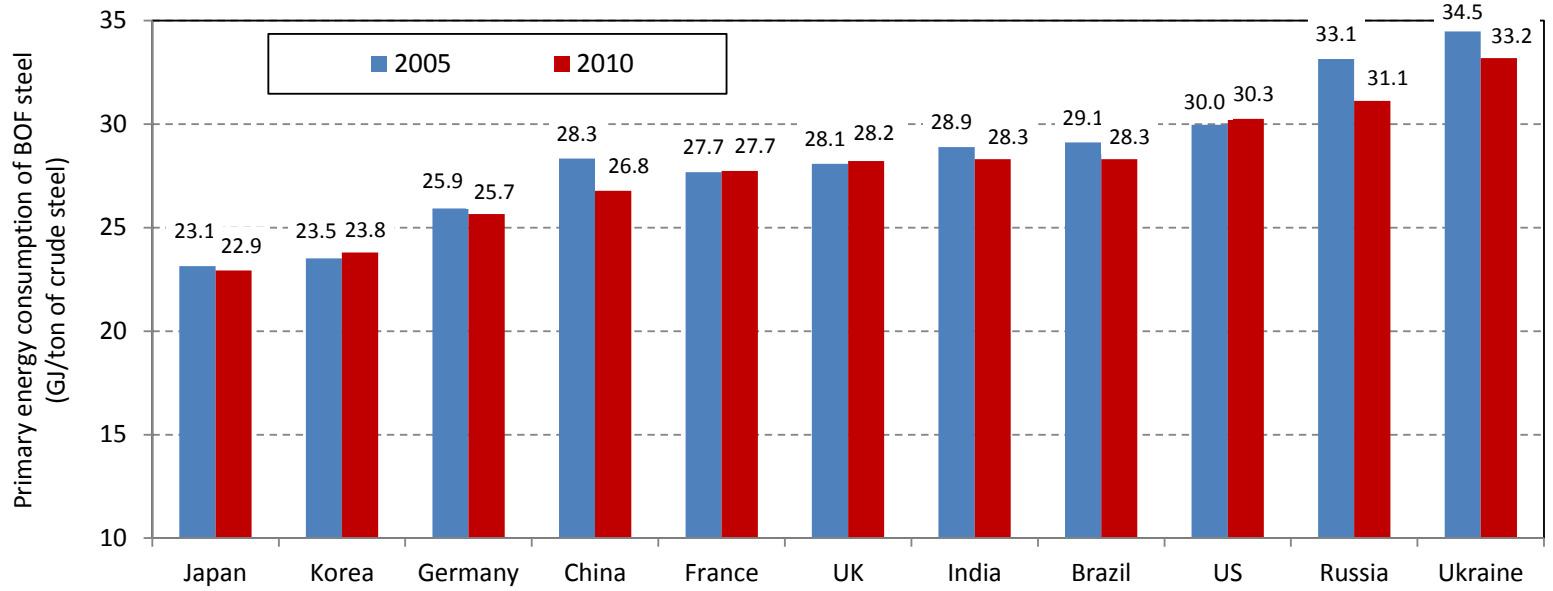
Comparison of Energy Efficiency in Major Energy-intensive Sectors (1/2)



Coal power

Source) RITE, 2014
based on IEA, 2013

Comparisons by sector reveal that Japan has high energy efficiency levels in major sectors

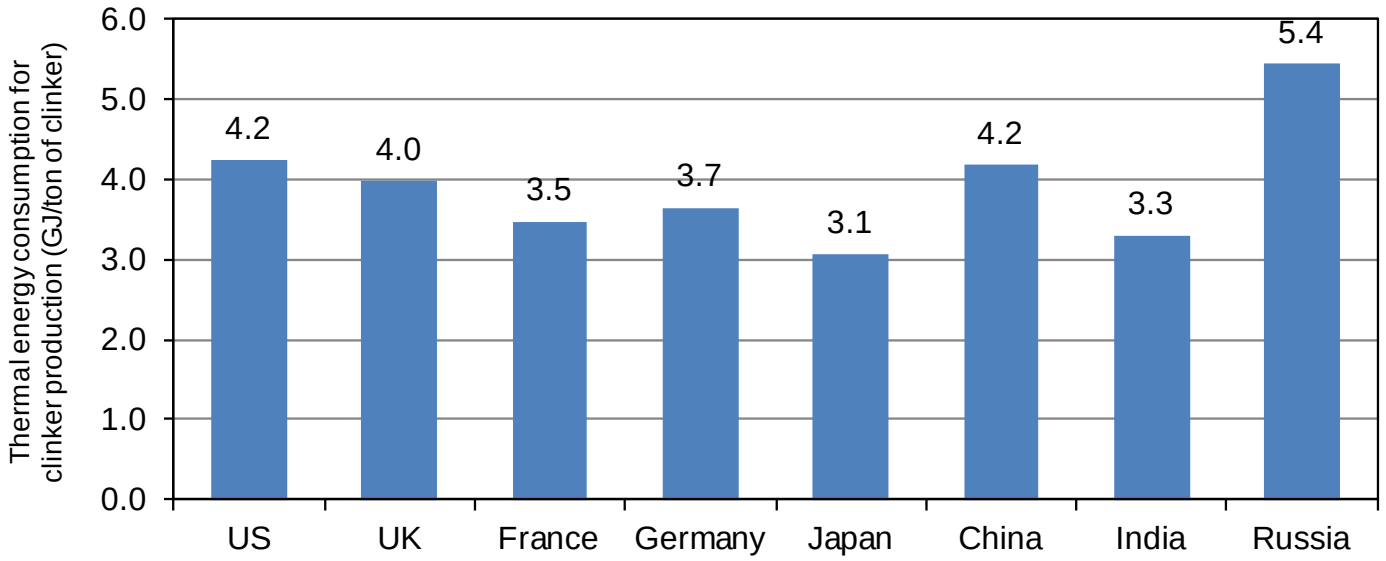


Iron & steel (BOF steel)

Source) Oda et al. 2012;
RITE, 2012

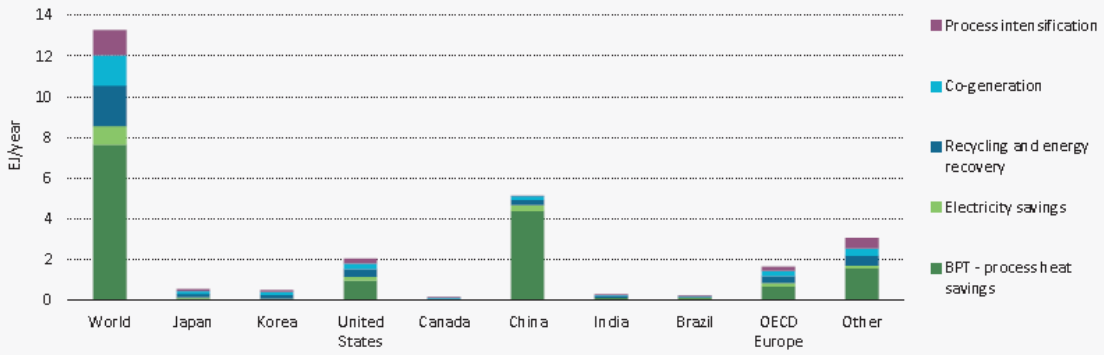
Comparison of Energy Efficiency in Major Energy-intensive Sectors (2/2)

Cement



Source: estimate by RITE based on WBCSD/CSI, etc.

Figure 12.15 Current energy savings potential for chemicals and petrochemicals, based on best practice technologies



