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Evaluations on Emission Reduction Efforts of the Nationally Determined Contributions for the Post-2020 Periods

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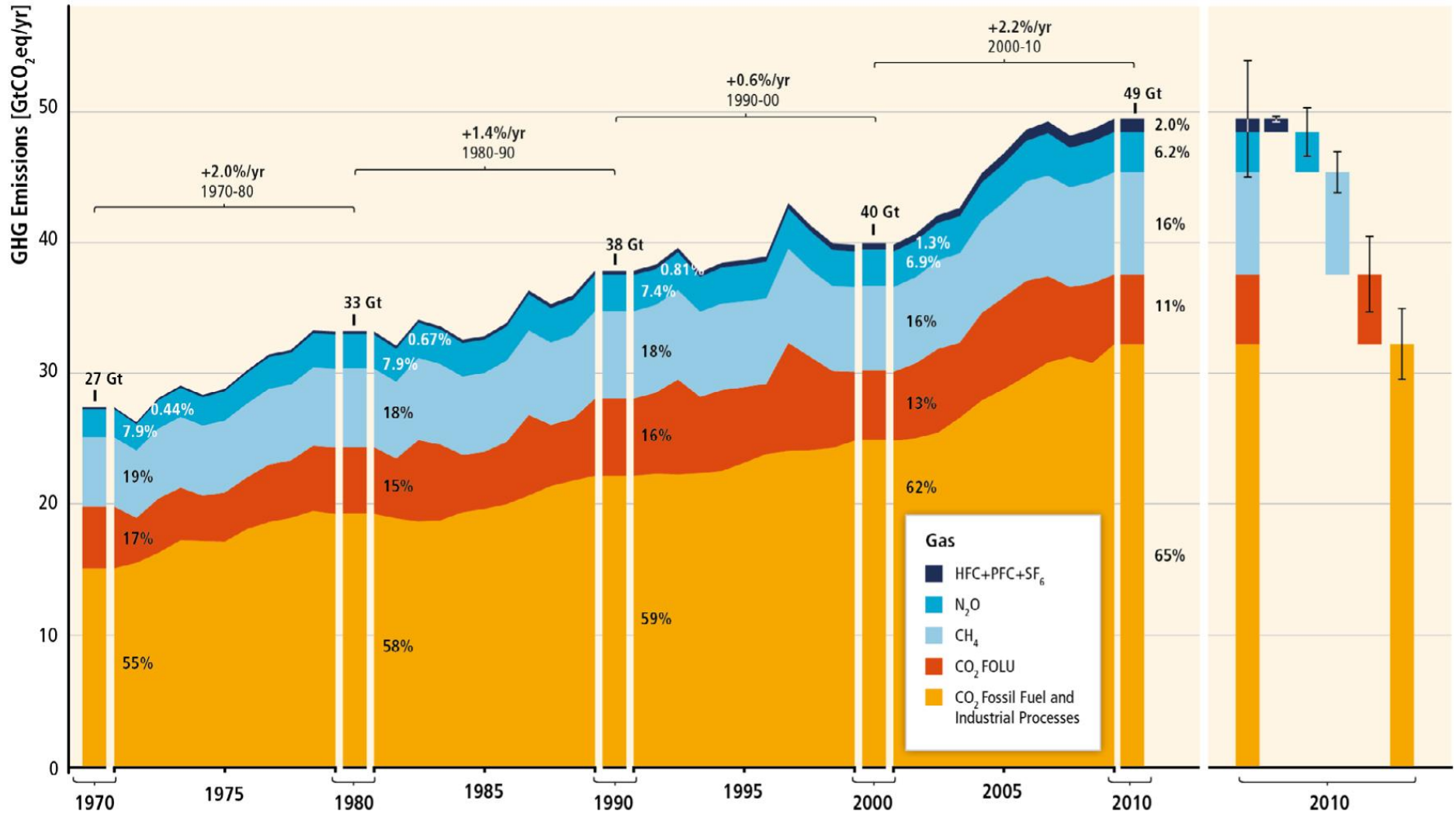
Background and objective

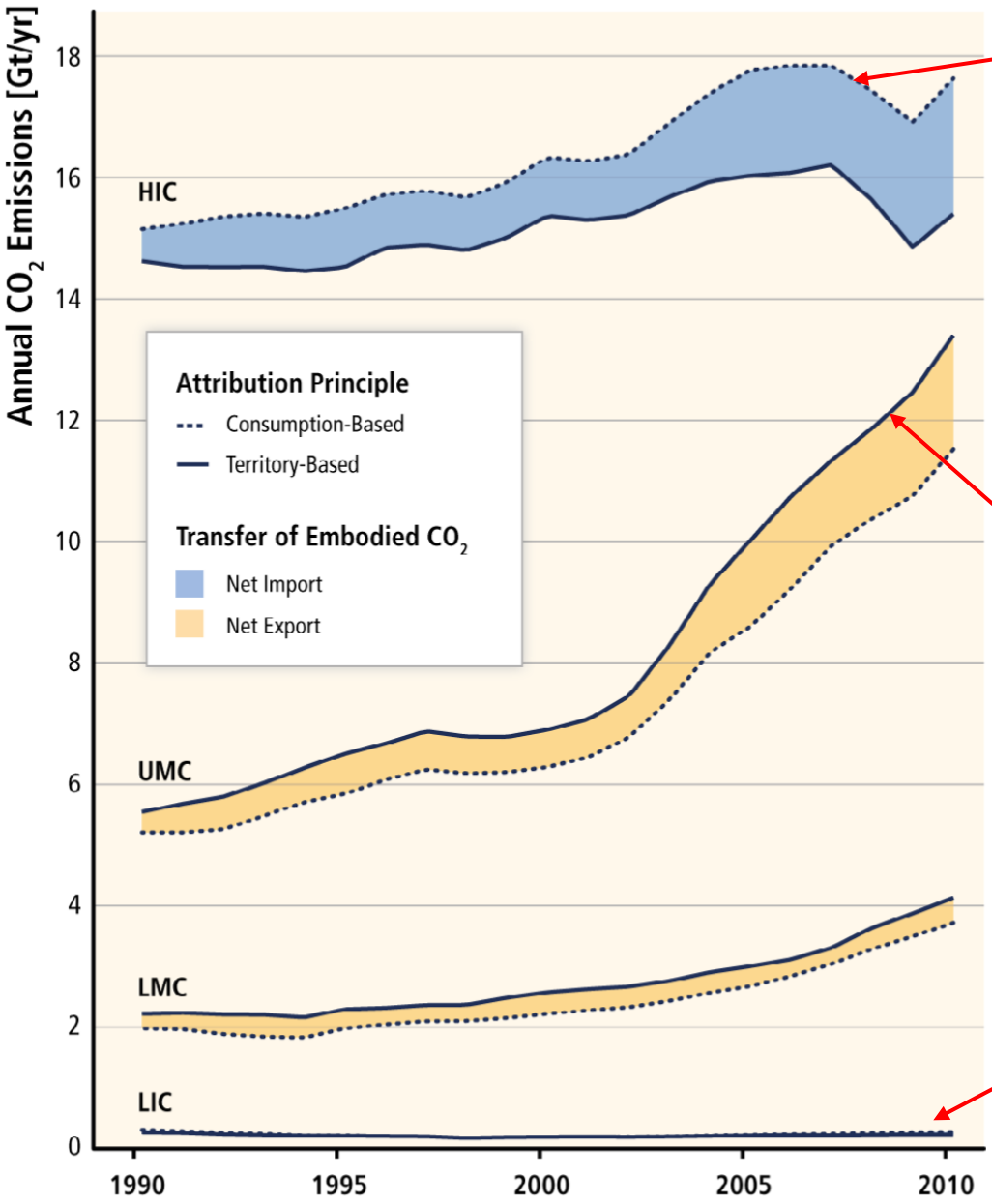
Trajectory of Global GHG Emission by Source



