COP25 side-event: Global Climate Change Policy

December 12, 2019

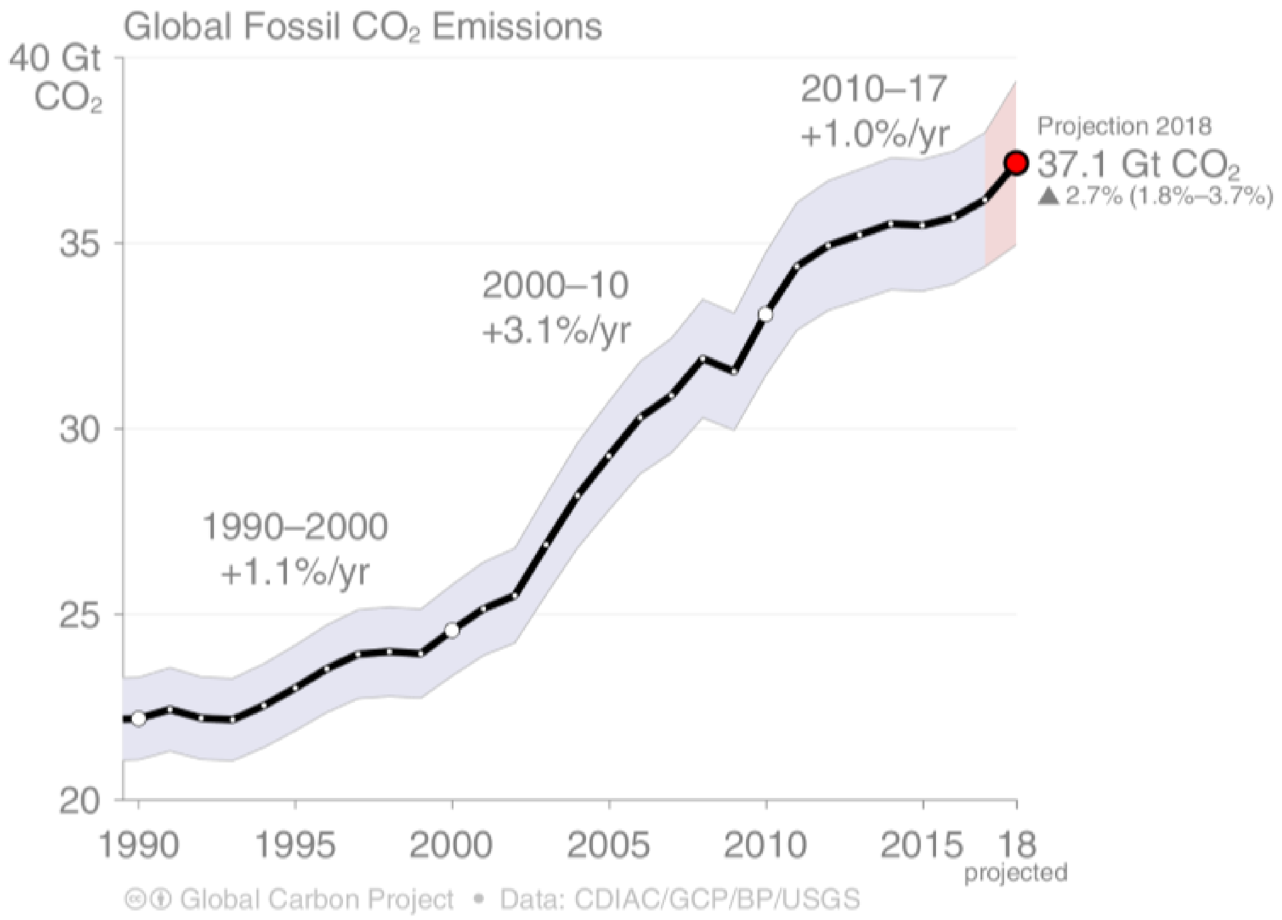
Evaluations on International Competitiveness of NDCs and the Role of Technological and Social Innovations toward the Paris Long-term Goals

Keigo Akimoto

Systems Analysis Group

Research Institute of Innovative Technology for the Earth (RITE)

Global CO2 Emissions Trajectory



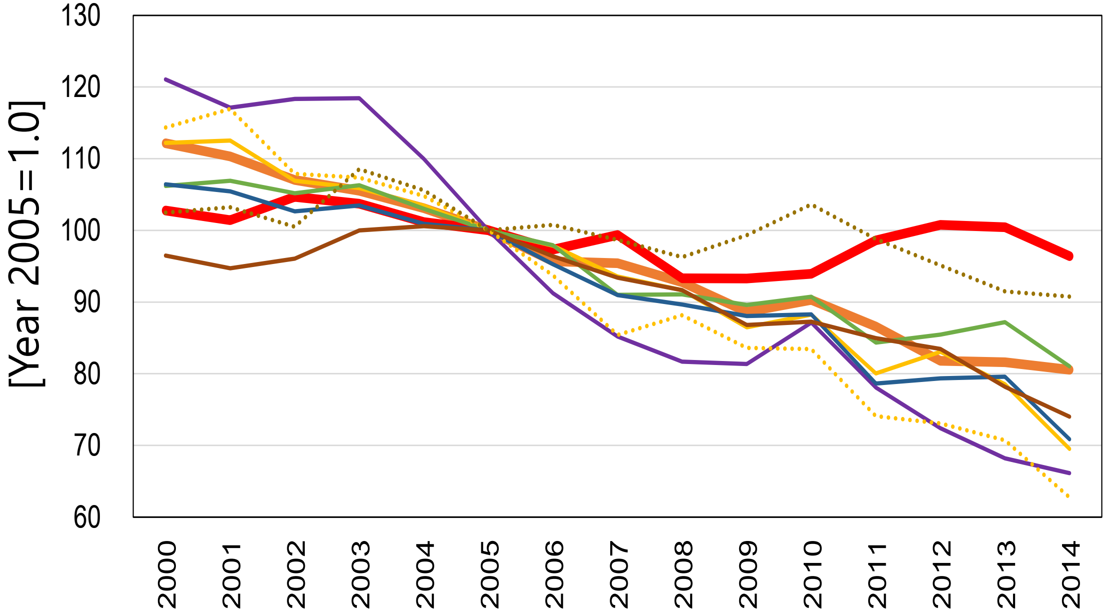
Estimates for 2015, 2016 and 2017 are preliminary; 2018 is a projection based on partial data.
Source: CDIAC; Le Quéré et al 2018; Global Carbon Budget 2018

- 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 contributor to this apparent decoupling was production adjustment of iron & steel etc. mostly in China (for a few years after 2010, the productions were too large), and the second largest was the shale gas revolution in the US.
- The global CO_2 emissions after 2016 are increasing again mainly due to repercussion of the production adjustments in China.