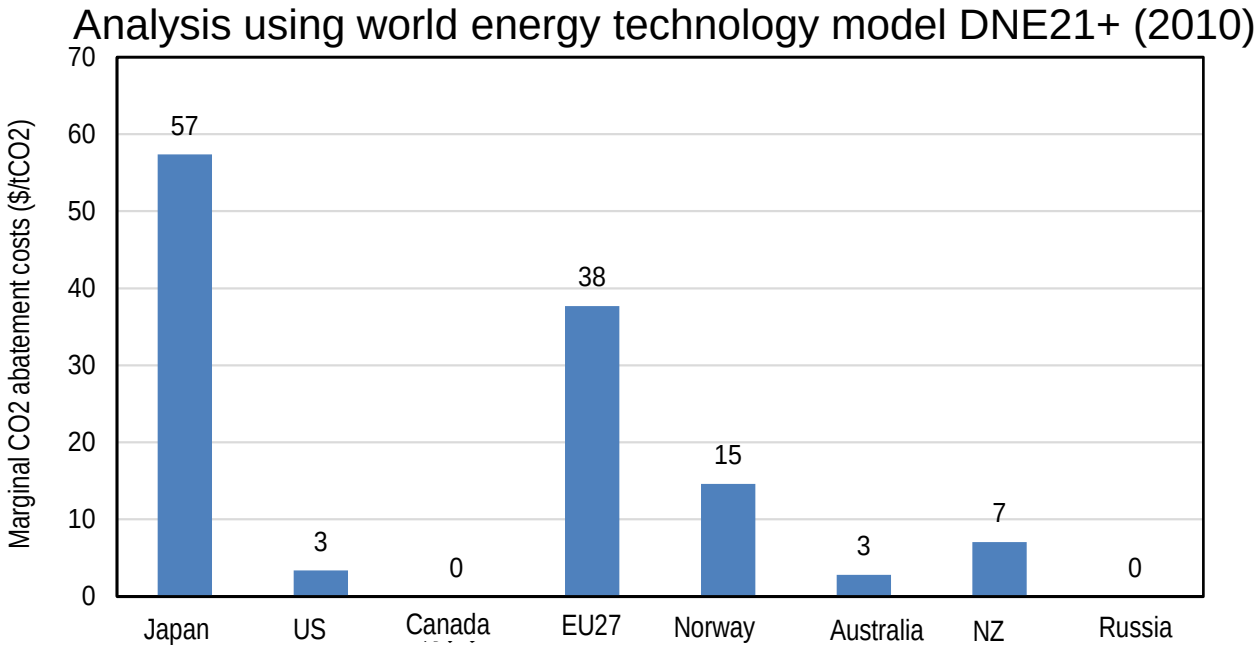
Key point *The chemical and petrochemical sector holds the potential for more than 13 EJ in energy savings.*

Chemical / Petrochemical

Source: IEA, ETP2012

2010 marginal abatement cost estimates using a technology-oriented bottom-up world energy model

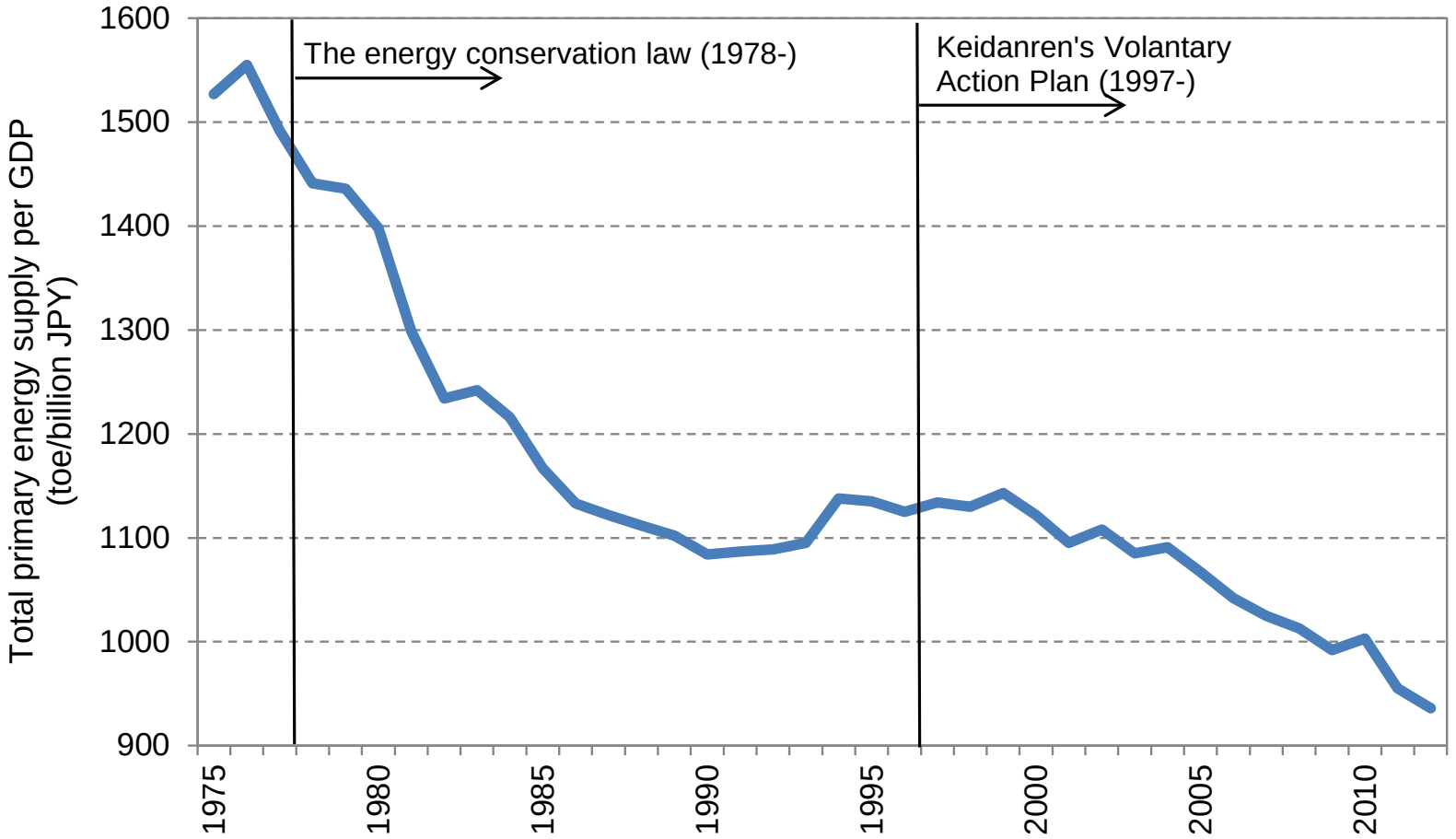
Emission reduction efforts cannot be easily evaluated using a single index due to the diversity of baselines defined by potential economic growth etc., historical energy efficiency efforts, and availability of energy resources including renewable energy among different countries. However, marginal abatement costs efficiently represent reduction efforts. Marginal abatement costs estimated from 2010 emissions for Annex I countries.



Notes: 1) Analysis used national historical emissions as upper limits for emission in model. For EU27 the figure in graph represents country with highest cost (Germany). Estimates for UK:17$/tCO2; France:16$/tCO2; Italy: 8$/tCO2. 2) Solar power and wind power being introduced regardless of cost-effectiveness supported by FIT and other measures, analyzed separately under model constraint of introduced volume. Therefore, these marginal costs are excluded from those shown in graph.

A model-based cost analysis may provide results with relatively large uncertainties. However, can be judged from these results that Japanese measures required larger reduction efforts than those of other countries.

Trajectory of Energy Intensity in Japan



Source: EDMC, 2013

The energy intensity of Japan had been improved drastically before year of 1997 when the Keidanren's Voluntary Action Plan started.

GHG emissions between 2008 and 2012 in Japan

	Reference year (1990 or 1995)	FY2008	FY2009	FY2010	FY2011	FY2012	Average between FY2008 and FY2012
Energy CO2	1059	1138	1075	1123	1173	1208	1144 (+6.7%)
Industry	482	419	388	421	417	418	413 (-5.5%)
Transport	217	236	230	233	230	226	231 (+1.1%)
Commercial	164	234	215	217	250	272	238 (+5.8%)
Residential	127	171	162	172	189	203	179 (+4.1%)
Energy conversion	68	79	80	81	88	88	83 (+1.2%)
Non-energy CO2	85	75	66	68	68	68	69 (-1.3%)
Other GHGs *	117	68	64	64	65	67	66 (-4.0%)
Total	1261	1281	1206	1256	1307	1343	1278 (+1.4%)
Sink (forestation etc.)	–	-46	-47	-49	-51	-53	-49 (-3.9%)
KP emission credit	–	–	–	–	–	–	-74 (-5.9%)
KP target	–	–	–	–	–	–	1156 (-8.4%)

Source: MOE, 2014

The Keidanren's Voluntary Action Plan covers about 80% of total CO2 emissions from industry and energy conversion sectors in Japan.

The emission from industry was reduced in 2008-2012 relative to 1990. The most of the emissions are covered by the Voluntary Action Plan.