Source) IPCC AR5, 2014

The global emission after 2000 increased more rapidly. The Kyoto Protocol was not able to exert large effects.

Trajectory of Global CO_2 Emission by Region



High income countries
($12,616 and more)

Consumption-based CO_2 emissions are not able to be decreased even in HIC.

Upper middle income countries
($4,086 to $12,615)
(China, Brazil, Iran, Malaysia, South Africa etc.)

Rapid increase in CO_2 emissions

Lower middle income countries
($1,036 to $4,085)
(India, Indonesia, Philippine, Egypt etc.)

Tackling poverty; less priority of CO_2 emission mitigation

Low income countries
($1,035 and less)

Source) IPCC AR5, 2014

Background and objectives of ALPS project and its major topics of study

Climate change is a very complex issue. Effective response measures in the real world are important. The aim of the ALPS project is to support the developments of international frameworks to realize green growth and effective response measures through better understandings for technologies, economics, policies etc. and quantitative analyses and evaluations.

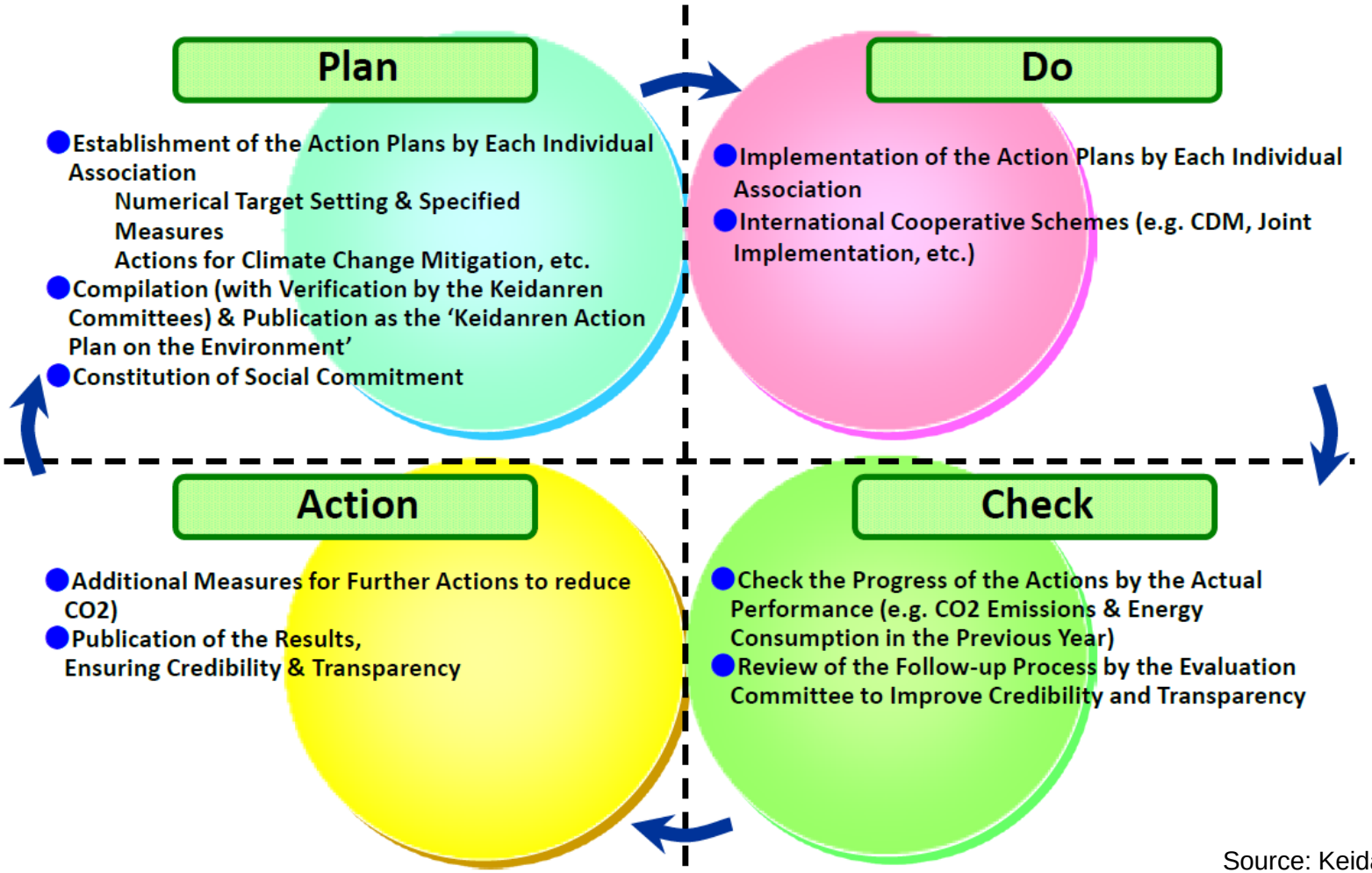
【major topics】

- Risk management strategy for climate change responses
  - Estimates of climate change damages, adaptations, and mitigation costs and their uncertainties
  - Long-term target and the emission pathways
  - Risk management strategy for climate change responses under uncertainties etc.
- Economical better understandings and analyses for real green growth
  - Considering the possibilities and limitations of removing energy saving barriers, endogenous technology learning for green growth
  - International secondary energy prices and their drivers, and the impacts on international competitiveness and green growth
  - Analyses for international constraint for funding to coal power etc.
- Climate change mitigation measures, particularly the systems measures.
  - hydrogen systems (total systems including supply, transport, consumption)
  - systems of building, and transportations etc.
- Analyses regarding international frameworks, discussions and policy interests
  - Review methods for post-2020 emission reduction targets of INDCs
  - Contributions to international model comparison projects etc.

