COP24 side-event: Mitigation Policy Choices and Levels of Effort

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Evaluations on emission reduction efforts of NDCs and the Implications of Global Effectiveness on Climate Change Mitigation

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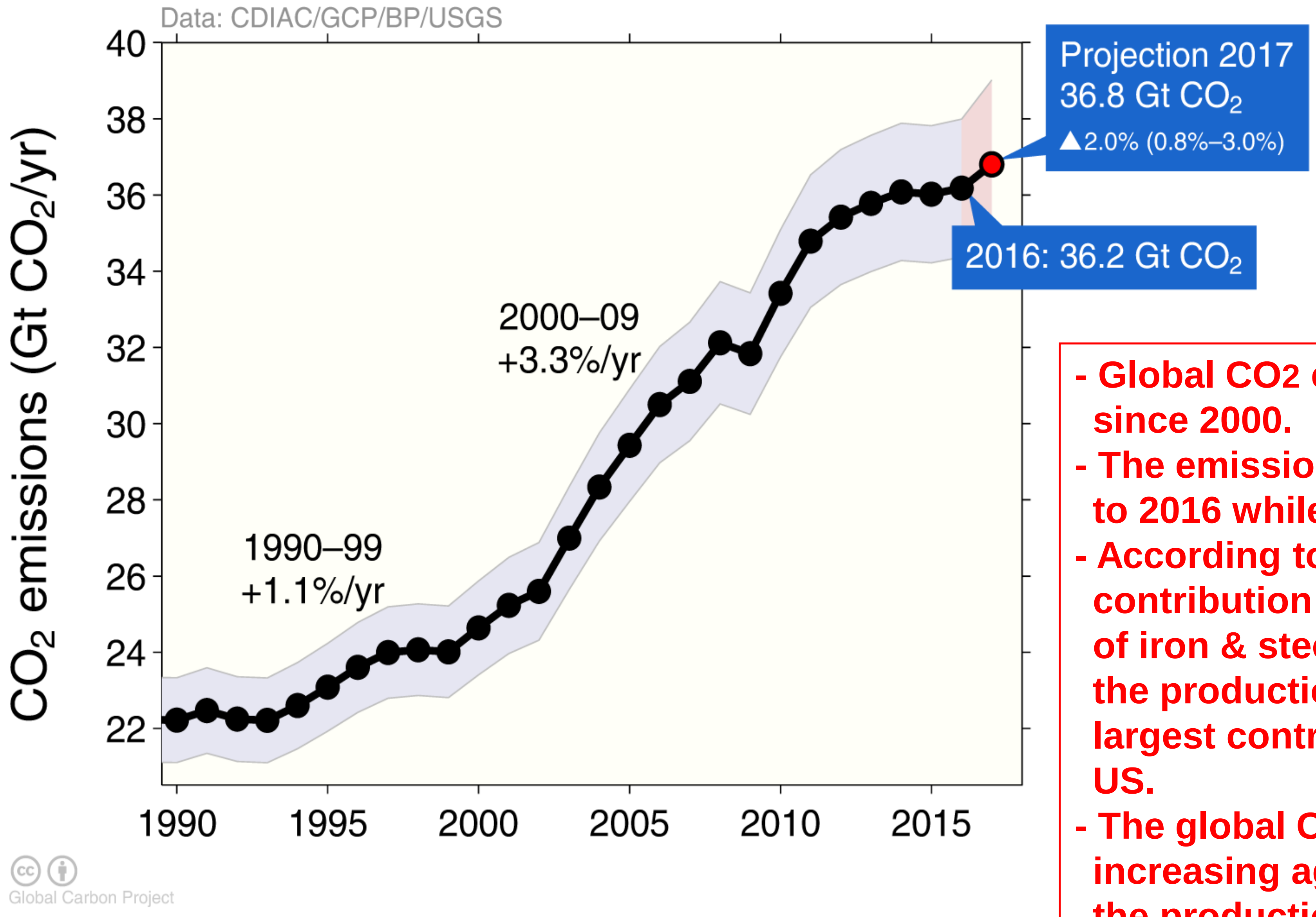
Global CO_2 Emissions Trajectory

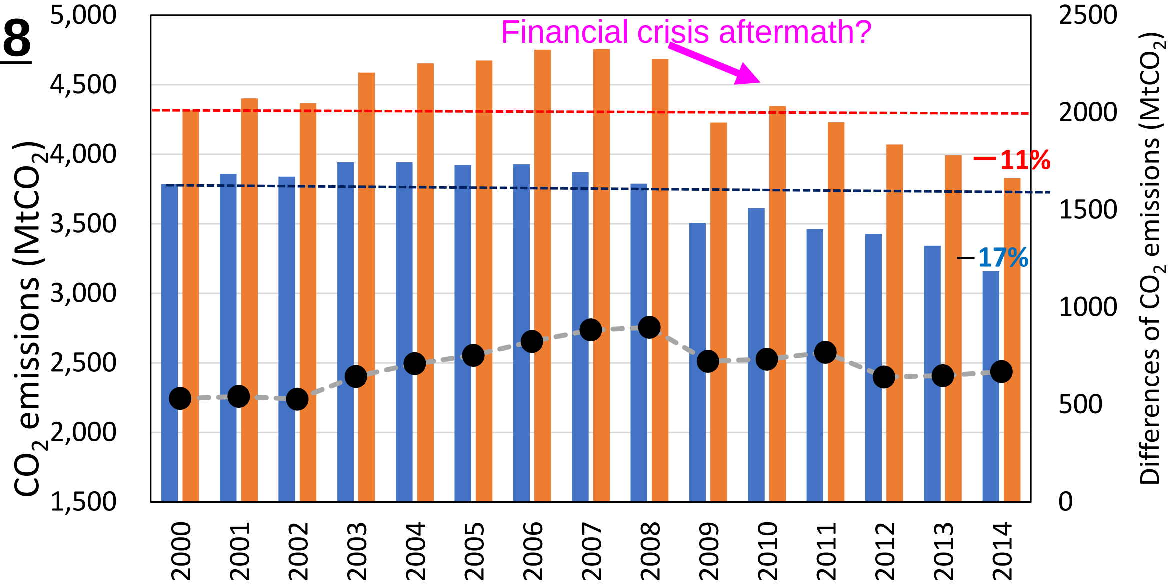


Source) Global Carbon Project

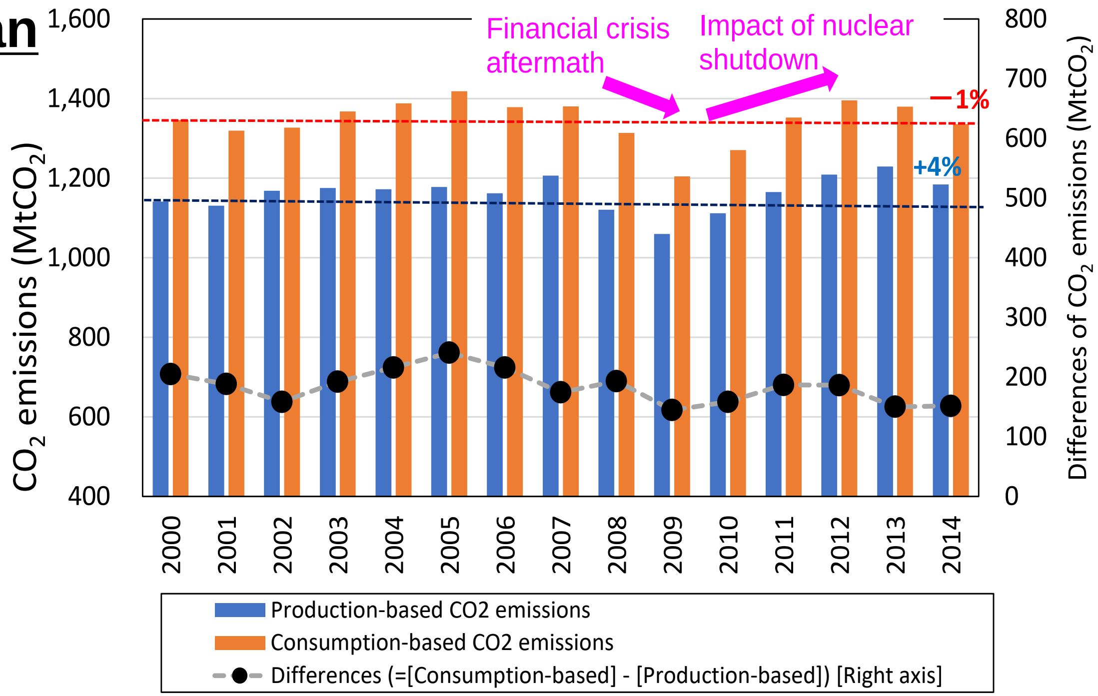
- Global CO_2 emissions increased more rapidly since 2000.
- The emissions were almost constant from 2013 to 2016 while the global GDP increased.
- According to our analysis, the largest contribution was due to production adjustments of iron & steel etc. mostly in China (since 2010, the productions were too large), and the second largest contribution was due to shale gas in the US.
- The global CO_2 emissions after 2016 are increasing again due to mainly mitigations of the production adjustments in China.