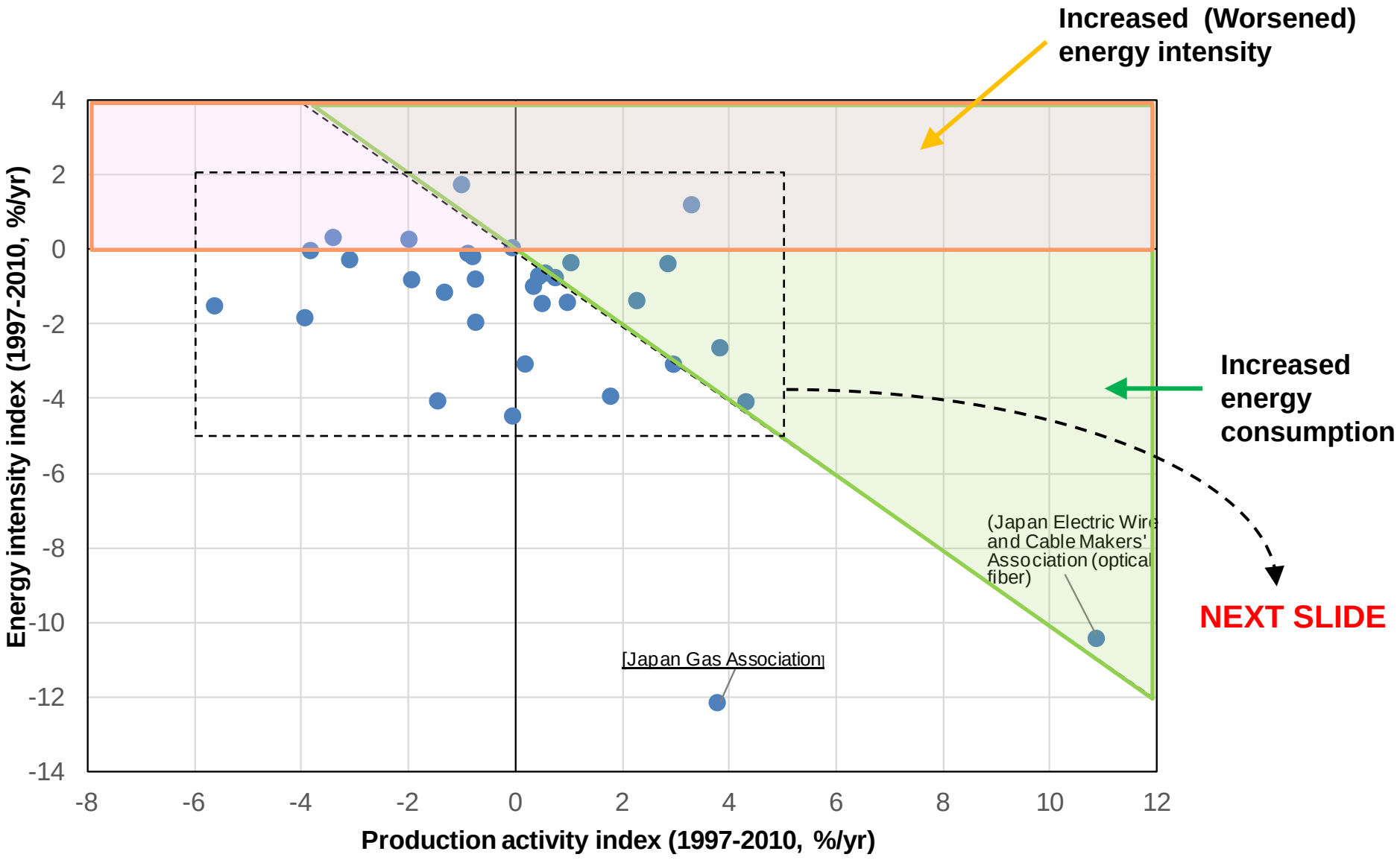
Analysis of reductions from estimated baseline

Targets upper reduction values, and actual performance against baseline performance (=1.0) estimated by applying actual energy intensity and CO_2 emission intensity performance data of 1997 for the following years using actual performance data for production (only selected business associations

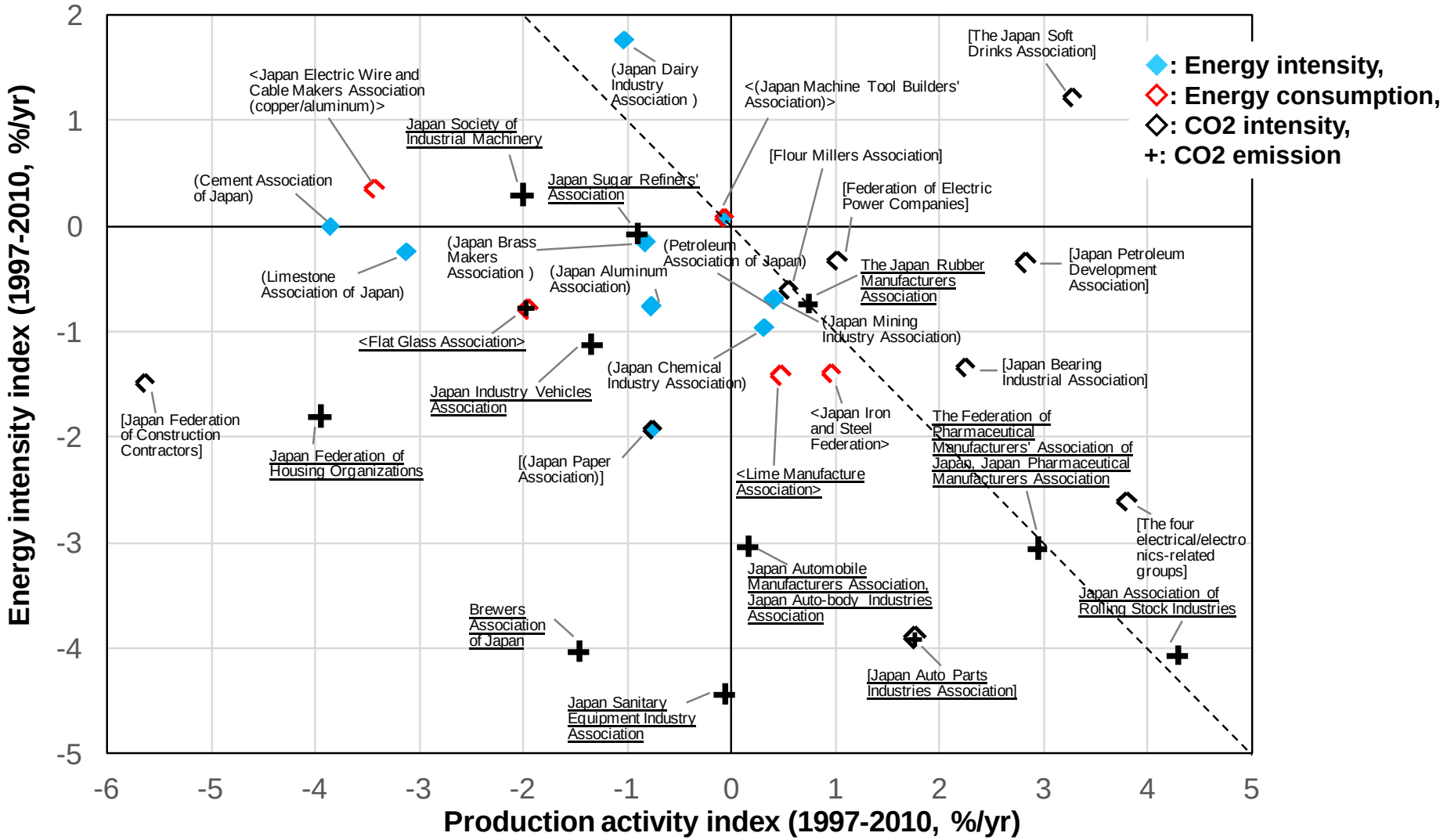
	Energy intensity	Energy consumption	CO2 intensity	CO2 emissions
Federation of Electric Power Companies of Japan (FEPC)	0.96	0.96	[0.91] 1.05(1.04)	1.05(1.04)
The Japan Iron and Steel Federation (JISF)	1.02	[0.85] 0.84	0.85(0.84)	0.85(0.84)
Japan Cement Association (JCA)	[1.00] 1.00	1.00	1.03(1.02)	1.03(1.02)
Japan Chemical Industry Association (JCIA)	[0.85] 0.90	0.90	0.90(0.87)	0.90(0.87)
Japan Automobile Manufacturers Association (JAMA) / Japan Auto-Body Industries Association (JABIA)	0.66	0.66	0.72(0.67)	[0.84] 0.72(0.67)
4 electrical and electronics associations	0.71	0.71	[0.83] 0.86(0.76)	0.86(0.76)
Japan Machine Tool Builders' Association (JMBTA)	[0.94] 1.11	[0.97] 1.11	1.23(1.11)	1.23(1.11)

- Targets in almost all sectors stricter than baseline performance values defined/estimated here. Actual performance worsened in some sectors compared to baseline performance, but improved in majority of sectors.
- Difficult to actually estimate baselines, especially defining sector-specific and company-specific baselines, as detailed cost-related data required for that. Voluntary action plans are considered suitable and appropriate method since defining explicit baselines is difficult.