Regarding evaluations of efforts of emission reductions for post-2020

- The global emission reductions were decided first and then the emission allocations among Annex I countries (developed countries) were decided and the decided targets had legal forces under the Kyoto Protocol. However, this approach failed.
- The post-2020 international framework for emission reductions will be pledge & review type (P&R).
- It is important to make peer-review systems for the pledged emission targets for effective emission reduction efforts through the establishment of the PDCA cycle.
- The INDCs (Intended Nationally Determined Contributions) will include the targets having different base year, intensity targets, and emission reduction ratio relative to BaU emissions.
- It is important to employ appropriate indicators to enable to measure emission reductions in order to realize emission reduction potentials for evaluating emission reduction efforts comparably among countries.
- Each indicator has both strong and weak points. Multiple indicators are required.

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 peer pressures to stimulate emission reductions worked weill in the VAP.

Candidate Indexes for Reviews of the INDCs to Evaluate Emission Reduction Efforts (Exante and Expost Reviews)

Candidate Indicators in Exante and Expost Evaluations

Exante evaluation

e.g.,

1) level of CO_2 and energy intensity of GDP >> affected by industrial structures etc.

2) improvement rate of CO_2 and energy intensity of GDP >> in general, the improvement room is small in countries that have already achieved high intensity levels.

3) emission reduction ratio from baseline emission >> baseline emissions are highly uncertain.

4) marginal abatement costs, average costs, and additional costs per GDP: model based >> large uncertainties of cost estimations.

Expost evaluation

e.g.,

1) level of CO_2 and energy intensity of GDP

2) improvement rate of CO_2 and energy intensity of GDP

3) relationship between energy intensity change and per-capita GDP change >> removing the influences of economic activity changes from the observed intensity improvements

4) energy (and CO_2) intensity level in major sectors

5) secondary energy prices, and carbon prices

6) emission reduction ratio from baseline emission

7) marginal abatement costs, average costs, and additional costs per GDP: model based

Points to be Noted for the Indexes

- Marginal abatement cost is an important indicator to measure emission reduction efforts and to consider domestic emission reductions particularly among countries with close economic conditions.
- When emission reduction contributions overseas are included, per-GDP emission reduction cost is also a good indicator. However, large differences in MAC among countries will induce carbon leakage, and differences in MAC should be within a certain acceptable level .
- Equal per-capita emission indicator is apt to be considered to be simple and clear. But this indicator cannot objectively decide the base year, the pathways to the convergence per-capita emission, the convergence year etc. The allowable emissions for each country are very different from the assumptions. In addition, potential emissions are different due to different geographic and climate conditions, population density etc.
- Cost-based indicators are sometimes criticized due to large uncertainties. However, such indicators are also useful because definite emission allocations are not required under a P&R type framework.

Self explanations of the NDCs by each country and the review principle

Pledge by country A　　Pledge by country B　　Pledge by country X

	Emissions per GDP	Emissions per capita	Marginal abatement cost	Per-GDP emission reduction cost	・・・
Country A	X	Y	Z	XX	
Country B	X’ （X’<X） 〇	Y’ （Y’>Y） ×	Z’ （Z’>Z） 〇	XX’ （XX’>XX） 〇	
・・・					

Each country justifies her NDCs by using the multiple (but appropriate) indicators. The reviews should be conducted also by using the multiple indicators and will make a peer-pressure if necessary.

Decomposition Factors of CO_2 Emission

Kaya identity

$$CO_2\ \text{emission} = \frac{CO_2\ \text{emission}}{PE} \times \frac{PE}{GDP} \times \frac{GDP}{POP} \times POP$$

CO_2 intensity: $\frac{CO_2\ \text{emission}}{PE}$

energy intensity: $\frac{PE}{GDP}$

GDP per capita: $\frac{GDP}{POP}$

population: POP

$\frac{POP}{GDP}$

Major candidate indicators for measuring emission reduction efforts, which exclude different economic conditions

$$\Delta CO_2\ \text{emission} = \Delta\frac{CO_2\ \text{emission}}{PE} + \Delta\frac{PE}{GDP} + \Delta GDP$$

annual change in CO_2 intensity: $\Delta\frac{CO_2\ \text{emission}}{PE}$

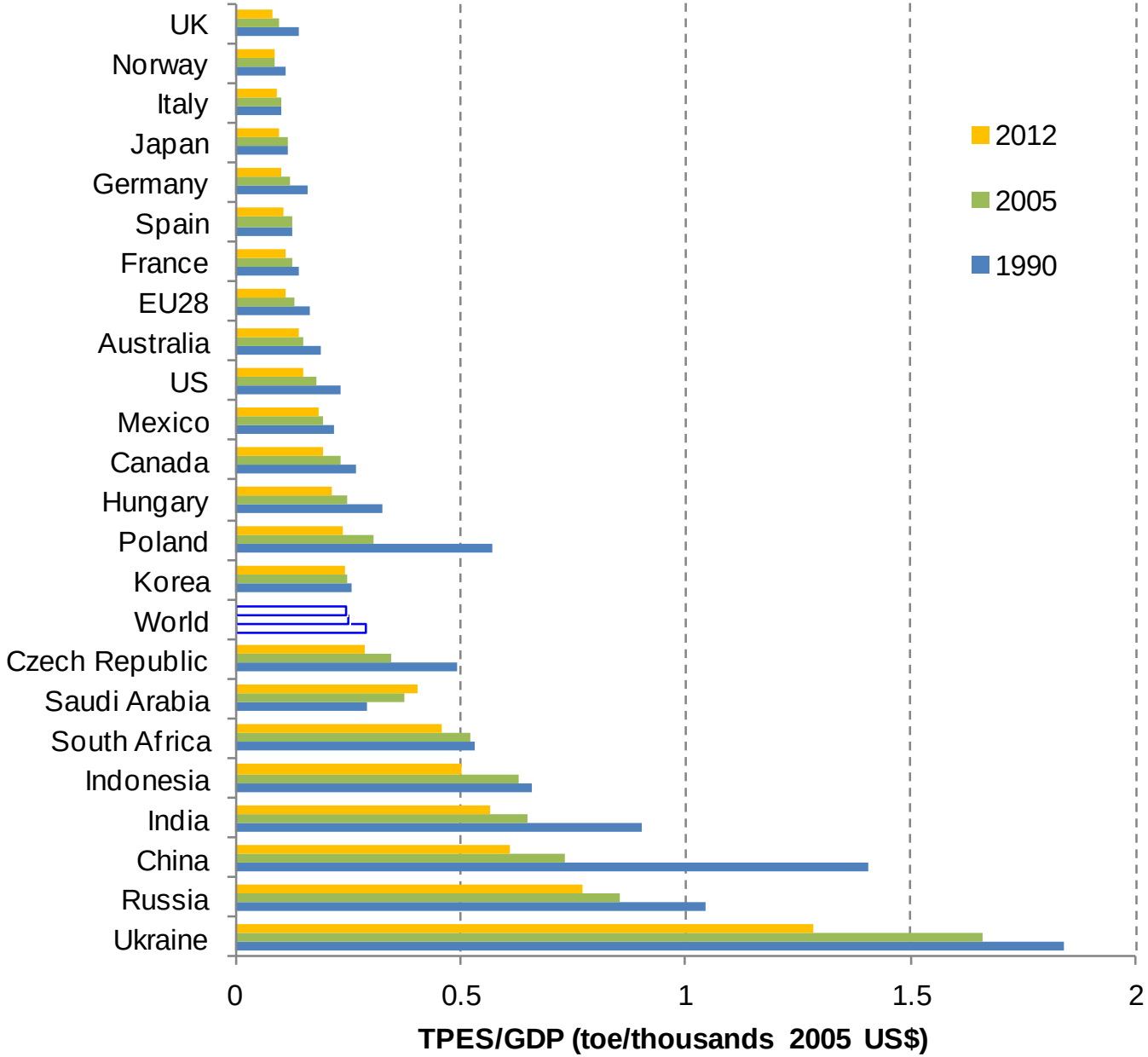
annual change in energy intensity: $\Delta\frac{PE}{GDP}$