Production-based & Consumption-based CO2 emissions

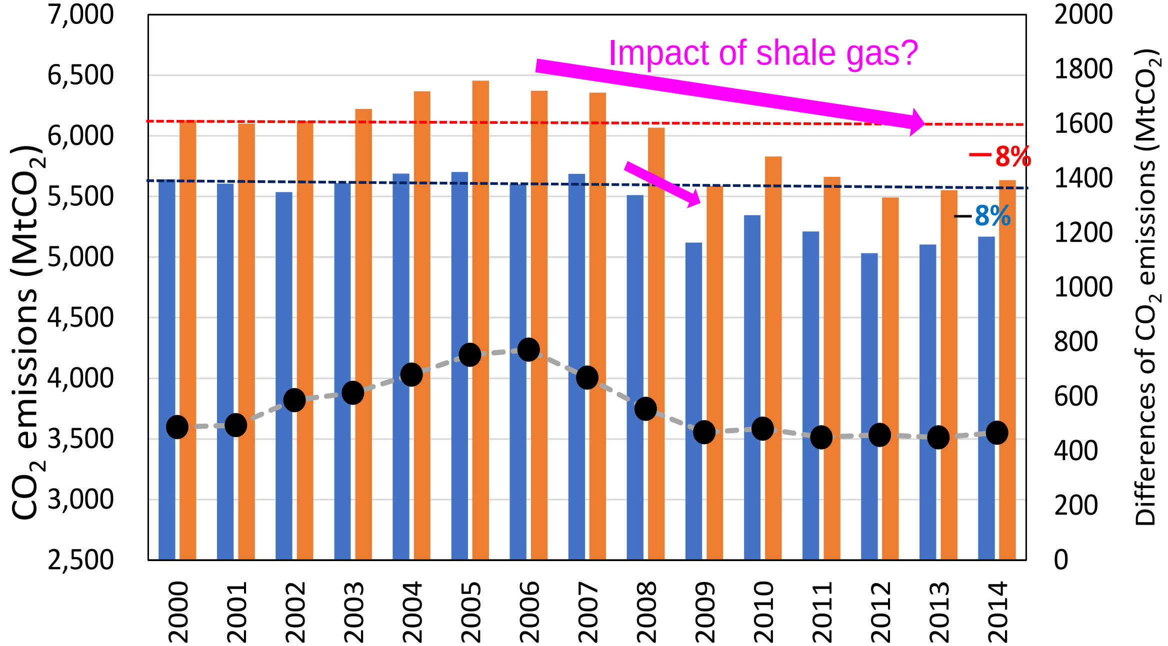
EU28



Japan



US

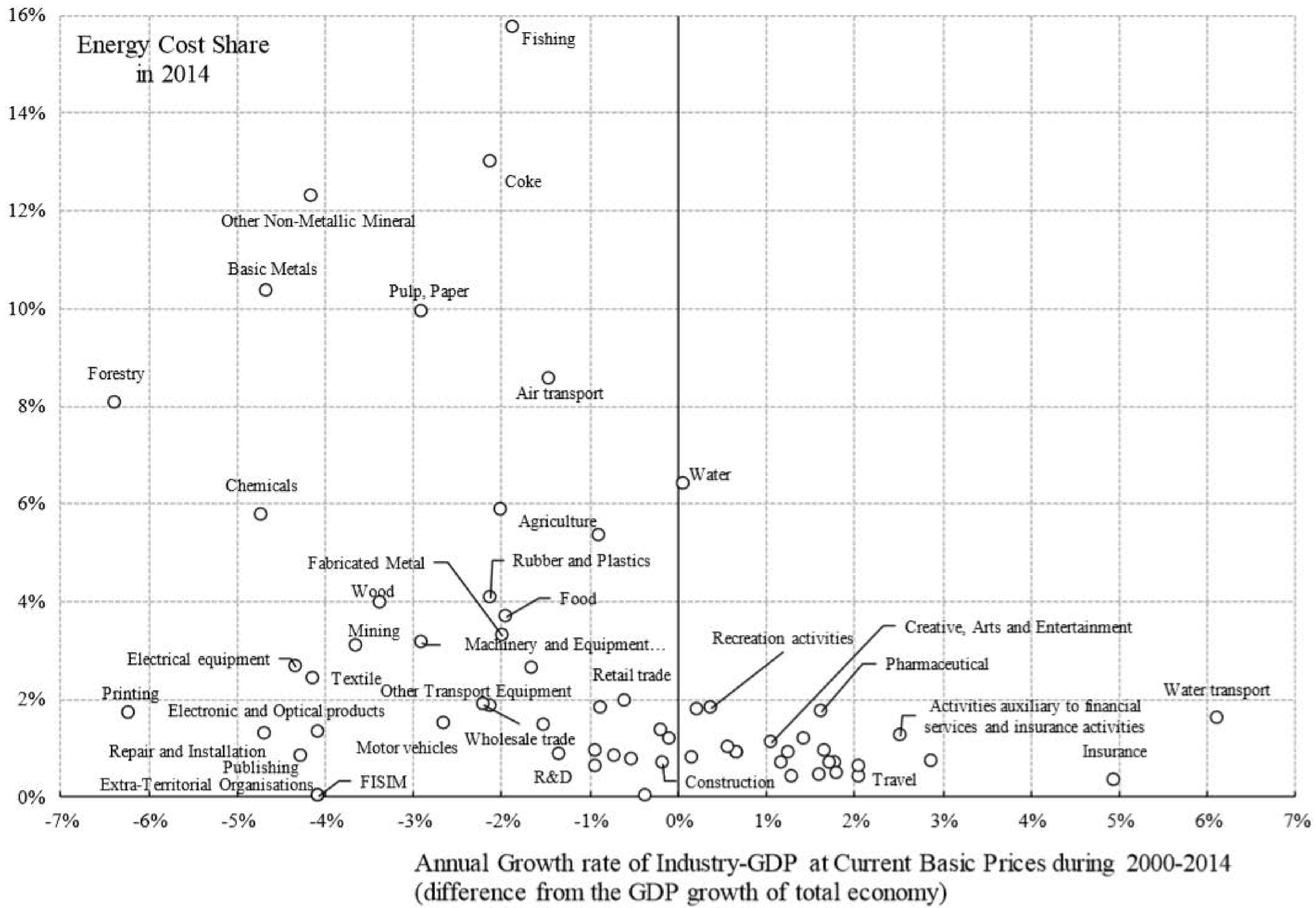


Source: estimated by RITE

- The embodied emissions in trade (difference between Consumption-based CO2 and Production-based CO2) increased in EU, almost constant in the US, and slightly reduced in Japan between 2000 and 2014.

- Climate policies and other kinds of policies affect domestic emissions and also global emissions through international trade.