Changes in economic activity and energy intensity of business associations of the Voluntary Action Plan (1997-2010) (Cont'd)

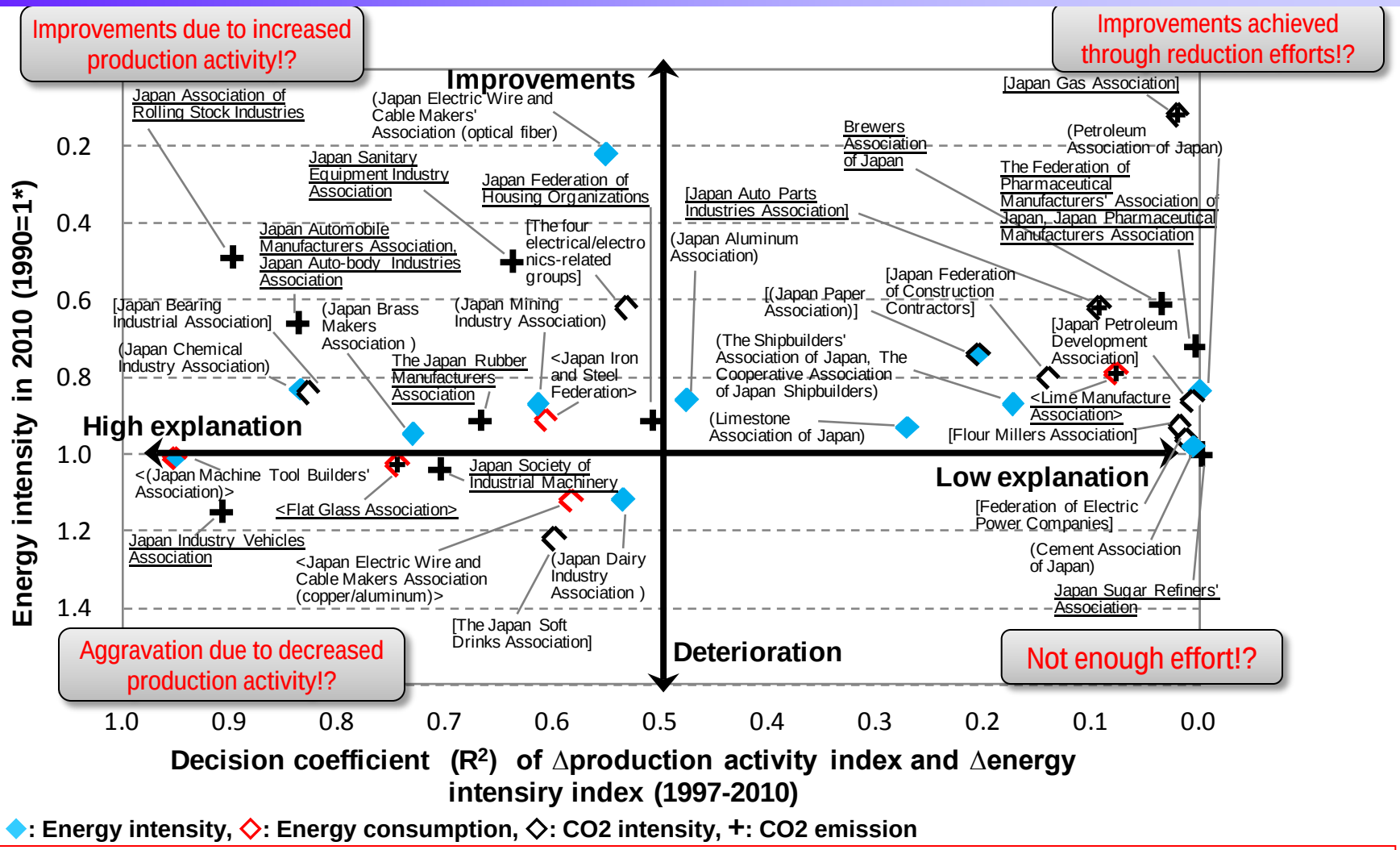


Changes in economic activity and energy intensity of business associations of the Voluntary Action Plan (1997-2010)



Energy intensity and energy consumption in many business associations decreased during 1997-2010, but energy intensity and/or energy consumption in some associations increased.

Energy intensity change in 2010 relative to 1990, and the explanations (R2) for annual improvement in energy intensity by annual increase in economic activity between 1997 and 2010 across industrial associations participating in VAP



◆: Energy intensity, ◇: Energy consumption, ◇: CO2 intensity, +: CO2 emission

- Target-specific pattern (among energy consumption, energy intensity, CO2 emissions and CO2 intensity targets) cannot be observed from plotting of sectors.
- Most sectors whose energy intensities worsened seemed to be affected by low production activities.

Impacts of Economic Recessions and the Earthquake on Emission Reduction Consequences (For 44 Associations under METI's FU)

The associations with emission target which achieved their targets

	Business association	Target	Result	Estimate
1	Japan Gas Association	0.26	0.24	0.24
2	Japan Iron and Steel Federation	0.90	0.893	0.93
3	Japan Automobile Manufacturers Association, Japan Auto-body Industries Association	0.75	0.60	0.61
4	Japan Auto Parts Industries Association	0.93	0.765	0.75
5	Lime Manufacture Association (energy)	0.90	0.718	0.82
	(CO2)	0.90	0.691	0.78
6	The Japan Rubber Manufacturers Association	0.90	0.70	0.77
7	Flat Glass Association (energy)	0.79	0.62	0.67
	(CO2)	0.78	0.63	0.66
8	Japan Electric Wire and Cable Makers Association (copper/aluminum)	0.71	0.62	0.64
9	Japan Society of Industrial Machinery Manufacturers	0.878	0.856	1.03
10	Japan Sanitary Equipment Industry Association	0.75	0.497	0.53
11	Japan Industry Vehicles Association	0.90	0.766	0.85
12	Japan Textile Finishers' Association (energy)	0.45	0.391	0.40
	(CO2)	0.38	0.337	0.34
13	Japan Glass Bottle Association (energy)	0.70	0.585	0.57
	(CO2)	0.60	0.466	0.45
14	Japan Foreign Trade Council	0.59	0.53	0.53

The associations with intensity target which did not achieved their targets

	Business association	Target	Result	Estimate
1	Japan Brass Makers Association	0.9095	1.0081	0.88
2	Japan Machine Tool Builders' Association	0.94	0.99	0.73
3	Japan Franchise Association	0.77	0.782	0.75
4	Limestone Association of Japan	0.90	0.921	0.84

Note 1) Federation of Electric Power Companies is excluded for this analysis.

Note 2) The following estimates were conducted;
Production activity modification: exploration of the activity by using the average change rate between1990 and 2006;
Intensity modification: using the modified production activity and the regression analysis results between production activity change and intensity change.
CO2 intensity of electricity is fixed at 305 gCO2/kWh excluding the impact of the Earthquake on the intensity of electricity.

- The 12 business associations of the associations with emission target which achieved their targets (14 associations) could have achieved their targets even if the activity reductions had not occurred between 2008 and 2012 due to economic recessions, the Great East Japan Earthquake etc.
- All the business associations of the associations with intensity targets which did not achieve their targets (four associations) could have achieved their targets if the activity reductions had not occurred between 2008 and 2012

Conclusion (1/2)

- Japan was able to achieve the target of a 6% reduction in GHG emissions relative to the 1990 level in the first commitment period of the KP.
- The VAP made an important contribution to the achievement of Japan's emission target for the KP through plural review processes within the PDCA cycle.
- It is not easy to judge whether emission reduction efforts have been conducted appropriately because each subject (e.g., country, industrial associations, company) has to take actions under very different conditions. This study tried a comprehensive evaluation using several analyses.
- According to the international comparison analyses for the emission reduction measures, the energy intensity relative to GDP in Japan is good but is not necessarily the best in the world, depending on the market exchange rate, industrial structures etc. However, when energy intensity level in major sectors across countries, marginal abatement costs etc. are evaluated together with the energy intensity of GDP, it is judged that large efforts have been made for emission reductions in Japan.