annual change in GDP: ΔGDP

Major candidate indicators for measuring emission reduction efforts

Note the relationships between the two factors

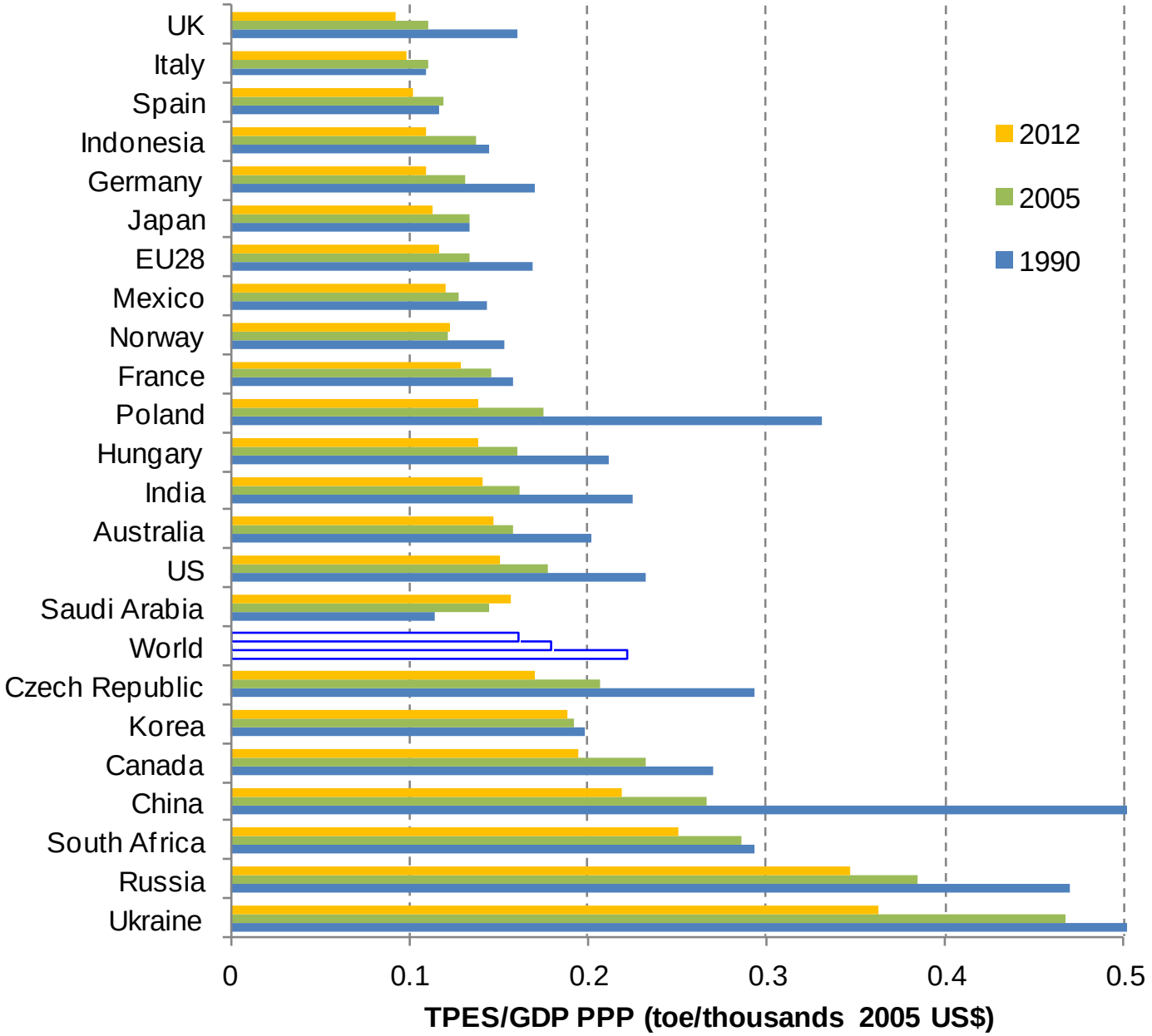
Comparison of Energy Intensity of GDP(MER)