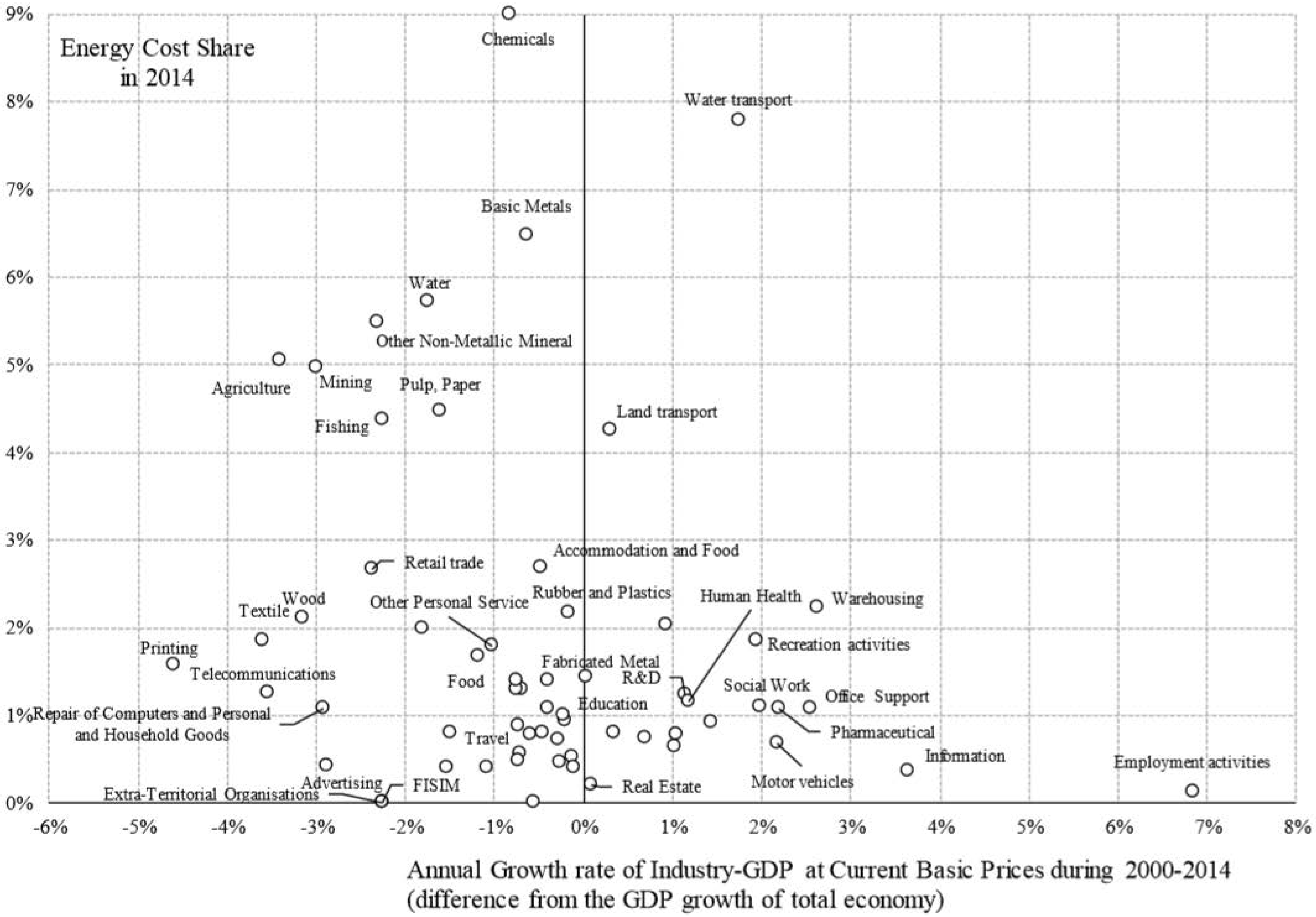
Energy cost share (2014) vs Economic growth (2000-14) of industrial sectors in UK



Source: K. Nomura, https://www.dbj.jp/ricf/pdf/research/DBJ_RCGW_DP60.pdf (in Japanese)

The industrial sectors having high share of energy costs in the total costs showed relatively small growth rate between 2000 and 2014. These sectors shifted outside the UK according to the analyses of consumption-based CO2 emissions.

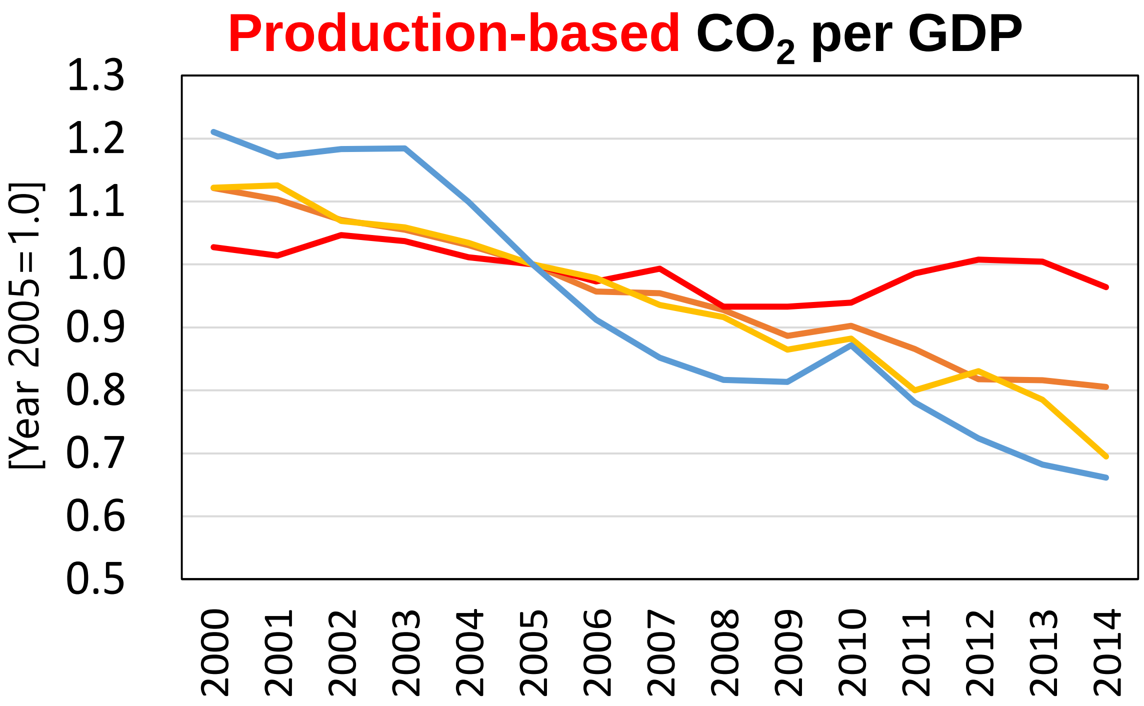
Energy cost share (2014) vs Economic growth (2000-14) of industrial sectors in Germany

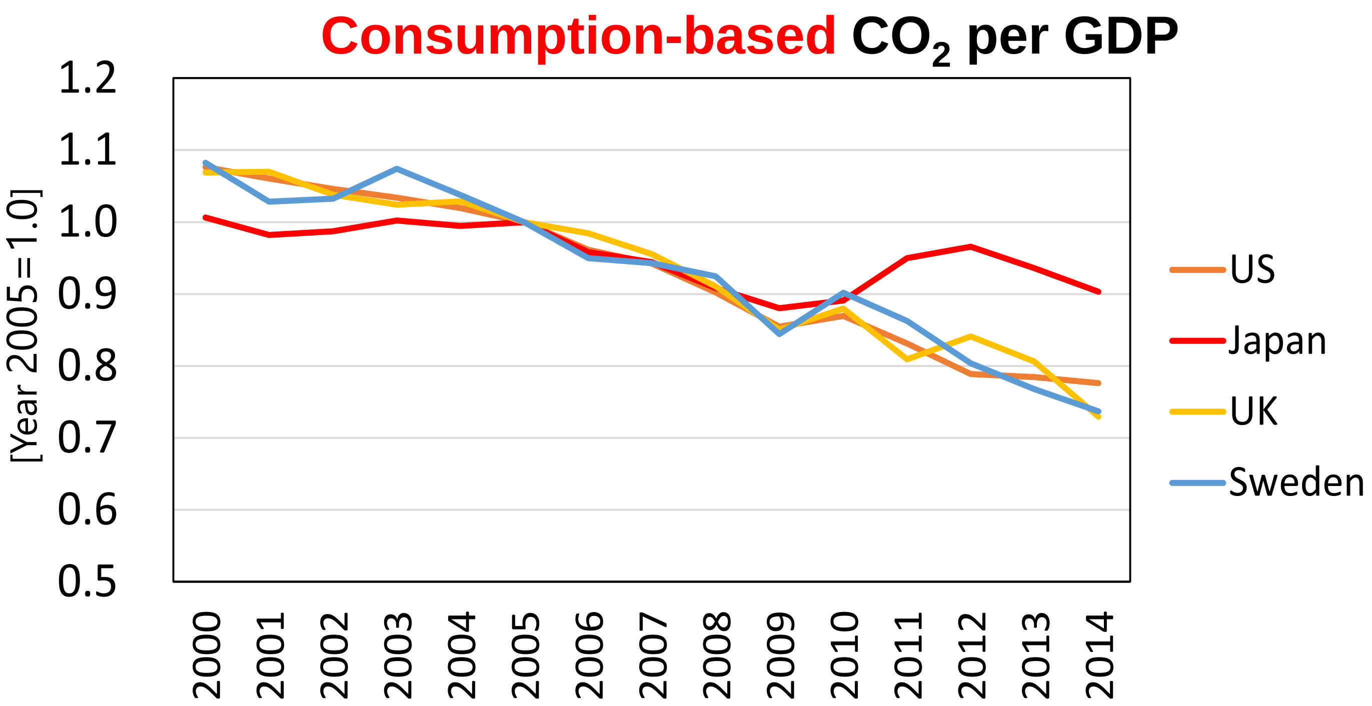


Source: K. Nomura, https://www.dbj.jp/ricf/pdf/research/DBJ_RCGW_DP60.pdf (in Japanese)

Employment activities and information service sectors whose share of energy cost are relatively small achieved relatively high economic growth between 2000 and 2014 in Germany. Relatively cheap Euro compared with the industry competitiveness of Germany helped motor vehicle sectors to achieve relatively high growth.