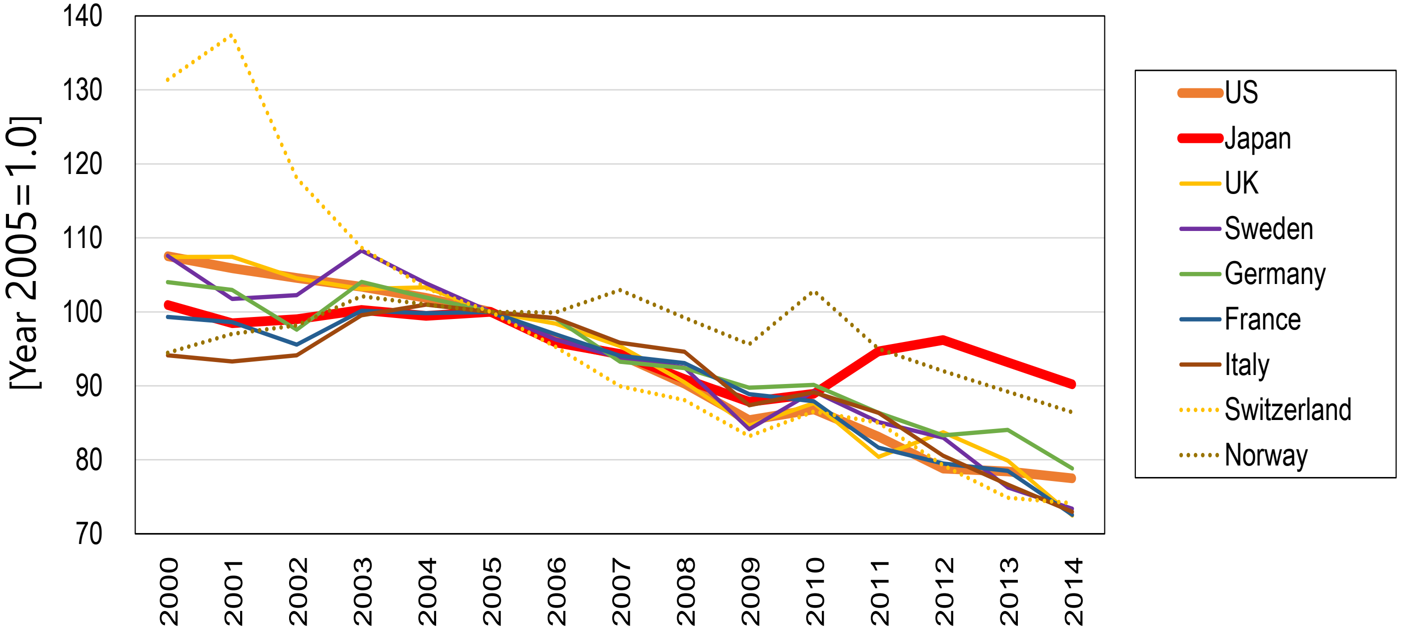
Source) Global Carbon Project

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

Production-based CO_2 per GDP



Consumption-based CO_2 per GDP



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 nine countries differs greatly.
- However, concerning the consumption-based emissions, the improvement rate of these countries does 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 caused by the Great East Japan Earthquake.
- Focusing only on production-based emissions may lead to wrong interpretation of emission reduction efforts of individual nations.

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.

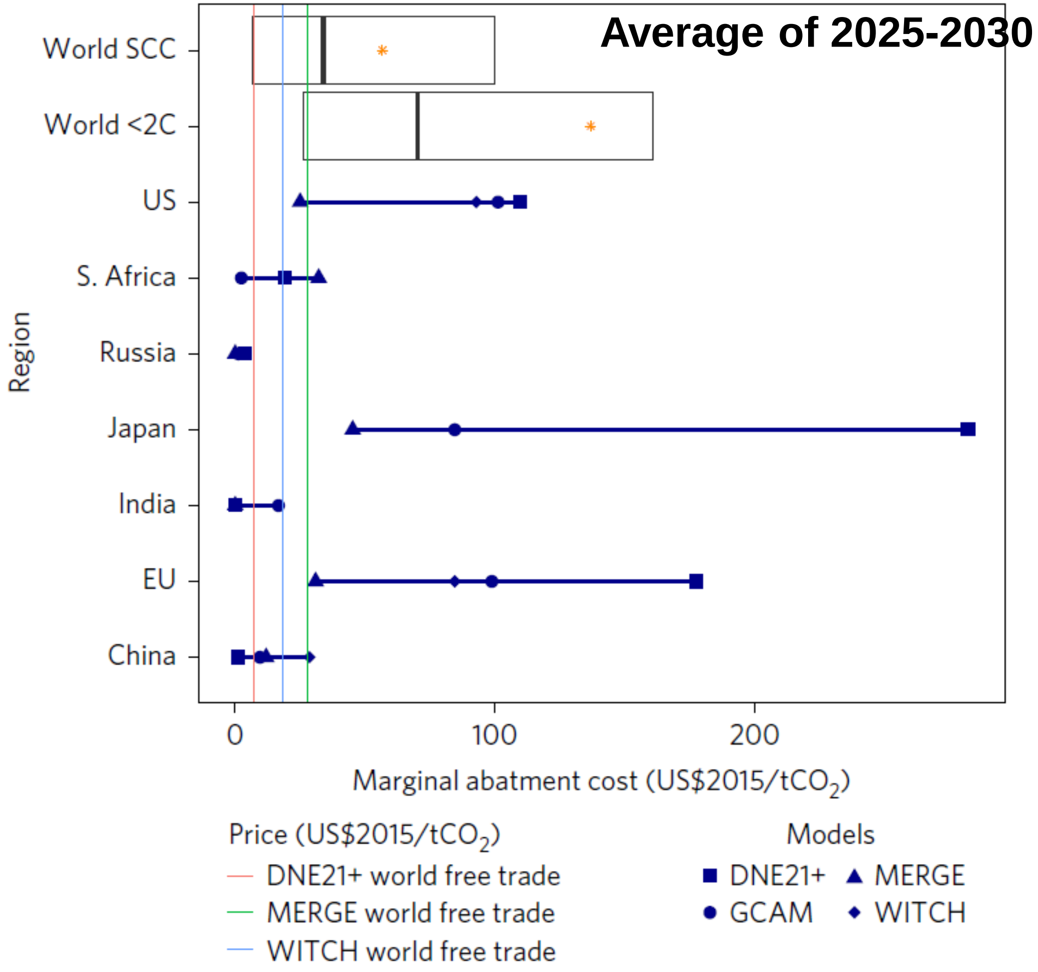
Emissions reduction ratio from base year of NDCs for major countries