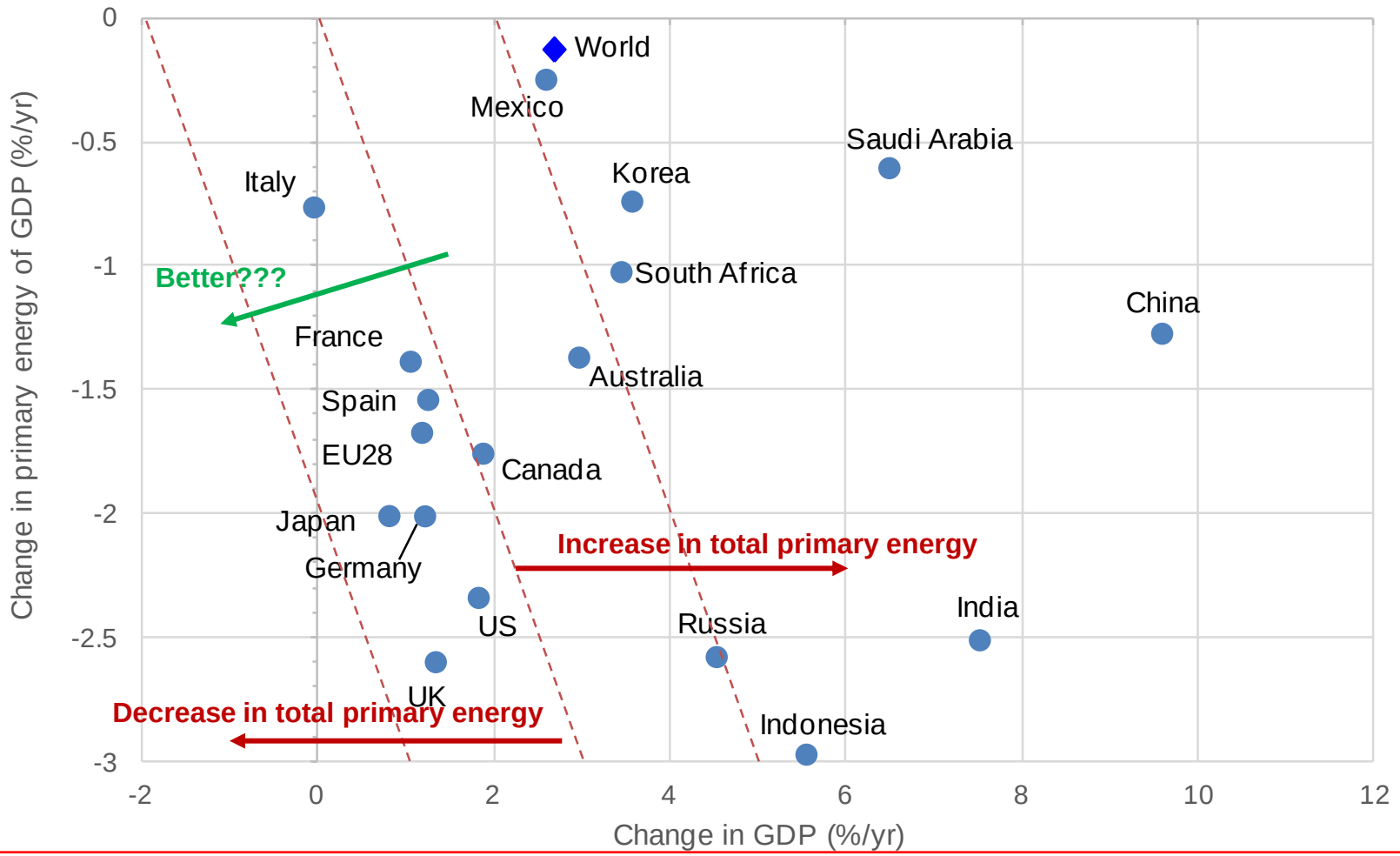
The intensity will be important for comparability of the efforts but other indicators are also necessary.

The energy intensity of GDP depends on several factors, such as the efforts for energy saving, industrial structures, market exchange rate etc.

Comparison of Energy Intensity of GDP (PPP)



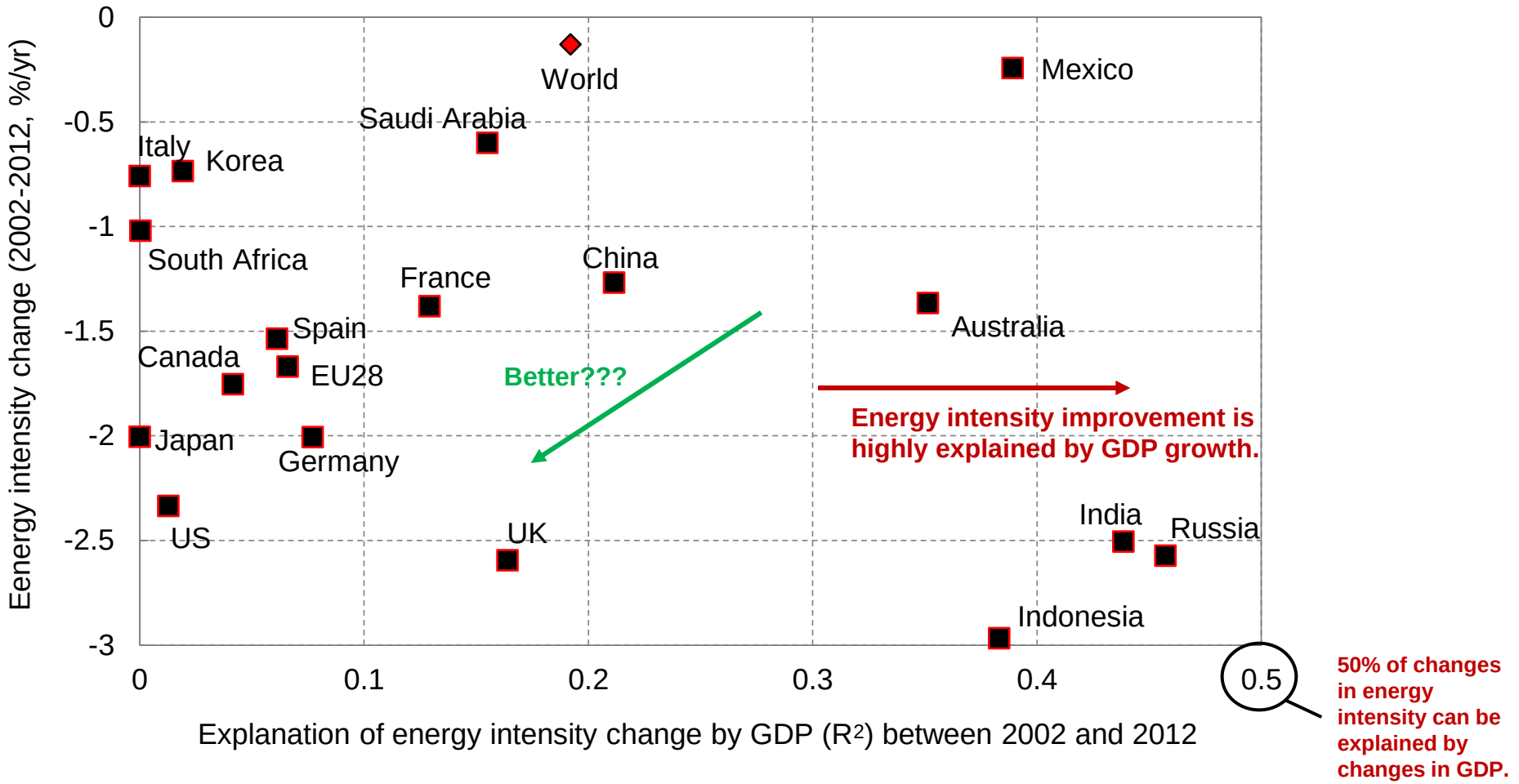
Changes in GDP vs Energy Intensity of GDP
Between 2002 and 2012 (past 10 years)



Not only the intensity level but also the intensity improvement rate is a candidate indicator to measure the emission reduction efforts. However, high economic growths usually induce high improvement of energy intensity, and therefore, high improvement of intensity does not necessarily mean large efforts for emission reductions.