Per-GDP CO2 Emission in US, UK, Sweden and Japan: Production-base v.s. Consumption-base





Note: 2010 local currency base

Source: estimated by RITE

- In terms of the production-based CO2 emissions per GDP, the degrees of improvement of the four countries differs greatly.
- However, concerning the consumption-based emissions, the improvement rates of the four countries do not differ that much when excluding the impact of Japan’s emission increase due to the shutdown of nuclear power generation after the Fukushima Daiichi nuclear power accident during the Great East Japan Earthquake.
- Focusing only on production-based emissions may lead to wrong interpretation of emission reduction efforts of individual nation.

How to measure the comparability of efforts of NDCs

The Paris Agreement allows pledges of various type emission reduction targets and adopts a review process for them.

The submitted Nationally Determined Contributions (NDCs) include the targets of emissions reduction from different base years, CO_2 intensity, and CO_2 emission reductions from baseline (w./w.o. clear definition of baseline).
We need to interpret them through comparable metrics to measure the efforts:

- Simple metrics (easily measurable and replicable)
  - Emissions reduction ratios from the same base year etc.
- Advanced metrics (more comprehensive, but require forecasts)
  - Emission reduction ratios from baseline emissions
  - Emissions per unit of GDP etc.
- More advanced metrics (most comprehensive, but require modeling)
  - Final energy prices
  - Marginal abatement cost (per ton of CO_2)
  - Abatement costs as a share of GDP etc.

and the effects on international competitiveness of the NDCs are significant for sustainable measures.

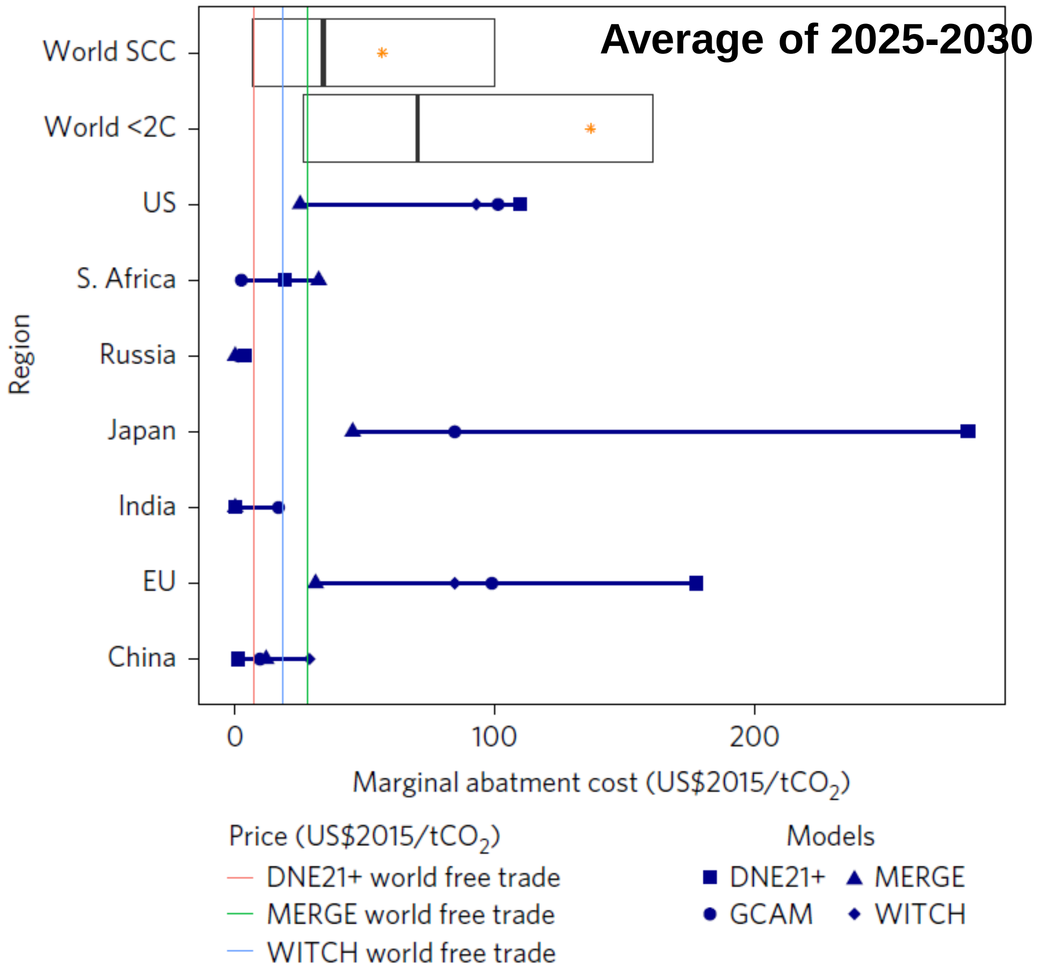
Emissions reduction ratio from base year of NDCs for major countries

	Emissions reduction ratio from base year		
	From 1990	From 2005	From 2013
Japan：in 2030, -26% from 2013 levels	-17.8%	-24.3%	**-26.0%**
US： in 2025, about -26 to -28% from 2005 levels	-15 to -17%	**-26 to -28%**	-19 to -21%
EU28： in 2030, -40% from 1990 levels	**-40%**	-35%	-24%
Russia： in 2030, -25% to -30% from 1990 levels	**-25 to -30%**	+13 to +6%	+7 to 0%
China： in 2030, CO_2 intensity of -60% to -65% from 2005 levels	+406 to +343%	**+96 to +72%**	+17 to +2%

Underlined: official NDCs, Others: estimated by RITE

Emission reduction ratios vary depending on the base year. The emission reduction ratios of NDCs cannot be used directly for comparison of emission reduction efforts, mainly because the base years are different across the nations.