	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, CO2 intensity of -60% to -65% from 2005 levels	+406 to +343%	**+96 to +72%**	+17 to +2%

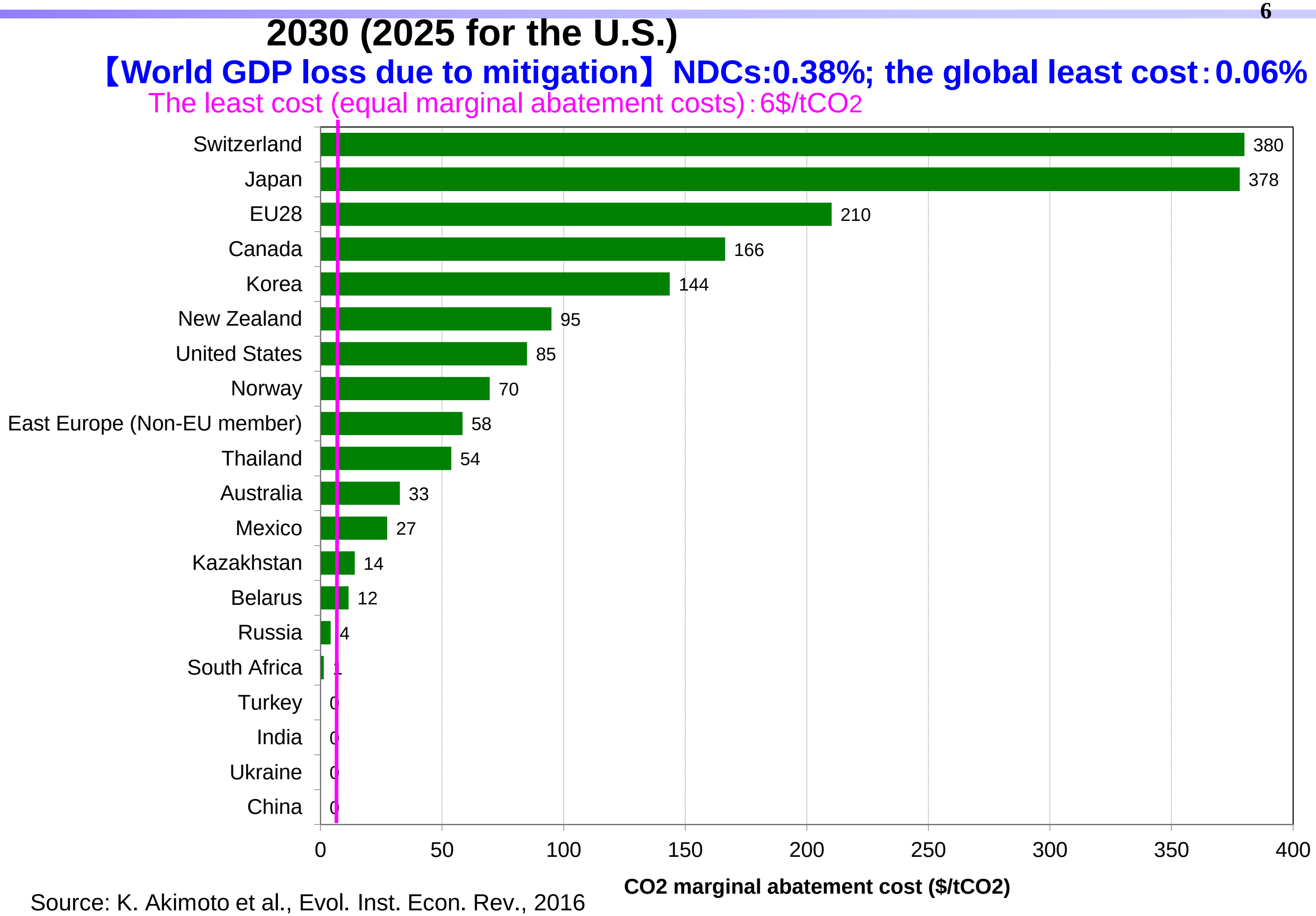
Underlined: official NDCs, Others: estimated by RITE

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



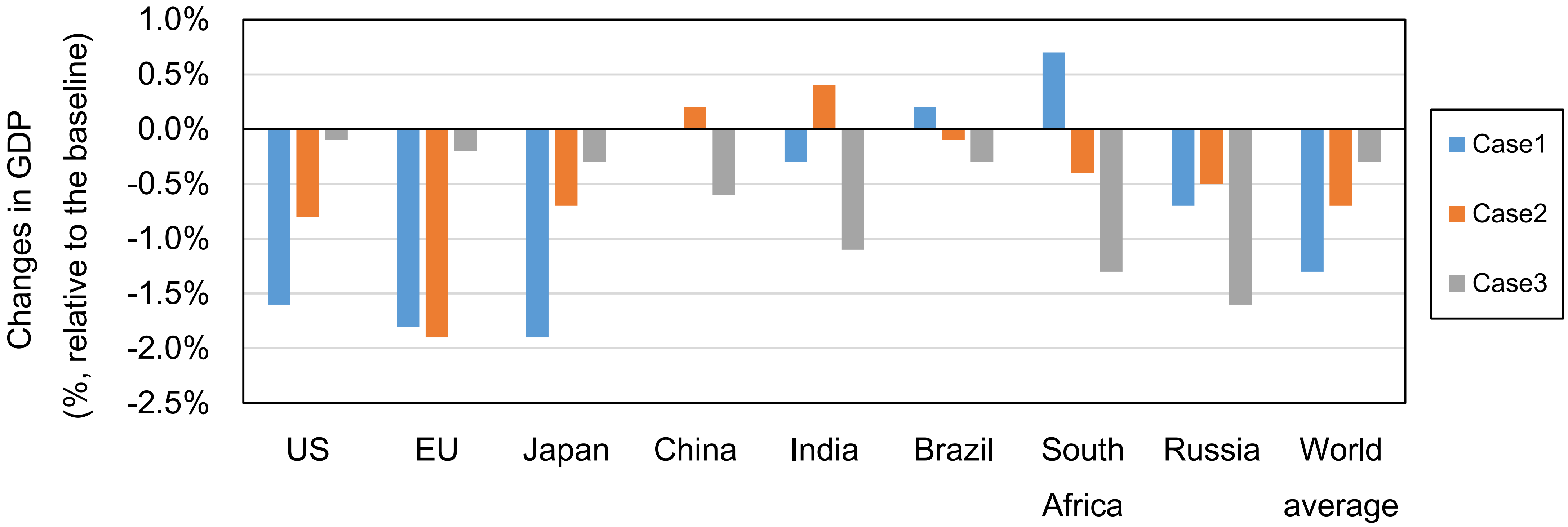
Source: K. Akimoto et al., Evol. Inst. Econ. Rev., 2016

- 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.
- Current economic conditions where lower GDP growth is projected will bring lower MACs in developed countries and higher MACs in developing countries which have intensity targets, e.g., China.