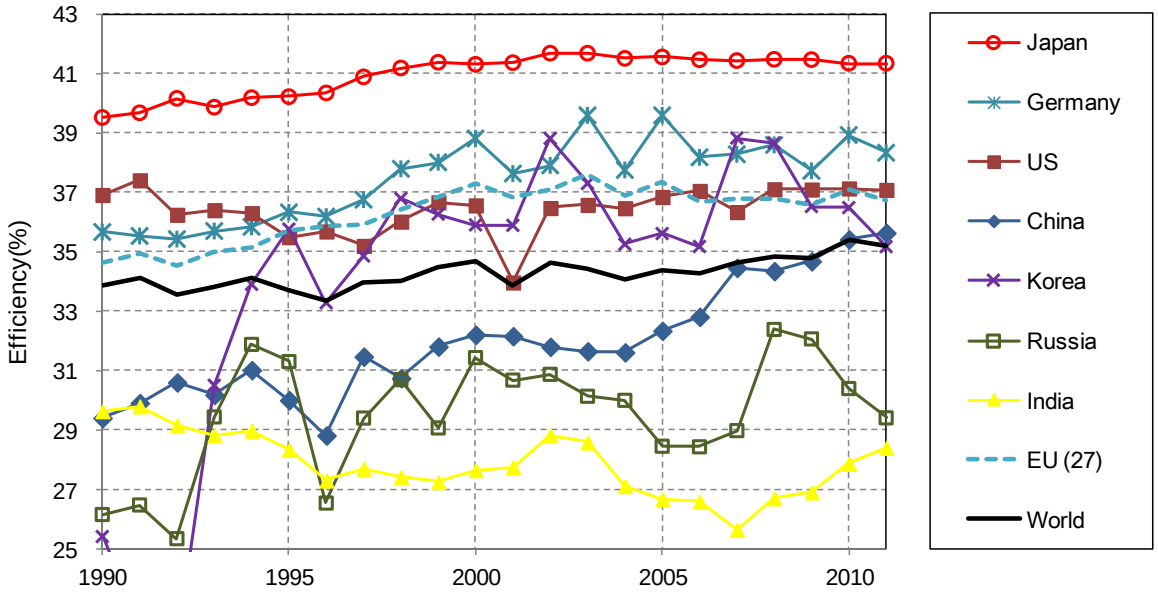
Examples of Index in Expost Evaluations (historical data and its analyses)

Explanation of energy intensity improvement by economic growth (R^2) between 2002 and 2012: for expost review



The high rate of energy intensity improvement does not necessarily indicate the efforts of energy efficiency improvements or CO2 emission reductions. Some countries whose energy intensity changes are well explained by changes of per-capita GDP. Thus, it will be also important to analyze the relationship between per-capita GDP and energy intensity changes.

Energy efficiency comparison for major energy-intensive sectors (1/2): for expost review