CO2 marginal abatement costs of the NDCs

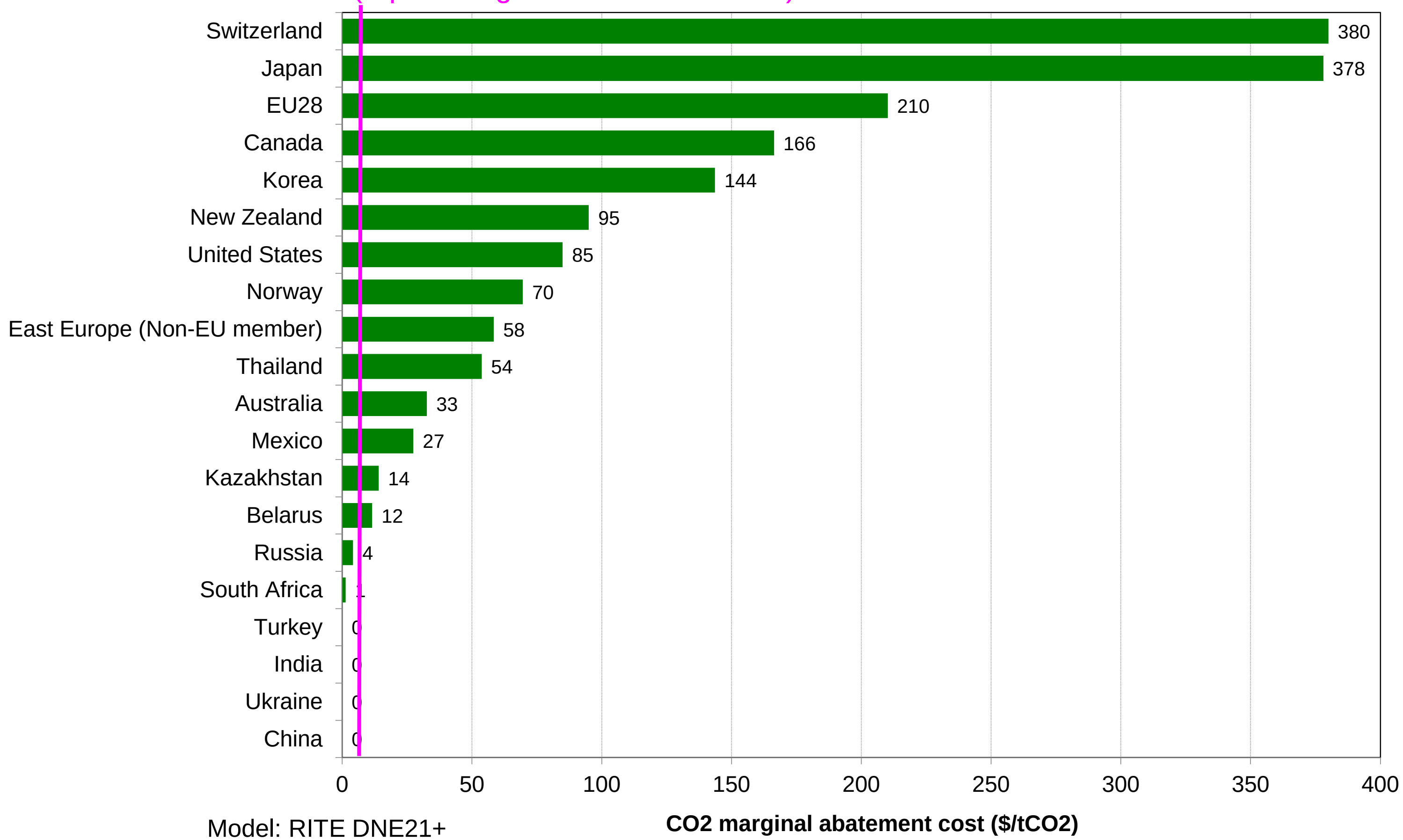


Source: J. Aldy et al., Nature Climate Change, 2016

2030 (2025 for the U.S.)

【World GDP loss due to mitigation】 NDCs:0.38%; the global least cost：0.06%

The least cost (equal marginal abatement costs)：6$/tCO2



Model: RITE DNE21+

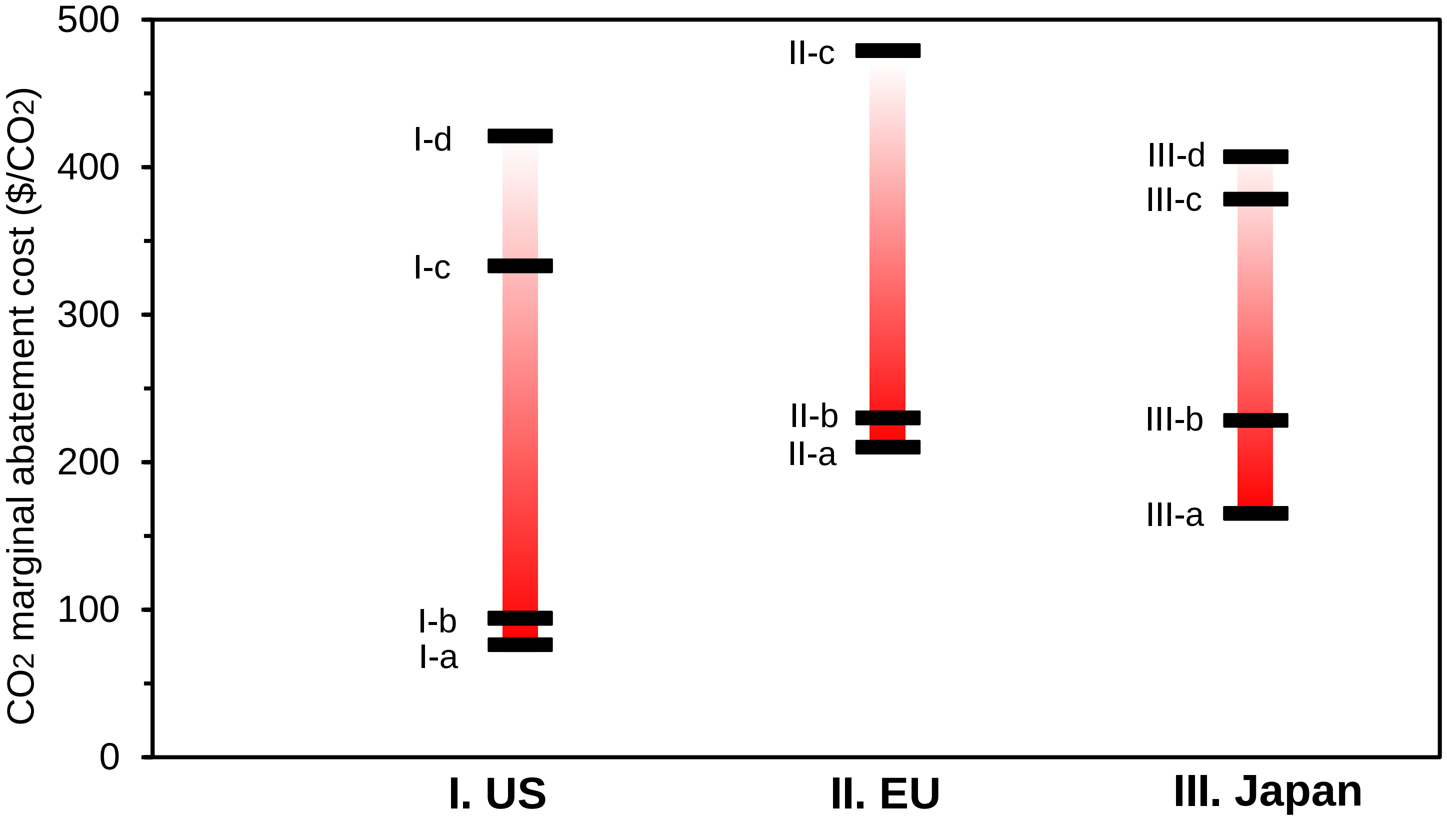
Source: K. Akimoto et al., Evol. Inst. Econ. Rev., 2016

The estimated marginal abatement costs of NDCs are largely different among countries, and therefore the world total mitigation costs are much larger than those for achieving the aggregated emission reductions under the least cost measures, i.e., under globally uniform MAC.

CO_2 marginal abatement cost for the U.S, EU and Japan considering several kinds of policy constraints

		Assumptions
United States	I-a	26% reductions relative to 2005 with least cost measures
	I-b	28% reductions relative to 2005 with least cost measures
	I-c	26% reductions relative to 2005. The amount of emission reductions in power sector proceeds according to the estimates for the Clean Power Plan by EPA.
	I-d	28% reductions relative to 2005. The amount of emission reductions in power sector proceeds according to the estimates for the Clean Power Plan by EPA.
EU28	II-a	40% reductions relative to 1990 with least cost measures
	II-b	40% reductions relative to 1990 for both the UK and non-UK EU nations
	II-c	The emission reductions for EU-ETS sectors are determined by the planned emission allowances, and the non-ETS sectors fill the rest of reductions to meet the 40% reductions relative to 1990.
Japan	III-a	26% reductions relative to 2013 with least cost measures. Maximum share of nuclear power in electricity generation is assumed to be 20%.
	III-b	26% reductions relative to 2013 with least cost measures. Maximum share of nuclear power in electricity generation is assumed to be 15%.
	III-c	26% reductions relative to 2013. Electricity share assumed to be same as the energy mix of Japanese governmental plan.
	III-d	26% reductions relative to 2013. Electricity share assumed to be nuclear: 15%, renewables: 29%, others: same as the energy mix of Japanese governmental plan.

CO_2 marginal abatement cost for the U.S, EU and Japan considering several kinds of policy constraints



The annual total emission reduction cost ;

US: the cost for I-c is about 5.1 times larger than that for I-a.

EU: the cost for II-c is about 1.5 times larger than that for II-a.

Japan: the cost for III-c is about 2.2 times larger than that for III-a.

I-a: -26%; the least cost
I-b: -28%; the least cost
I-c: -26%; power sector according to CPP
I-d: -28%; power sector according to CPP
* CPP: Clean Power Plan

II-a: the least cost
II-b: Brexit (-40% for UK)
II-c: splitting into ETS and non-ETS sectors

III-a: the least cost under nuclear of maximum 20%
III-b: the least cost under nuclear of maximum 15%
III-c: following the NDC including the energy mix (nuclear of 20%)
III-d: following the NDC including the energy mix but nuclear of 15%

- It is not easy to achieve the least cost measures because there are various kinds of social and political constraints in each nation.