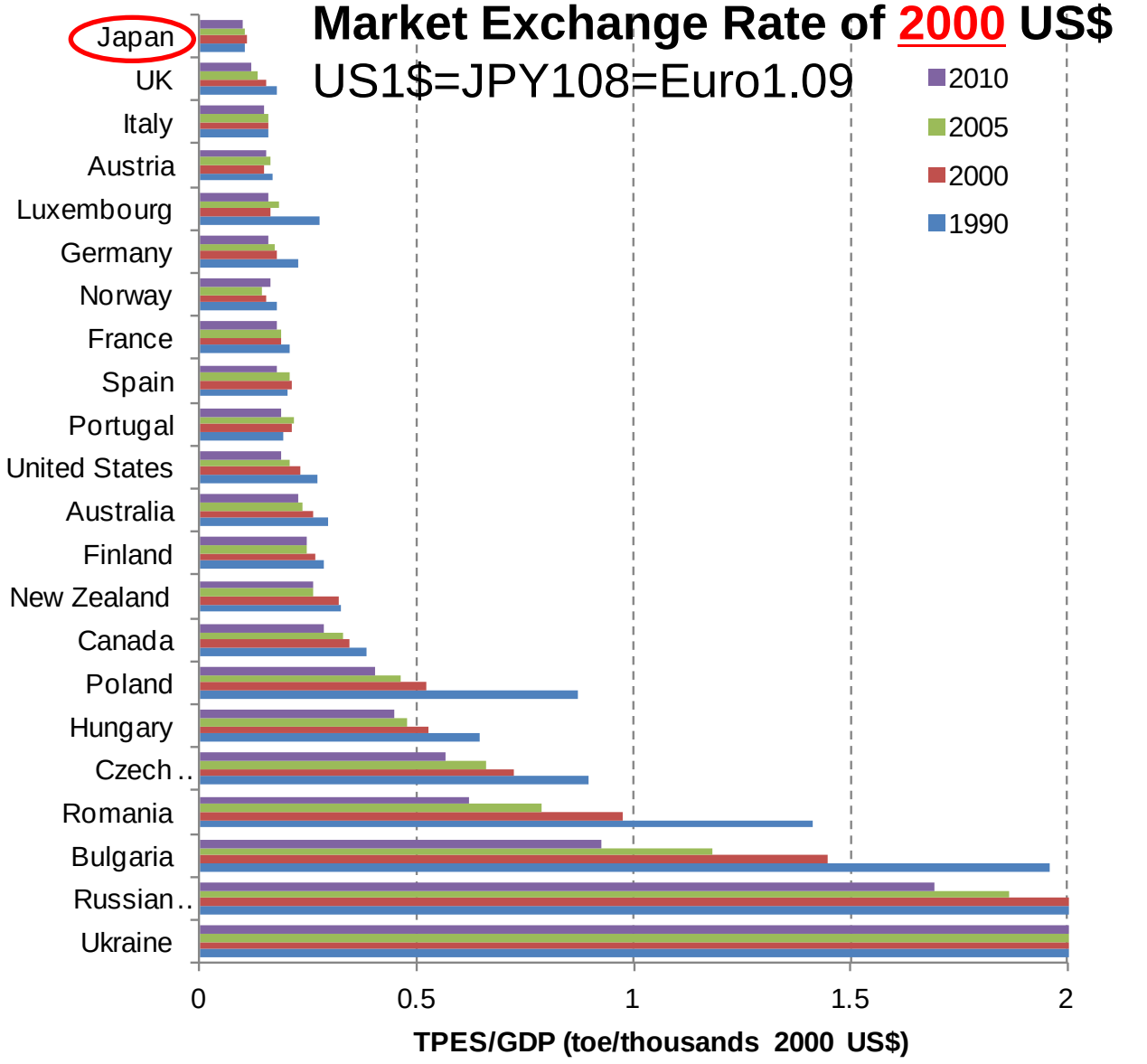
Conclusion (2/2)

- According to the quantitative analyses for emission reduction measures of industrial associations participating in the Voluntary Action Plan, the energy intensities of some of the associations increased (worsen), and the amount of energy consumption of some of the associations increased. However, according to the analysis result for explanations of between production activity changes and energy intensity changes, the worse in energy intensities can be largely explained by the worse in production activity.
- This study also indicates that emission reduction measures with considerable costs were conducted even under the Voluntary Action Plan, although the cost estimates are relatively high uncertain.
- The participating associations reported their actions and results to the Keidanren and the government and were annually reviewed by their respective committees. In addition, the peer review systems were considered to have worked well across the business associations within the Keidanren and across the member companies under each business association, with peer pressure having an effect on their efforts.

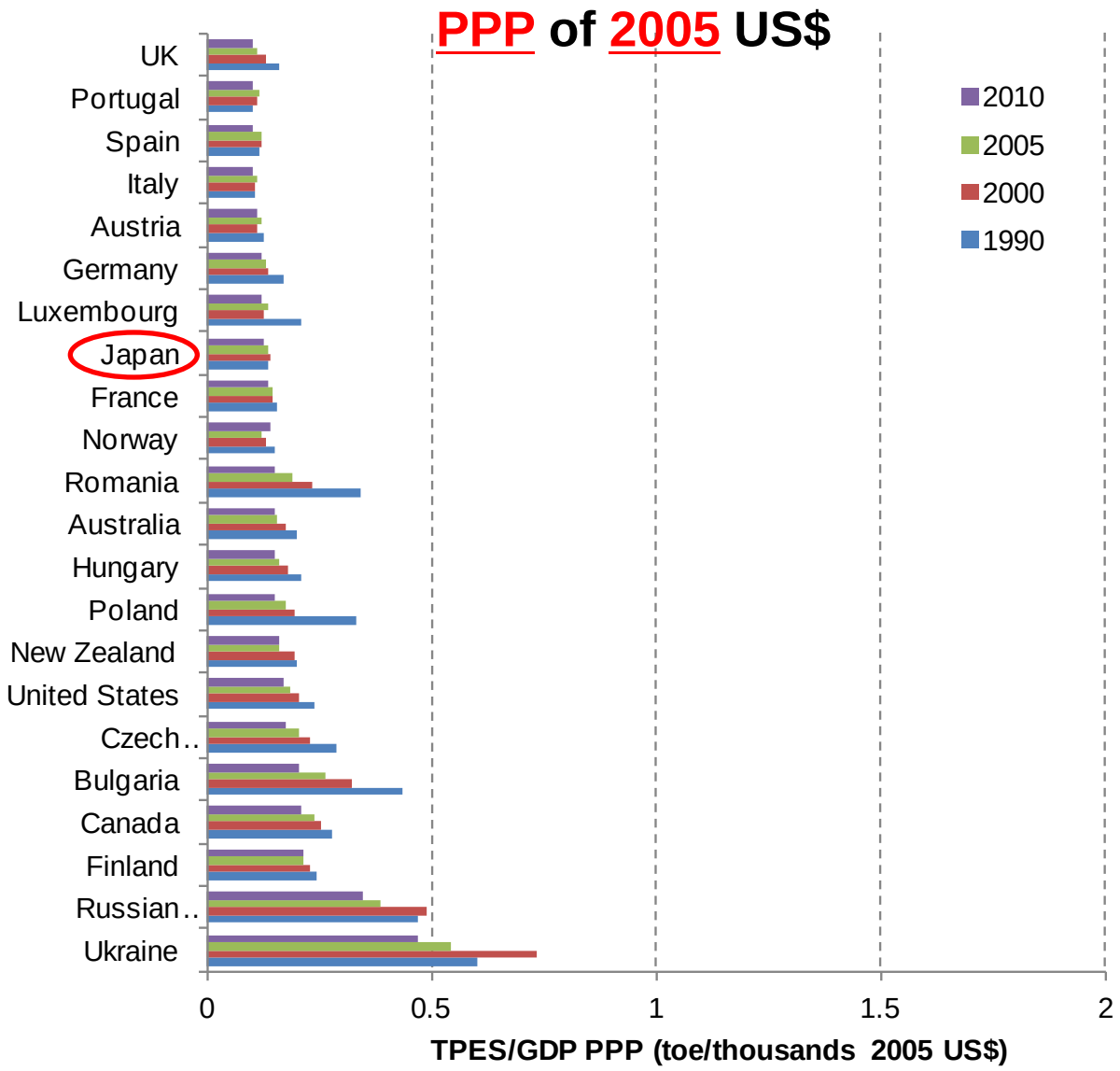
Appendix

Comparison of Energy Intensity Measured by MER2000US$ among Annex I Countries

- Japan's energy intensity level is the highest when it is calculated by using market exchange rate of 2000 US$.



Comparison of Energy Intensity Measured by PPP among Annex I Countries



Energy Assessment Model: DNE21+

- Linear programming model (minimizing world energy system cost)

  When any policy (e.g., emissions reduction targets, specific efficiency improvements goals, carbon taxes) are applied, the model finds out the energy systems whose costs are minimized.