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 <u>national</u> emission reduction targets without CO2 trading**	**<u>Global</u> 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: 927$MtCO_2$)	Electricity share same as the energy mix of Japanese governmental plan.(24% 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 [$MtCO_2$eq.] GHG emissions	–		
Russia	27.5% GHG reduction relative to 1990	–		

GDP impacts of the NDCs for the major countries in 2030



Case 1: NDCs (including typical energy policies within NDCs)

Case 2: Equal MACs among sectors within each nation

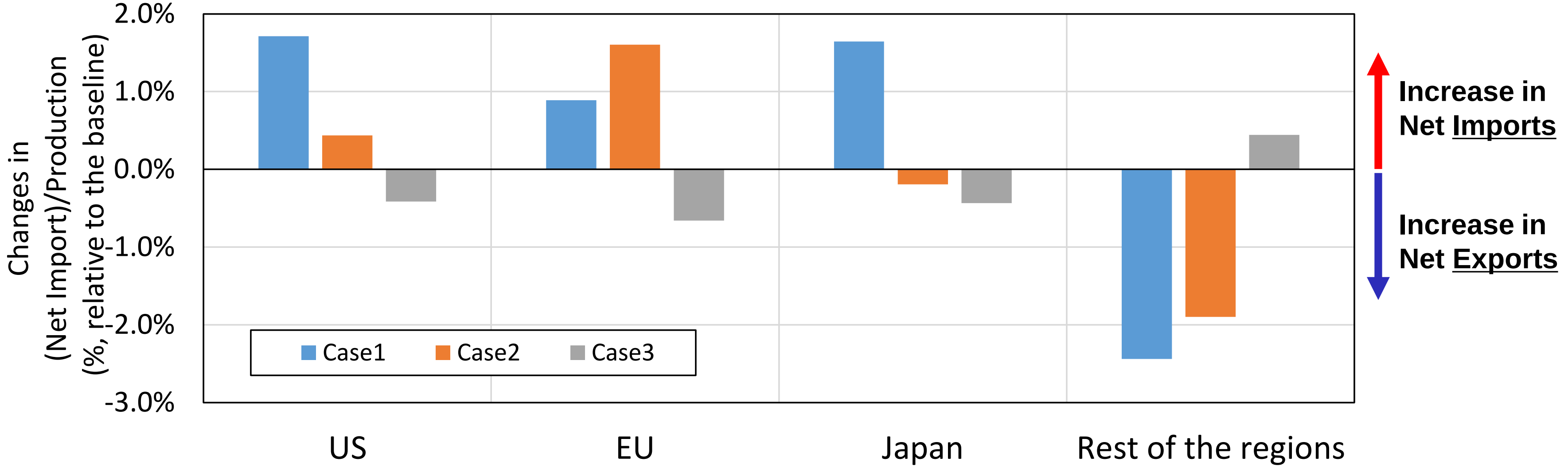
Case 3: Equal MACs among nations and sectors (Global trade)

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

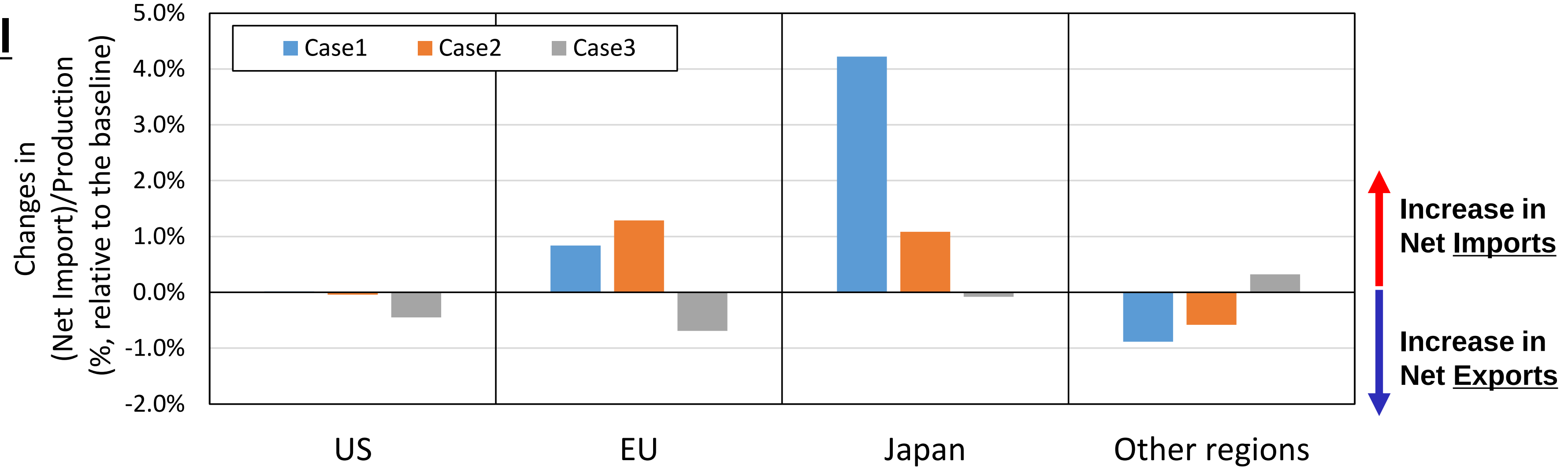
- **The negative GDP impacts are large in the US, EU, and Japan in Case 1 (NDC case).**
- **The negative GDP impacts for the US and Japan in Case 2 (Equal MACs among sectors within each nation) will be smaller than those in Case 1.**
- **The negative GDP impacts for the US, EU, and Japan, and the global impacts in Case 3 (Equal MACs among nations and sectors) will be much smaller than those in Cases 1 and 2.**
- **The positive GDP impacts in Cases 1 and 2 for some developing countries are estimated.**
- **The negative GDP impacts for Russia are estimated in all of the three cases mainly due to the decreases in fossil fuel exports.**