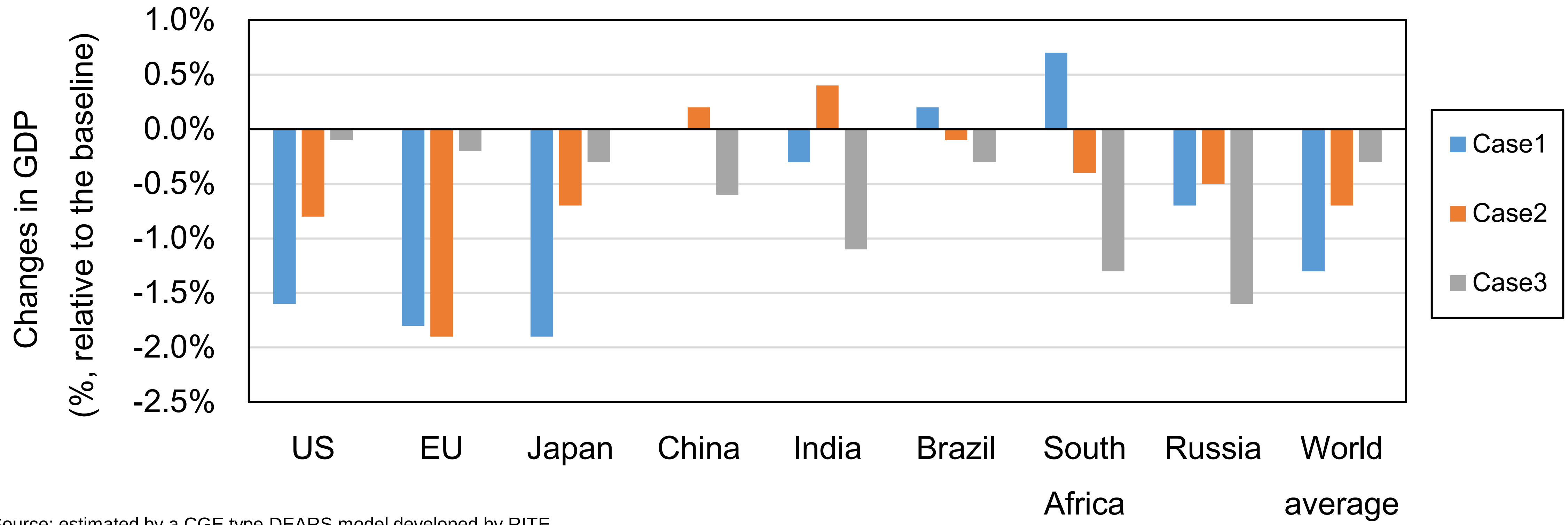
- The mitigation costs constrained by other policies can be much higher than those under the least cost measures.

Source: estimated by RITE DNE21+

Analyzed three cases for evaluating economic impacts of NDCs for major nations/regions

	Case 1: NDCs		Case 2: Equal MACs among sectors within each nation (Autarky)	Case 3: Equal MACs among nations and sectors (Global trade)
	National emission reduction targets in 2025/2030 without CO2 emission trading	**Other related policies**	**Individual achievement of national emission reduction targets without CO2 trading**	**Global achievement of aggregated emission reduction targets**
U.S.	26% GHG emission reduction in 2025 relative to 2005	CO_2 intensity of power generation: 462[gCO_2/kWh], & 27% renewables in TPES	Same emission reduction target as those in Case 1 without CO2 emission trading	National emission reduction targets in Case 1 are aggregated globally, with global CO2 emissions trading
EU	40% GHG reduction relative to 1990	20% renewables in TPES		
Japan	26% GHG reduction relative to 2013 (energy-related CO_2 emissions: 927MtCO_2)	Electricity share same as the energy mix of Japanese governmental plan.(22% renewables, 26% coal, 20% nuclear)		
China	65% reduction of CO_2/GDP relative to 2005	20% renewable in TPES		
India	35% reduction of GHG/GDP relative to 2005	40% non-fossil in power generation		
Brazil	43% GHG reduction relative to 2005	45% renewables in TPES		
South Africa	398-614 [MtCO_2eq.] GHG emissions	–		
Russia	27.5% GHG reduction relative to 1990	–		

Impacts of the NDCs on GDP for the major countries in 2030

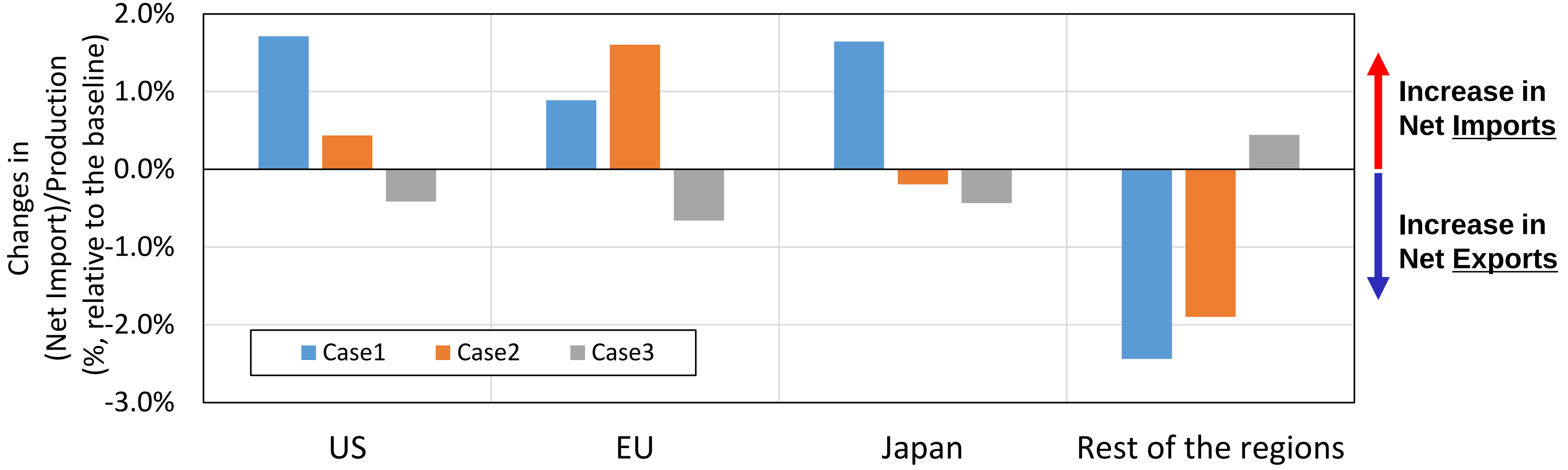


Source: estimated by a CGE type DEARS model developed by RITE

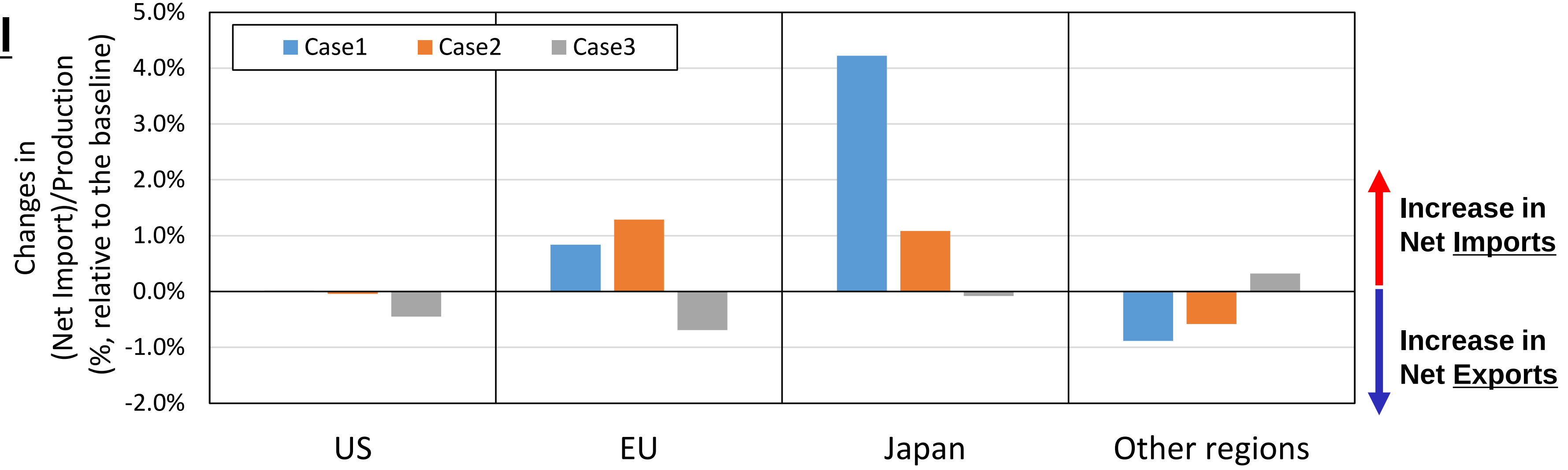
- For the U.S., the decreases in GDP in Cases 1 and 2 are 1.6% and 0.8% relative to the baseline, respectively. The estimated GDP loss in Case 1 is much higher than that in Case 2, mainly due to the constraints on carbon intensities of the power sector assumed in the proposed CPP.
- For EU, the decreases in GDP in Cases 1 and 2 are almost the same, because the renewable target is cost efficient for the 40% emission reduction target.
- For Japan, the decreases in GDP in Cases 1 and 2 are 1.9% and 0.7%, respectively. The energy mix of the Japanese governmental plan results in larger decreases in GDP and sectoral productions (the energy mix is determined not only by cost efficient emission reductions but also by energy security issues etc.).