- Evaluation time period: 2000-2050

  Representative time points: 2000, 2005, 2010, 2015, 2020, 2025, 2030, 2040, 2050

- World divided into 54 regions

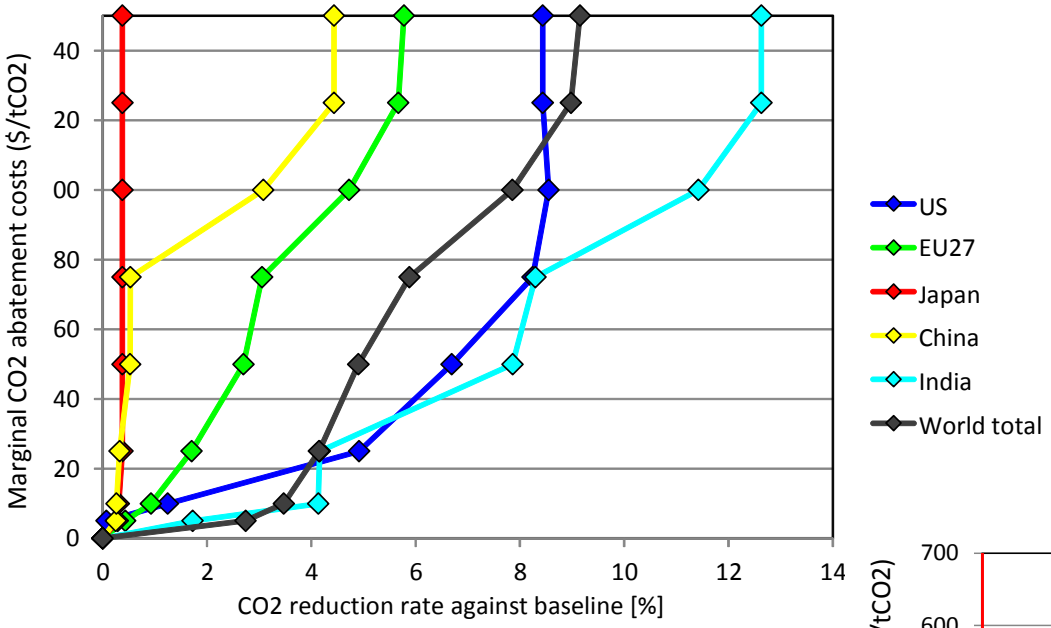
  Large area countries are further divided into 3-8 regions, and the world is divided into 77 regions.

- Bottom-up modeling for technologies both in energy supply and demand sides (200-300 specific technologies are modeled.)
- Primary energy: coal, oil, natural gas, hydro, geothermal, wind, photovoltaics, biomass, nuclear power, and ocean energy
- Electricity demand and supply are formulated for 4 time periods: instantaneous peak, peak, intermediate and off-peak periods
- Interregional trade: coal, crude oil, natural gas, ethanol, hydrogen, electricity and CO_2
- Existing facility vintages are explicitly modeled.

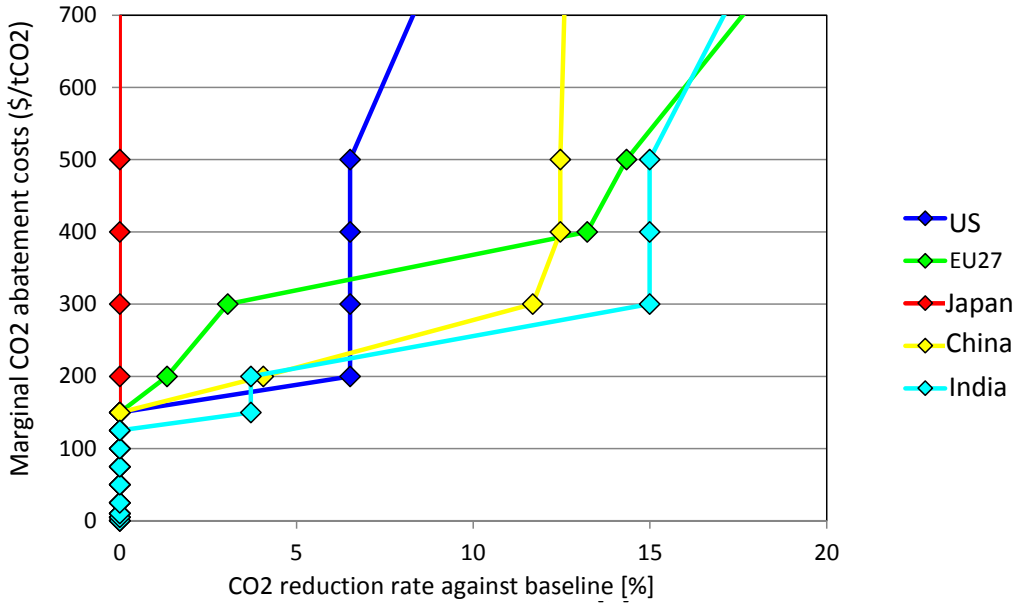
The frame work of the DNE21+ model is similar to the IEA ETP model.

2010 marginal abatement cost estimates for major sectors using a technology-oriented bottom-up model

Iron and Steel



Cement



With high energy efficiency levels, marginal abatement costs are high for Japan's iron & steel and cement sectors, and thus little room for further reductions.

Electricity emission intensity based on respective national data for 2010.

Energy-Economic Model: DEARS

(Dynamic Energy-economic Analysis model with multi-Regions and multi-Sectors)

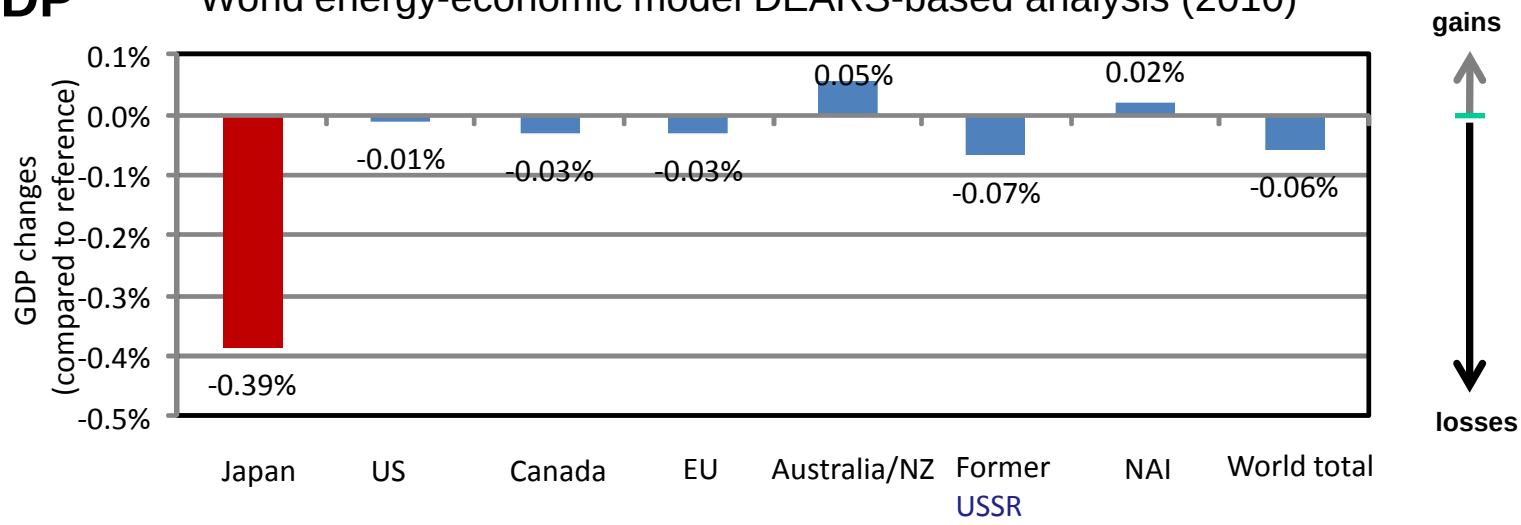
- Integration model of top-down-typed economic module and bottom-up-typed energy systems module
- Dynamic non-linear optimization model (Maximization of global consumption utility)
- Evaluation time period: up to middle of this century (10 years steps)
- World divided into 18 regions
- Non-energy sector into 18 sectors
- Energy：8 types of primary energy and 4 types of secondary energy
- Economic module that represents international economic structures based on input-output tables of GTAP (Global Trade Analysis Project) database
- Simplified energy systems module
  - ✓ Bottom-up modeling for technologies in energy supply (e.g., power generation) and CCS (carbon capture and storage)
  - ✓ Primary energy (8 types): Coal, Crude oil, Natural gas, hydro&geothermal, wind, photovoltaics, Biomass and Nuclear
  - ✓ Top-down modeling for energy demand (Residential sector: price and income elasticities of demand for energy and income, Industrial and transport sectors: price elasticiy. Those are linked to economic module.)
  - ✓ Final energy (4 types): Solid, Liquid and Gaseous fuels and Electricity