Trade impacts in Chemical and Iron & steel sector in 2030

Chemical



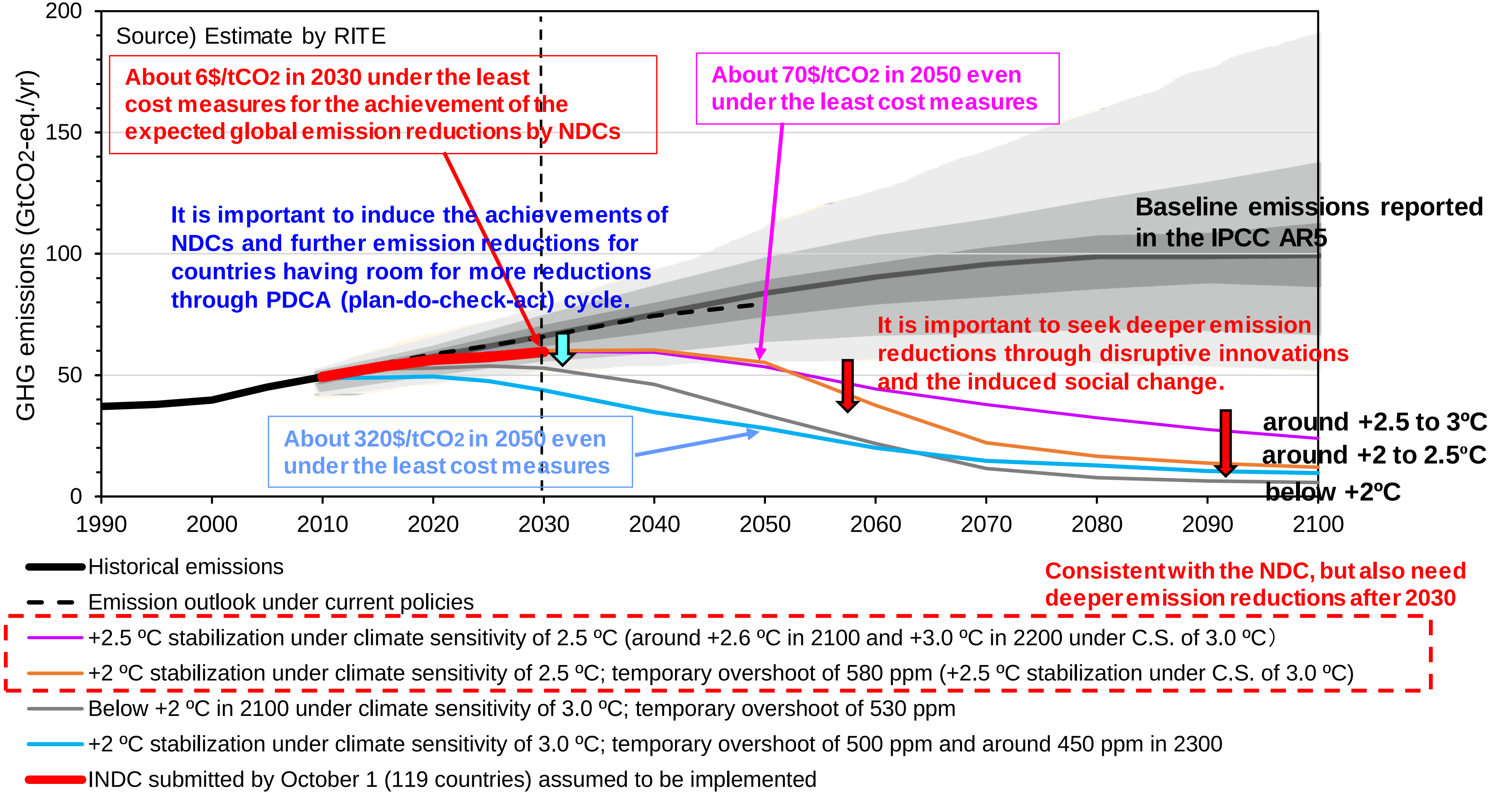
Iron & steel



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

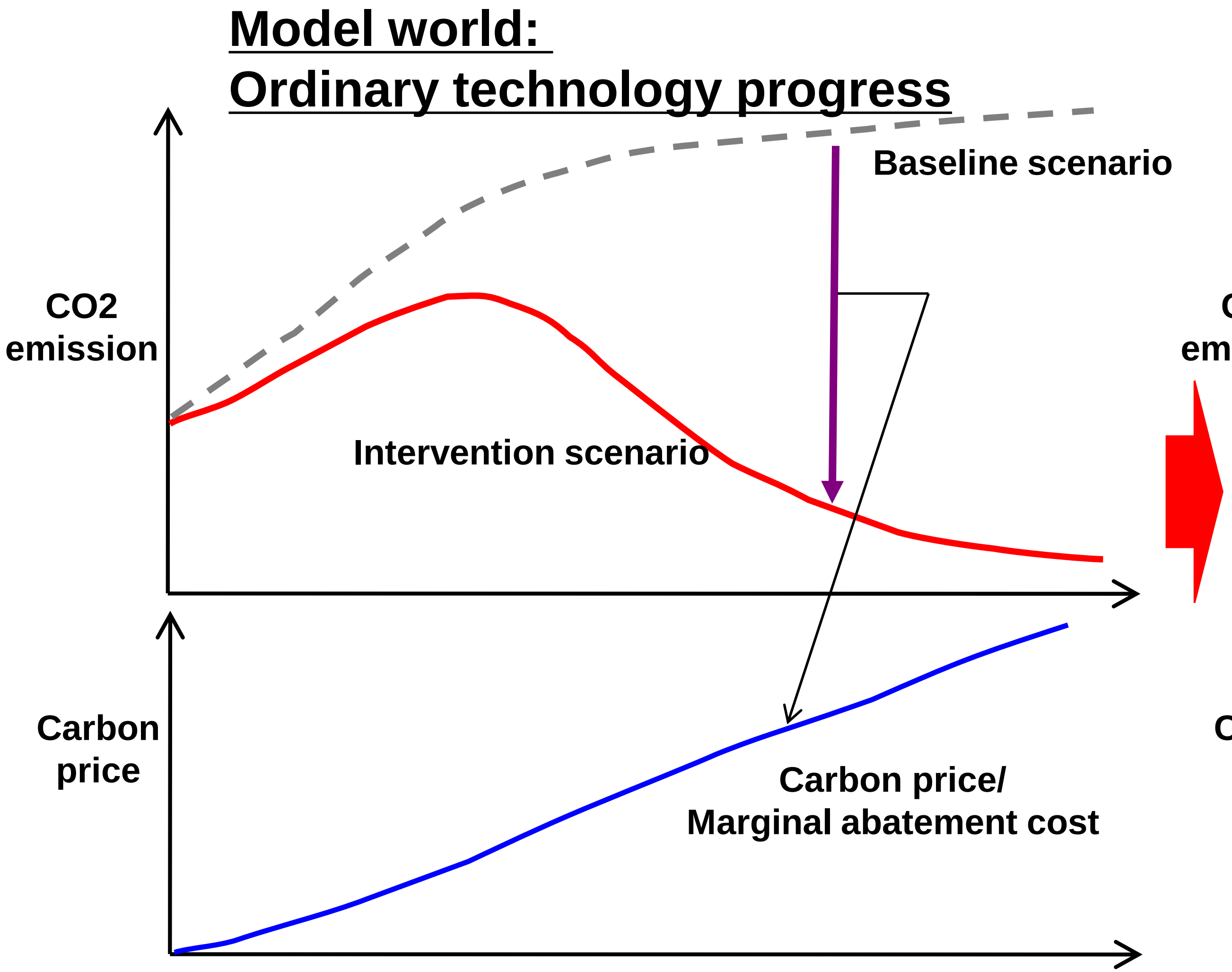
- The NDCs will make large impacts on the potential international trade balances in Chemical sector in the US, EU and Japan, and in Iron & steel sector in Japan and EU. (Cases 1 and 2)
- Under the global emission trade case (equal MACs), the impacts will be relatively small. (Case 3)