Impacts on Trade in Chemical and Iron & steel sector in 2030

Chemical



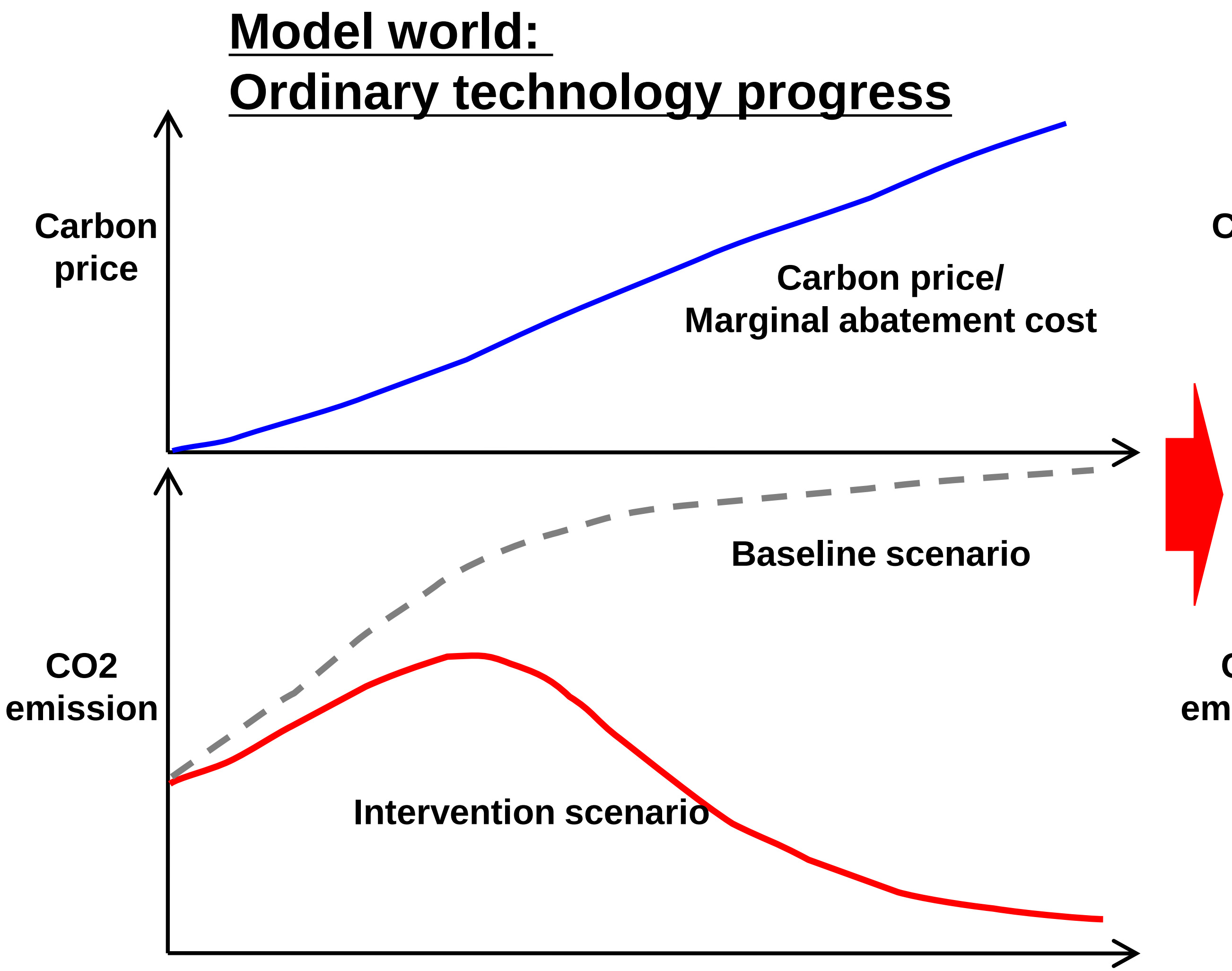
Iron & steel

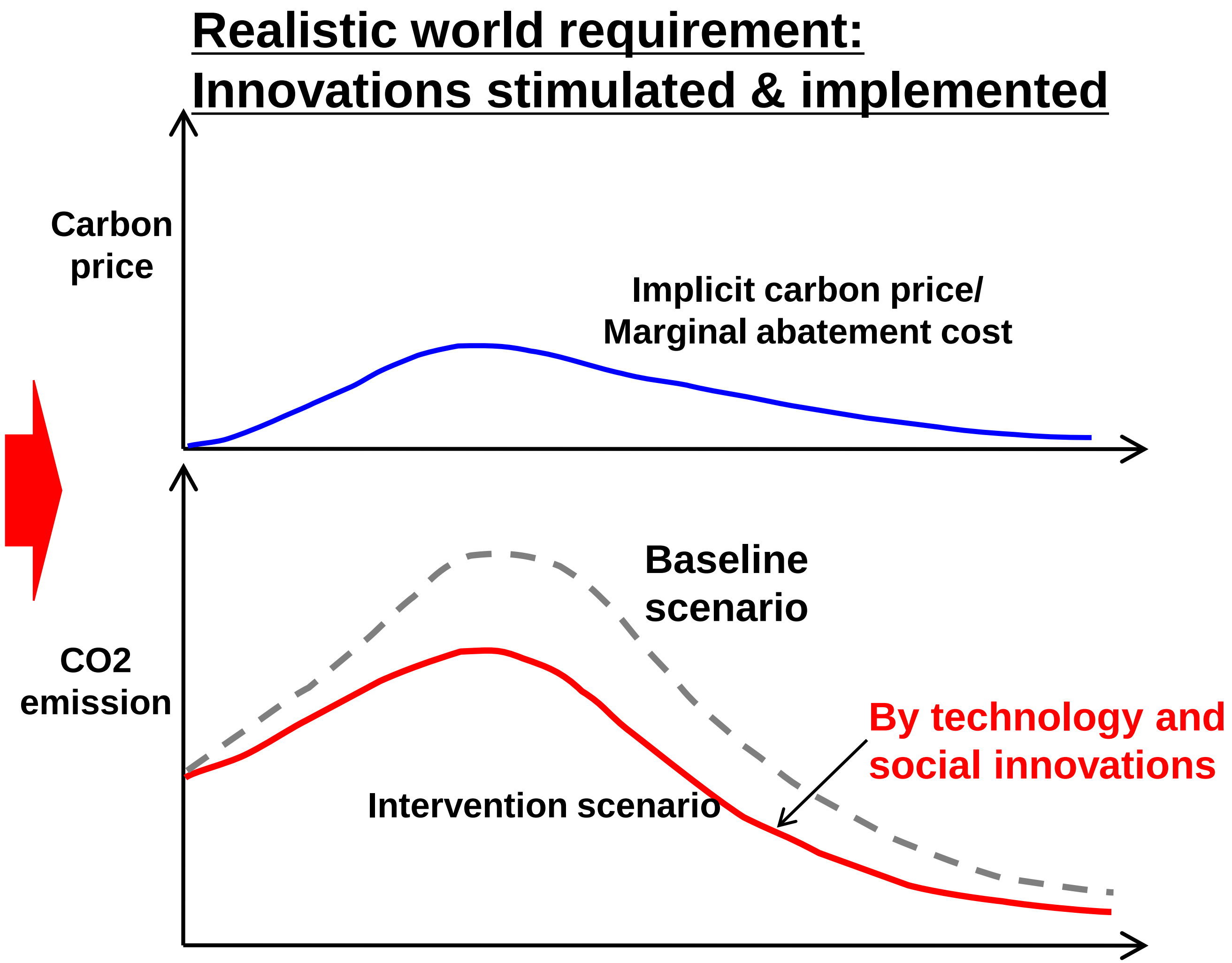


Source: estimated by a CGE type DEARS model developed by RITE

- The NDCs will make a large impacts on the potential international trade balances in Chemical sector in the US, EU and Japan, and in Iron & steel sector in Japan and EU. (Cases 1 and 2)
- Under the global emission trade case (equal MACs), the impacts will be relatively small. (Case 3)