Assessment of impact on entire economy with an energy-economic model

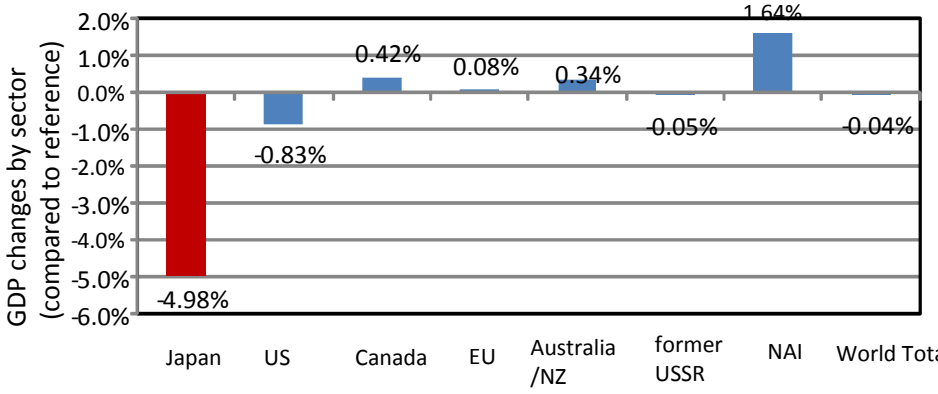
Assessing world economic impacts by treating marginal abatement costs estimated by technology-model (DNE21+ model) as exogenous condition in energy-economic model DEARS

(1) GDP

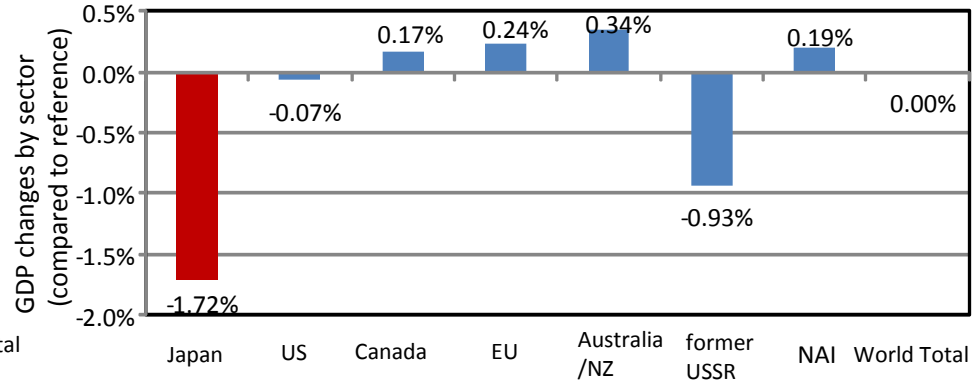
World energy-economic model DEARS-based analysis (2010)



(2)Iron and steel sector

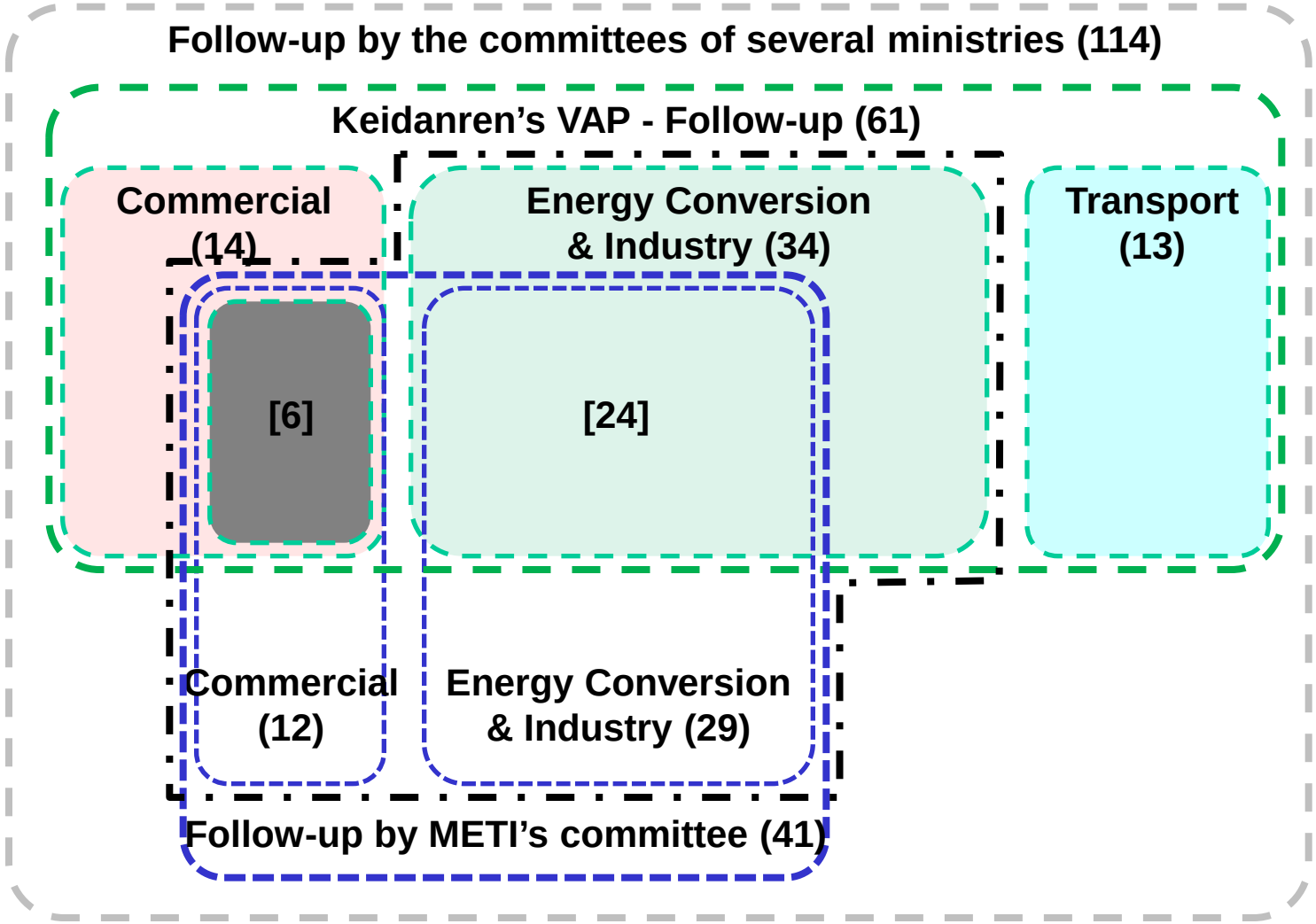


(3)Cement and ceramics sector(cement)