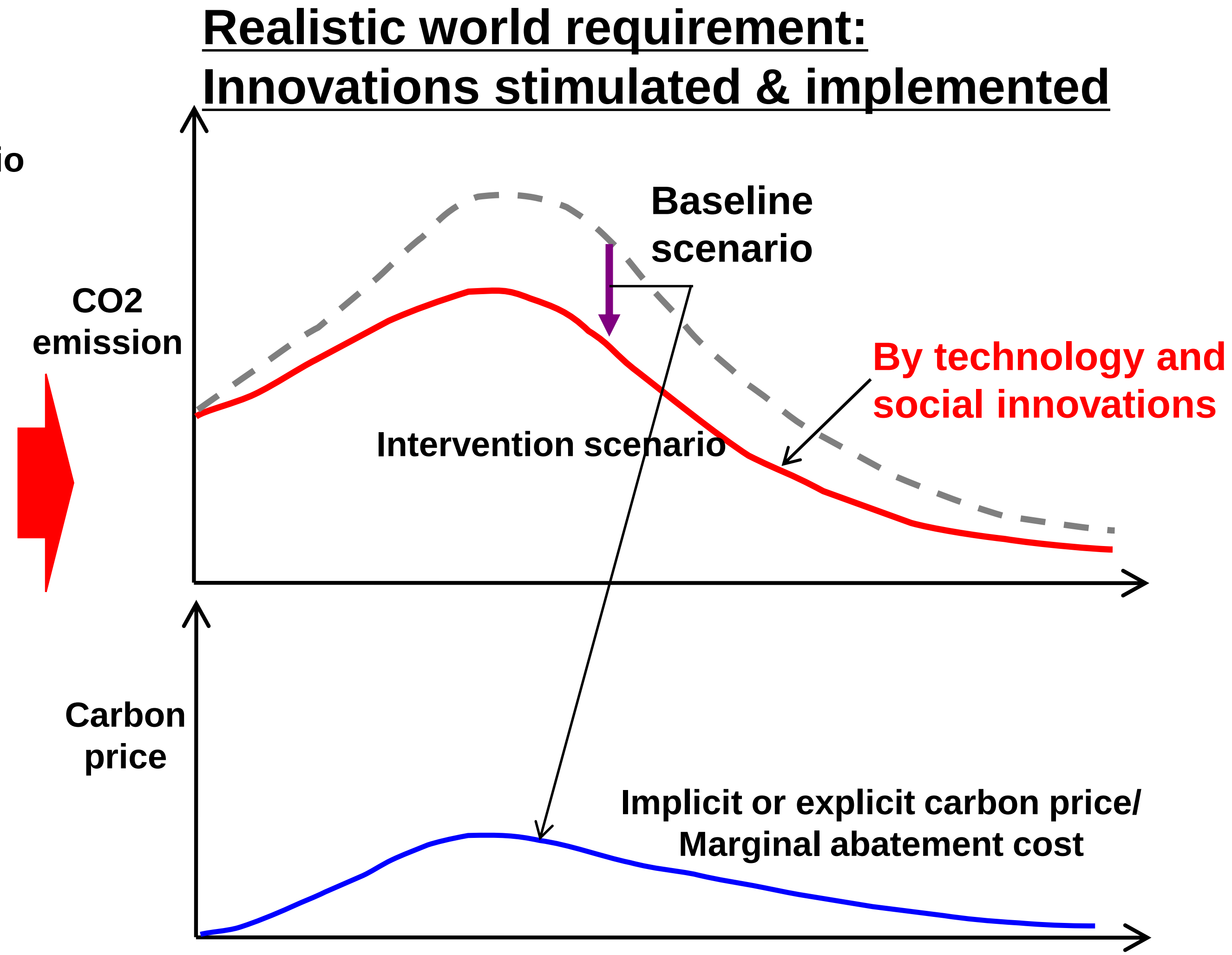
Expected global GHG emissions of the aggregated NDCs and the corresponding emission pathways up to 2100 toward +2 °C goal



- The expected global GHG emission in 2030 under the NDCs corresponds to the emission to be achieved under only 6 $/tCO2 of global carbon price. But the required global carbon price for the 2 °C goal will be 320 $/tCO2 in 2050. IPCC reports also show a similar range of carbon prices in 2050. Disruptive innovations and the induced social change are necessary to lower the carbon price.
- Global cooperation harmonizing emission reduction efforts is important, but broad innovations both of energy supply and demand sides are key to achieve the 2 °C goal or much deeper emission reduction.