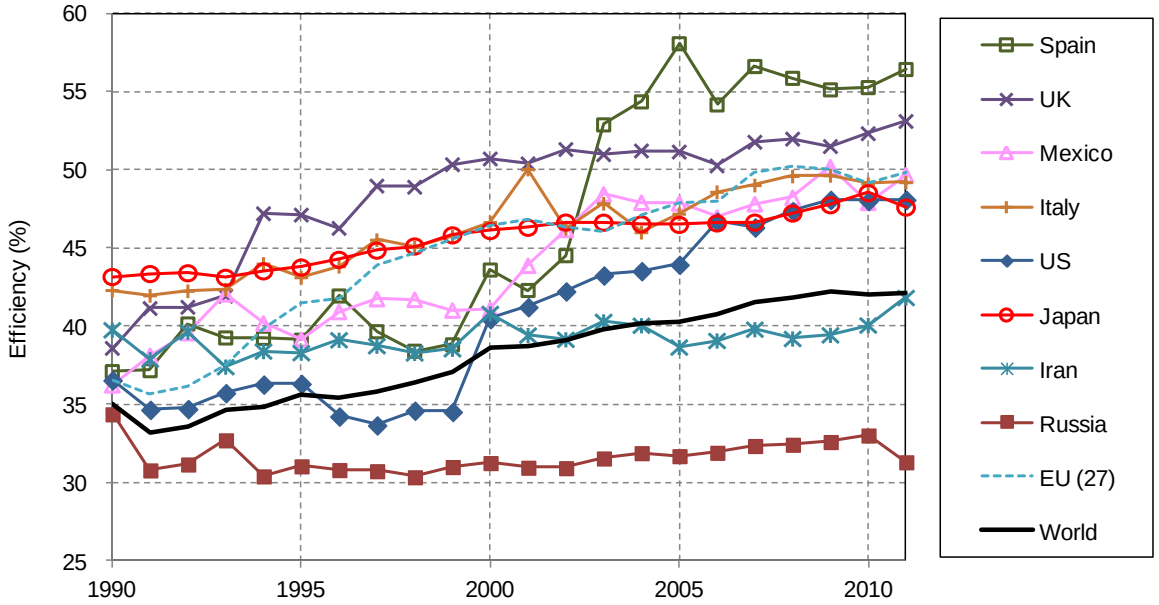


Coal power

Source) RITE, 2014
based on IEA, 2013

Gas power

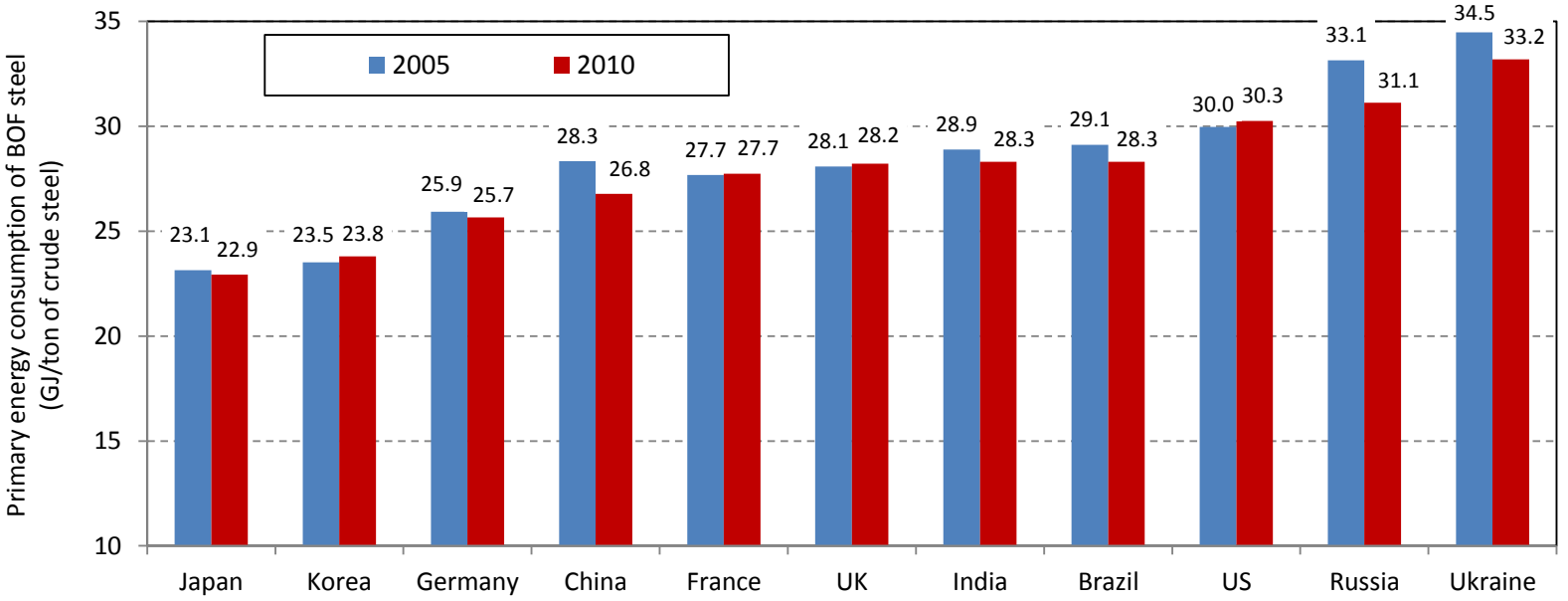
Source) RITE, 2014
based on IEA, 2013



The level of energy intensity of GDP is affected by differences in industrial structure. Measuring energy efficiency individually for major energy-intensive sectors or production processes is important.

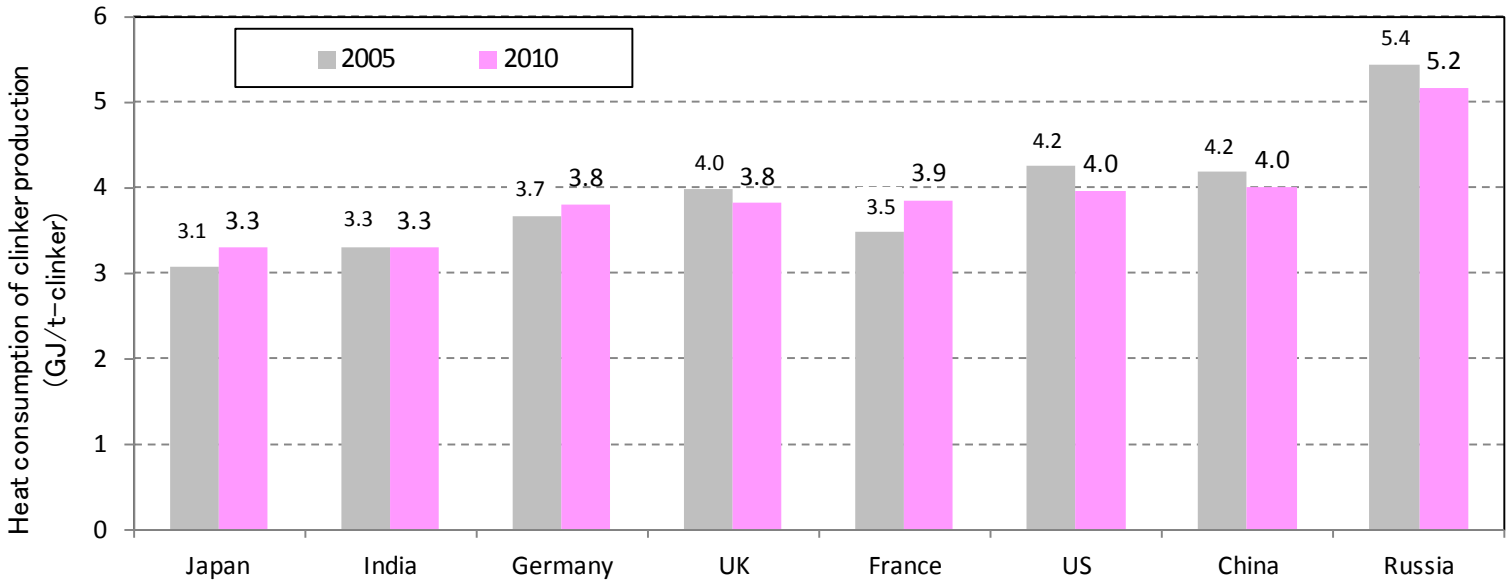
Energy efficiency comparison for major energy-intensive sectors (2/2): for expost review

Iron & steel (BOF steel)