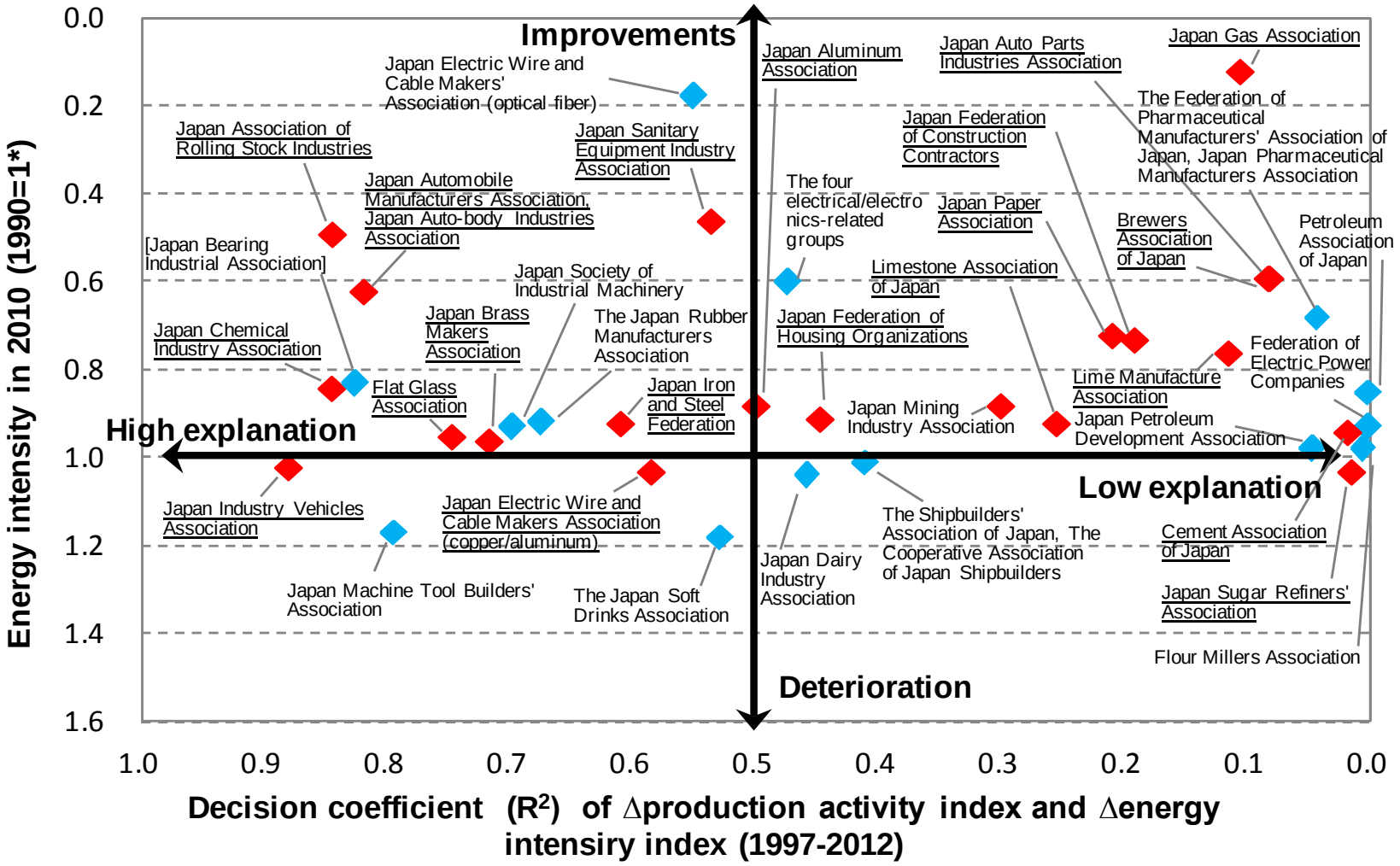


Larger economic impacts are estimated for Japan in terms of GDP loss and sector-specific added-value loss. Analysis for international economic impact is complex as reduced consumption affects production in other countries, etc.

The Participant Business Associations under the Follow-ups of Keidanren and Japanese Government



Energy intensity change in 2012 relative to 1990 and the explanations (R2) for annual improvement in energy intensity by annual increase in economic activity between 1997 and 2012 across industrial associations participating in VAP



Net CO2 emission reductions in 2012. ♦: emissions reduced from 1990 levels, ♦: emissions increased from 1990 levels

-Evaluations including periods after Great East Japan Earthquake need be carefully conducted as capacity utilization ratio drops and increased use of non-utility power generating facilities were induced by earthquake.

Comparison of Voluntary Action Plan and Tokyo Cap and Trade Program (Building Sector)

Items	Voluntary Action Plan (RECAJ*)	Tokyo Cap and Trade (offices)
Major targets	energy consumption per unit floor area	CO2 emission reduction from baseline -8%/-6%
Index	energy intensity	energy-related CO2
Period	1997-2012	First phase:2010-2014 Second phase : 2015-2019
Rate of change 2010=>2011	(energy intensity) -11.0%	(CO2 emissions) -11.5%
Compliance period	annual	five years
Participants	industry groups	business operators (facilities, under EUETS)
Credits	Kyoto mechanism credits applicable	domestic credits only

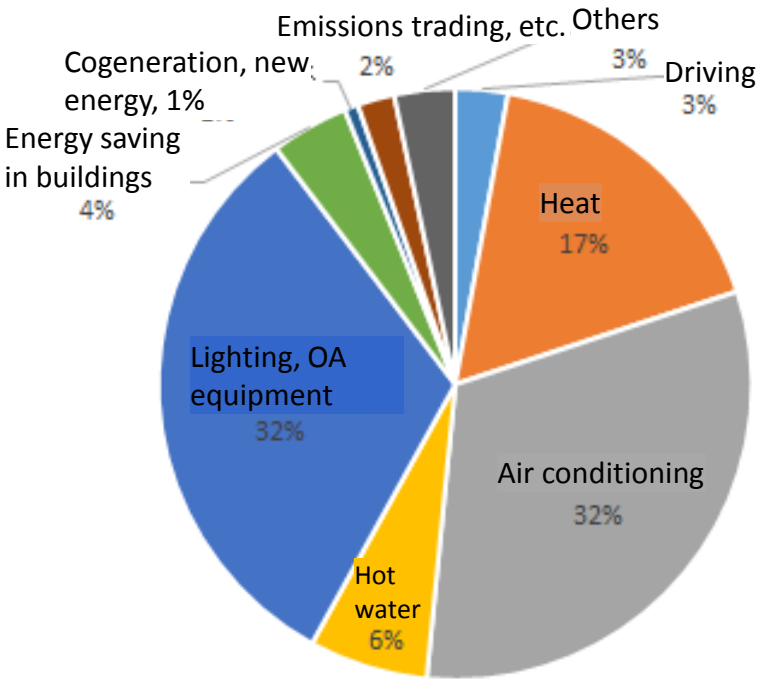
- VA involves many energy-intensive industries while Tokyo Cap and Trade mainly covers large buildings.
- Limitation in available and comparable data

  →**Comparisons of measures** taken by office sector
- Despite large differences in terms of approaches, comparison of actual measures implemented revealed similar level of efforts, including use of credits.

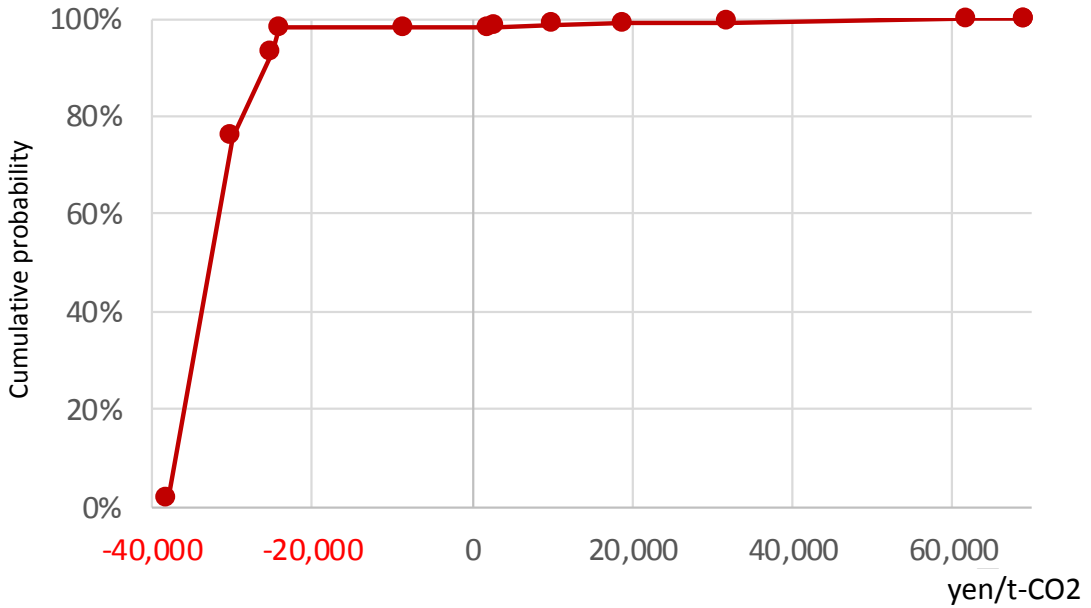
*RECAJ: The Real Estate Companies Association of Japan

Features of Tokyo Cap and Trade Program

Measures taken under Tokyo Cap and Trade (offices)



Cumulative distribution of measures by cost



Note: Costs for reduction measures varied, this study basically employed costs provided by reduction option in *Evaluation of cost benefits (B/C) based on a consideration of costs incurred by low-carbonization in the household and office sector and non-energy benefits (NEB)* (2009). For data deficiencies, additional data provided from Nishio et al (2011) *Cost benefits and barriers to energy efficiency measures in the office sector* and Tokyo Metropolitan Government Bureau of Environment (2013) *Total emission reduction obligations and assessment of transaction prices under Tokyo Cap and Trade Program*

-**M**easures under Tokyo Caps and Trade mostly require little cost, with measures less than 0 yen accounting for 98.1% of all measures. Caps and trades programs do not necessarily entail stringent measures.
- Careful administrative action in order to remove barriers to energy efficiency; and hence, significant additional costs on the part of administrative and business operators.
- Inactive emissions trading. Credit purchases centered on Tradable Green Certificates, purchased for CSR purposes.

Case studies of reduction costs for emission reduction measures (iron and steel)

Case 1. Replacement with combined cycle at joint thermal power plants

- Replacement of existing steam-powered units with combined-cycle units despite uncertainties of future iron and steel demand forecasts
- Compared with steam-powered units allowing highly flexible operation, combined-cycle units entail investment of 2700 yen/tCO2 (when five-years payout time is adopted)

Case 2. Charging waste plastics into coke oven

- One of few options for CO2 reduction, utilization of waste plastic rapidly increased in 2000
- However, investments in waste plastic co-coking plants amounted to approx. 13000 yen/tCO2 (when five-years payout time is adopted)
- Actual trends beyond 2005 reveal tendency to avoid investment in facilities using waste plastic co-coking technologies.

Under Voluntary Action Plan, certain costs have been accepted for efforts to reduce CO2 emissions. However, case studies imply that cost-inefficient investments are being avoided.