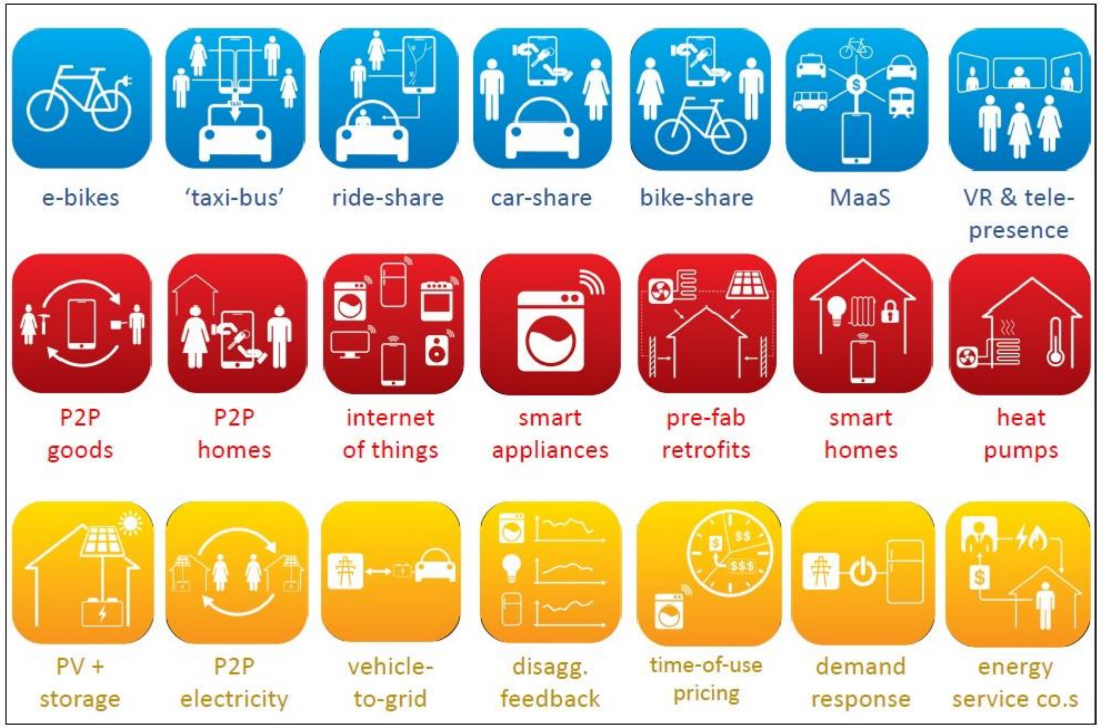
Image of standard scenario by models and real world scenarios for deep cuts





- High carbon prices of over 100$/t$CO_2$ in real price are unlikely to be accepted globally in a real world. Global harmonization will be really unrealistic in the level.
- Technology and social innovations which will bring low (implicit or explicit) carbon prices and the induced low energy demand societies are key to achieve deep emission cuts.

Disruptive Innovations of End-use Technologies



Source: C. Wilson (IIASA)

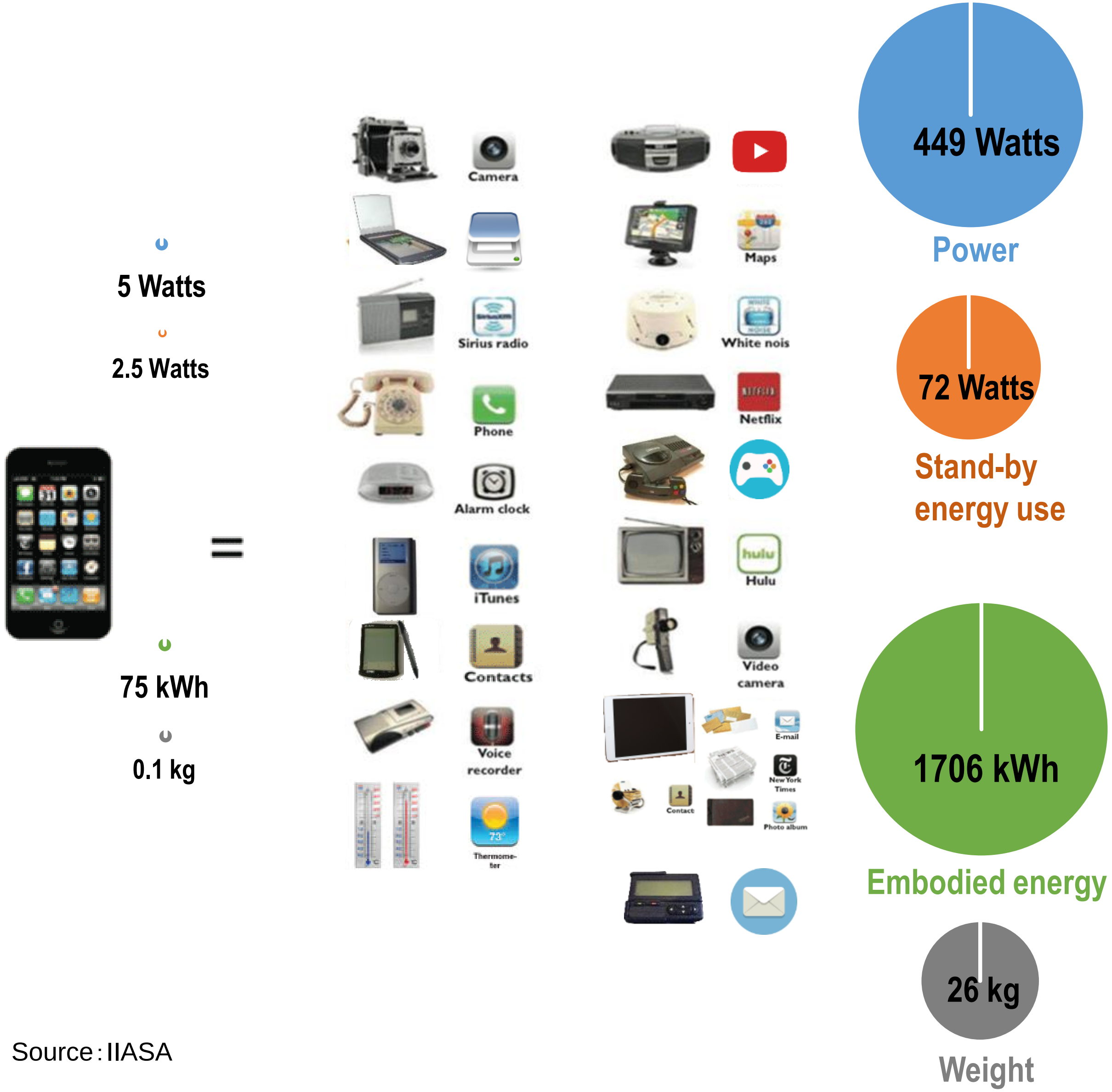
Disruptive innovations of end-use technologies such as IoT, AI, will be able to induce:

1) **Shift from atomized to connected**
2) **Shift from ownership to user-ship**
3) **Sharing economy & circular economy**

Human society will be able to continue economic growth and resolve many social issues through building highly integrated systems of Cyberspace (virtual) and Physical space (real)