Image of standard scenario by models and real world scenarios for deep cuts

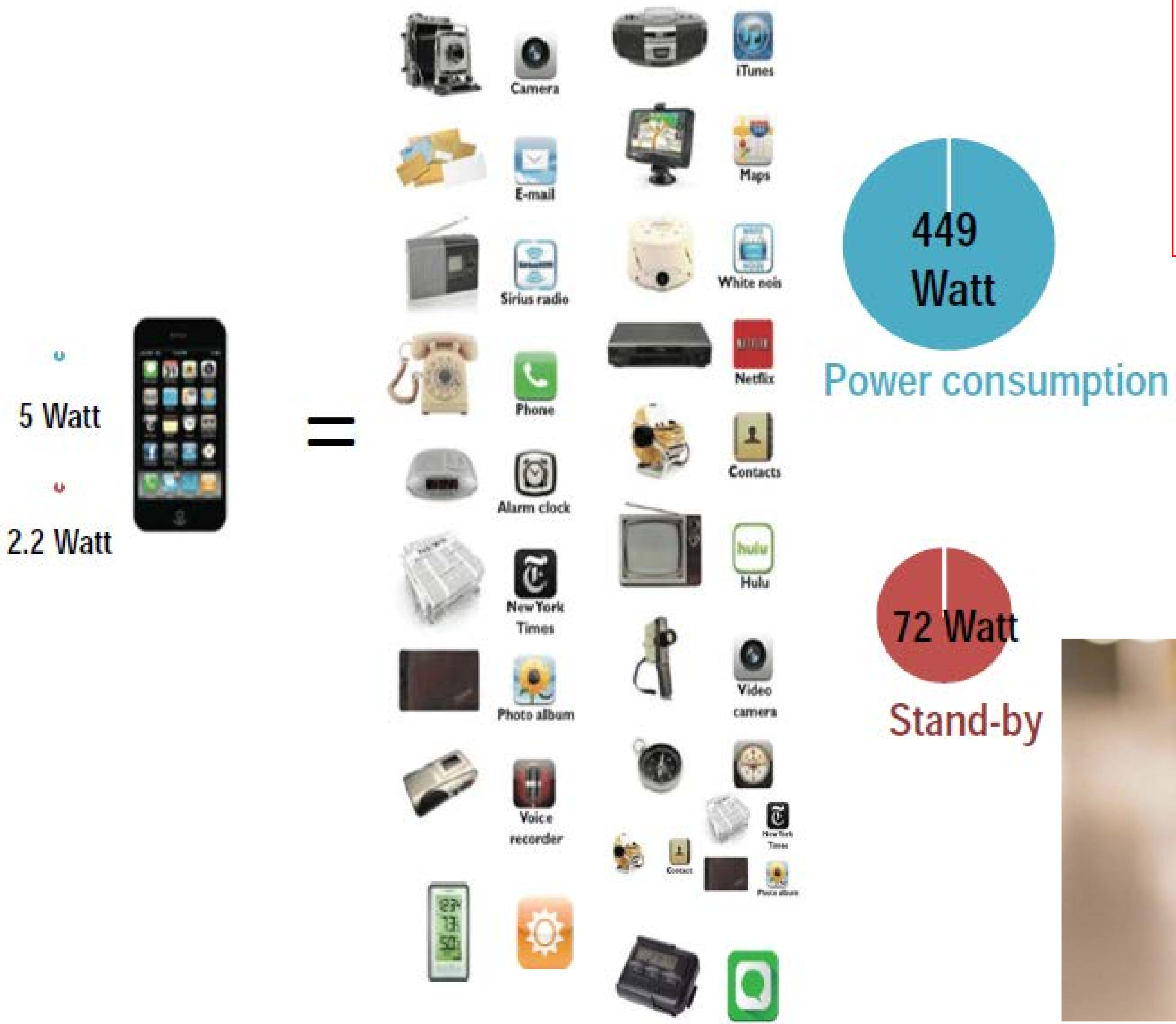




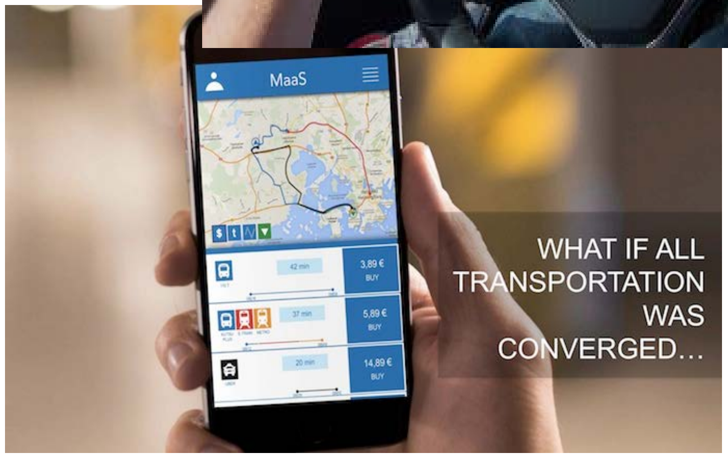
Explicit high carbon prices of such as over 100$/t$CO_2$ in real price are unlikely to be accepted in a real world. Technology and social innovations resulting in low (implicit or explicit) carbon prices (including coordination of secondary energy prices) are key for deep emission cuts to be implemented.

Innovations of end-use technologies and the induced social changes

- Wide range of technological innovations and their integrations are required for improving our welfare and sustainable development.
- AI, IoT, big data etc. will be able to stimulate such innovations.



Source: IIASA



Operation ratio of automobiles is about 4%, for example. The large room for the improvement exists by the achievement of complete autonomous cars.

Source: Finland

CO_2 marginal abatement cost in 2050 for 2 °C goal under the middle energy demand scenario vs low energy demand scenario with car- & ride-sharing

The global emissions in 2050: -40% compared to 2010
(corresponding to below 2 °C in 2100 with 50% probability)

CO_2 marginal abatement cost (MAC) in 2050

Middle energy demand scenario: SSP2	Low energy demand scenario: SSP1 with car- & ride-sharing
180 $/t$CO_2$	100 $/t$CO_2$

Unit: $/t$CO_2$ (real price);
Equal marginal abatement costs among all nations are assumed.
SSP: Shared Socioeconomic Pathway

Source: estimated by RITE DNE21+ model

MAC in SSP1 with car- and ride-sharing assumptions is much smaller than in the standard scenario, SSP2, due to achievement of low energy demands even in non-climate policies through the achievement of an economically efficient society induced by energy demand side innovations, such as IT, IoT and AI.

Conclusions

- Increasing trend of global CO_2 emissions continues.
- In some developed nations, a relatively long decreasing trend of the emission can be observed, but it was induced mainly by industrial structure change, and the consumption-based CO_2 emissions were not reduced in most of the nations. High energy cost burden induced the leakage of industries. The international competitiveness issue is very important.
- The marginal abatement costs for the currently submitted NDCs are greatly different among nations. Such large differences will hinder global efficiency of emission reductions and sustainable efforts of participating nation.
- Several social and political conditions hindering the least cost mitigation measures exist in each nation. Cheaper emission reduction measures should be pursued, but some of the realistically unavoidable constraints should also be considered.
- According to the assessments for the macro economic impacts, some developing nations/regions with almost zero marginal abatement costs will have positive impacts on GDP and on outputs of some energy-intensive sectors as carbon leakages take place through international trade. The coordination of the NDCs through the review process will be important.
- On the other hand, the coordination based on high carbon prices is unrealistic in the real world. The opportunities for decreasing energy demand, particularly through further improvements in IT, IoT or AI, will be expected for deep reductions with much lower mitigation costs.