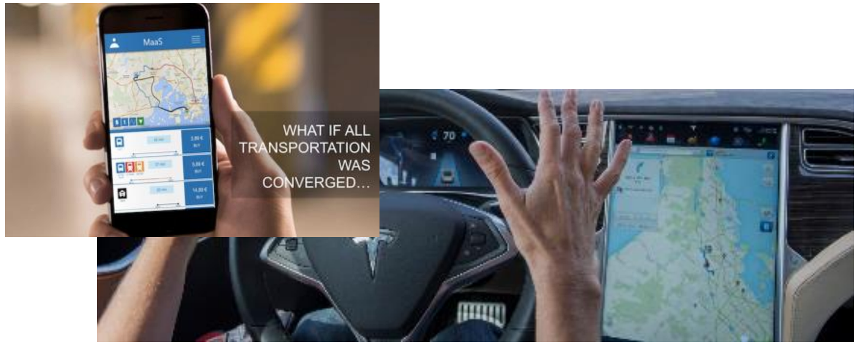
Source: Government of Japan (Cabinet Office)

Innovations in end-use technologies through IT and AI, and the induced social changes



Source: IIASA

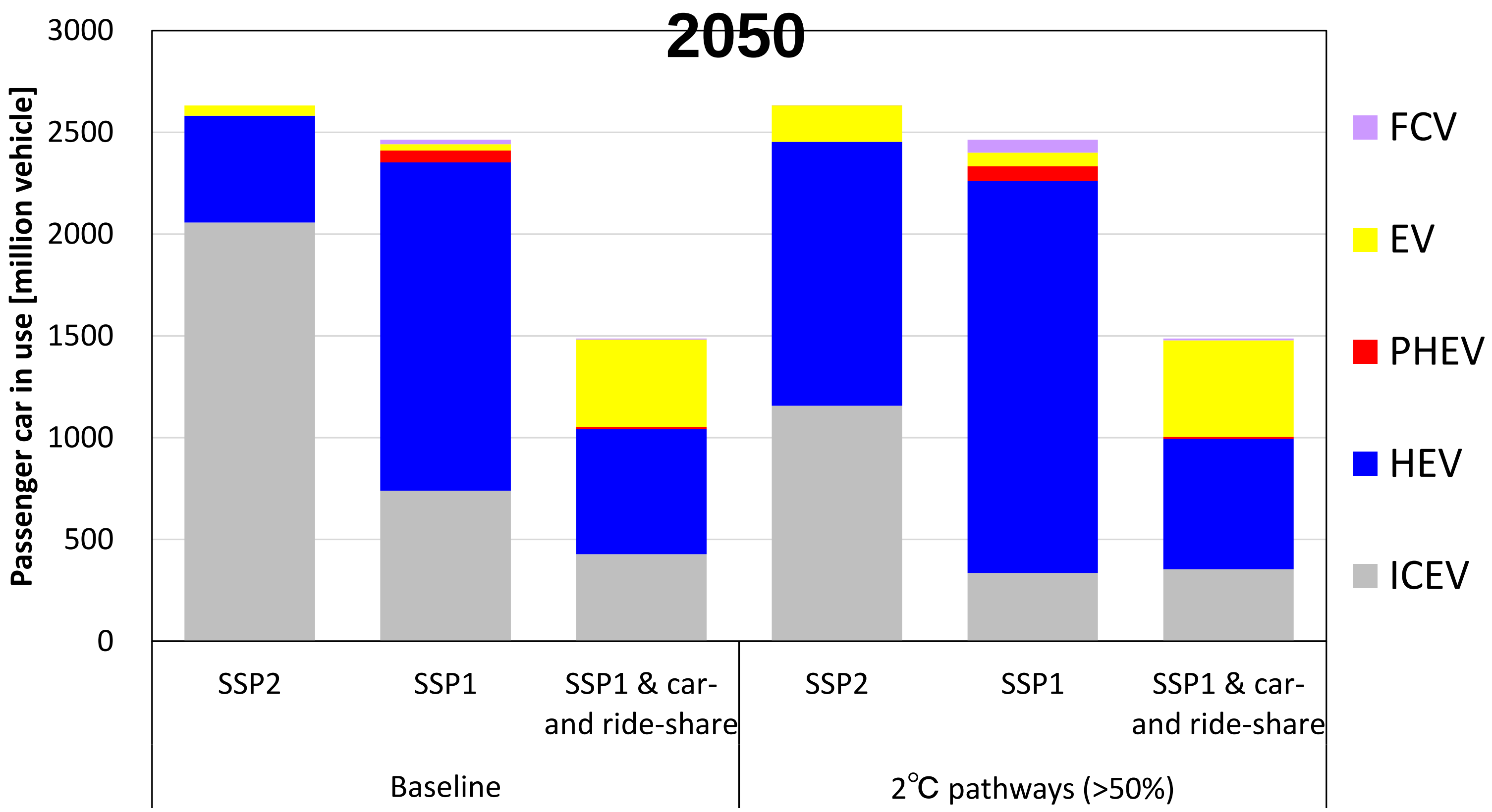
- **Energy consumption is not our purpose, but is just a phenomenon accompanied with consumption of goods and services, which is conducted for our welfare increase. Energy embodied in goods and services must be taken into account.**
- **The end-use products and services will usually diffuse rapidly, and the embodied energy and CO_2 may decrease rapidly.**



Operation ratio of automobiles is about 5%. Large room exists for its improvement by the achievement of fully autonomous cars.

There are large opportunities to achieve social changes and to increase energy efficiency through fully autonomous cars, food system improvement, etc. which can be induced by innovations of IoT, AI etc.

Global automobiles owned: impacts of sharing induced by fully autonomous cars



Source) estimated by using DNE21+, developed by RITE

CO_2 marginal abatement costs for 2 °C

Unit: \$/tCO_2 (real price)
In case of uniform carbon price (the least cost case)

	2050	2100
SSP2 (Middle scenario)	154	269
SSP1	165	187
SSP1 & car- and ride-share	126	185

- Assumed cost reductions of environmental friendly cars, e.g., hybrid vehicle, PHEV, EV, FCV for SSP1 lead to wide diffusion of these cars. (SSP2 ⇒ SSP1)
- The sharing brings higher operation ratios, and then induces economic travels even with high price cars as well as reductions in number of cars, and EVs diffuse relatively more widely even in Baseline scenario. (SSP1 ⇒ SSP1 & car- and ride-share)
- The marginal abatement costs for the sharing mobility scenario (SSP1 & car- and ride-share) are much lower than those for the scenarios without sharing mobility.

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 overseas transfer 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 nations.
- 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 are unrealistic in the real world. Broad innovations both of energy supply and demand sides will be necessary and key to achieve the 2 °C goal or much deeper emission reduction.
- The energy demand decrease opportunities particularly through IT, IoT, AI will be desired/expected for deep reductions in the mitigation costs.