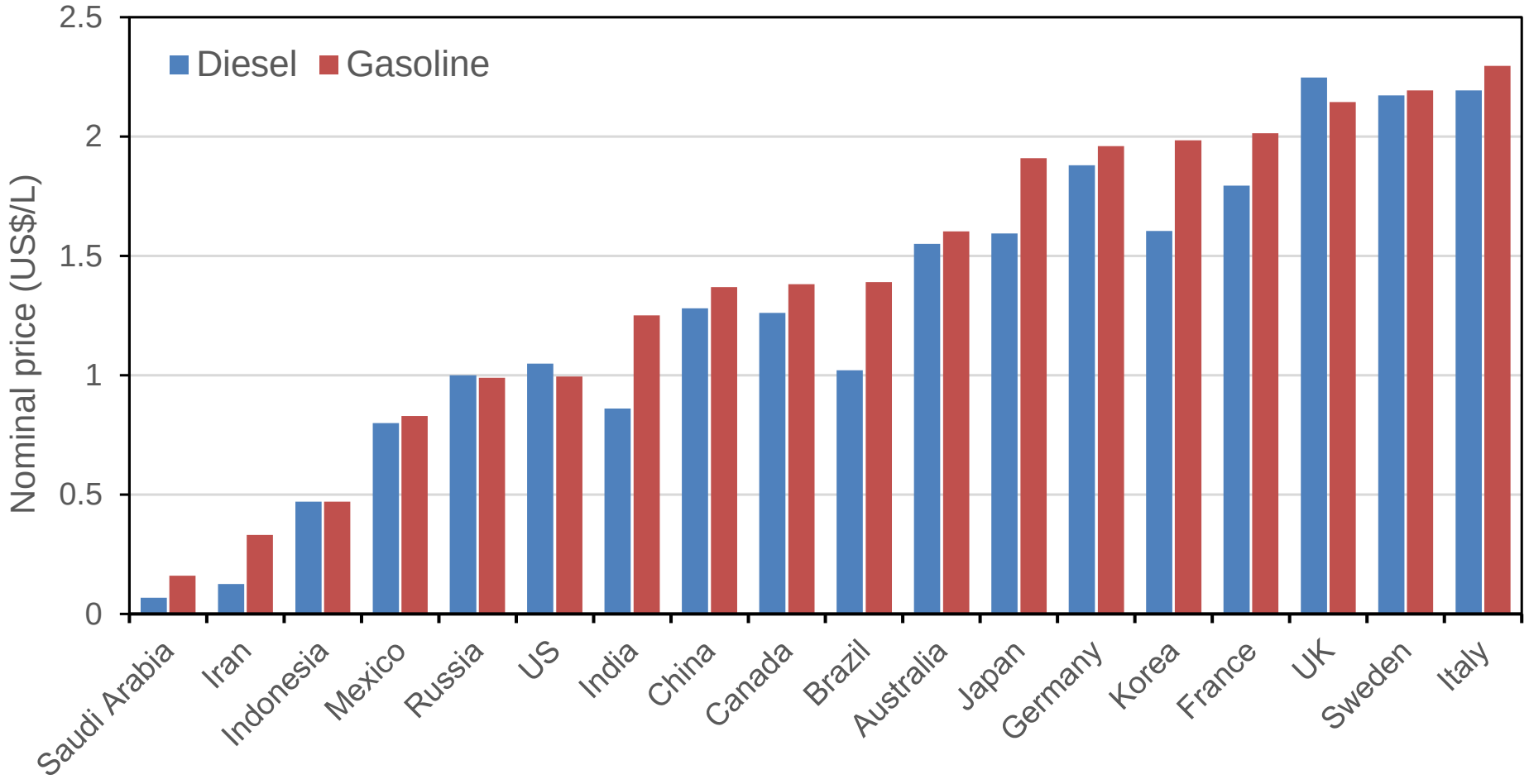
Source) Oda et al. 2012; RITE, 2012

Cement



Ref）RITE estimates based on WBCSD/CSI, etc

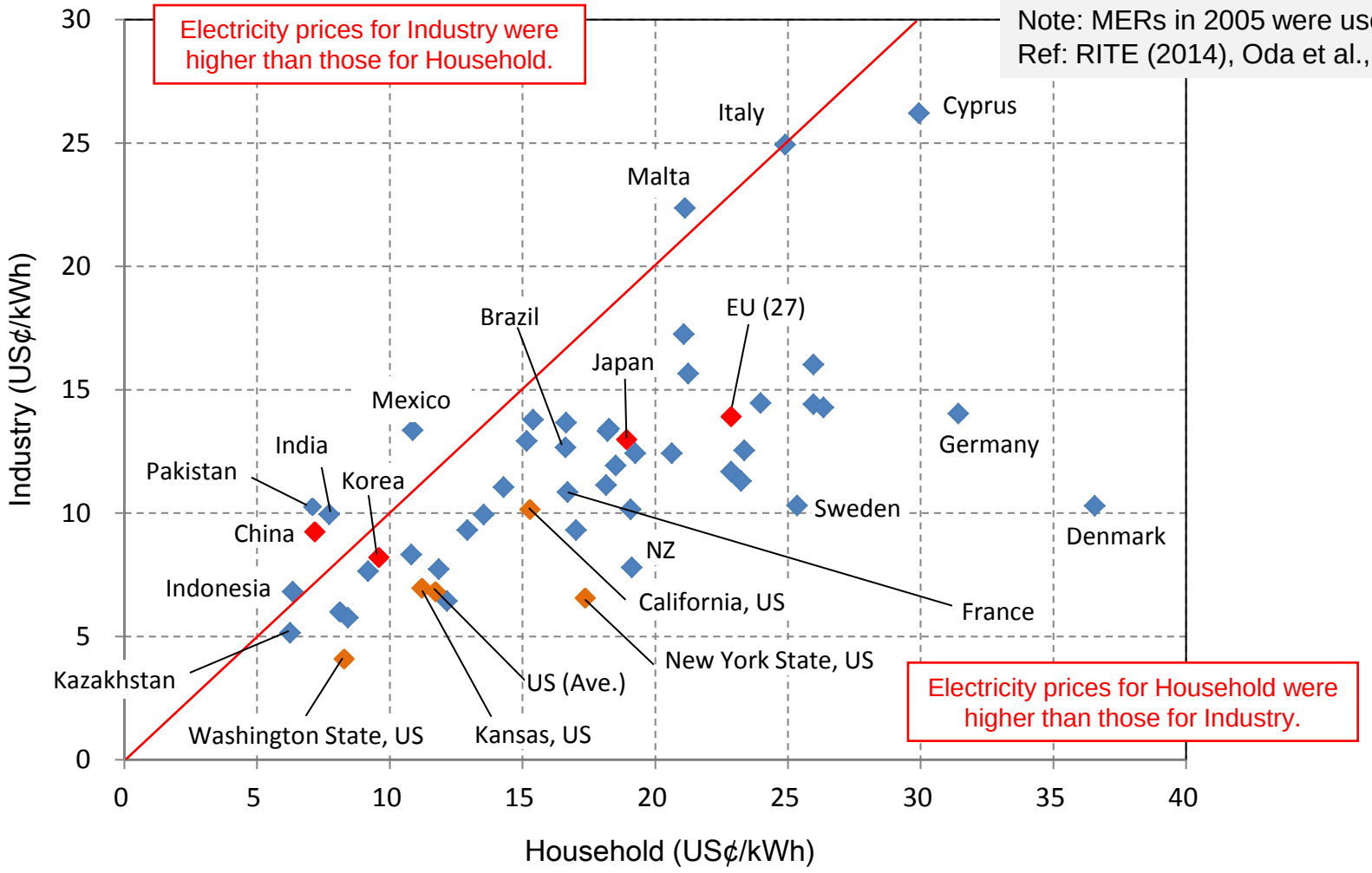
Secondary energy prices – retail prices of gasoline and diesel in 2012: for expost review



Source) RITE, 2014 based on IEA, 2013 and GIZ, 2013

Gasoline and diesel prices in some countries, esp. the Middle East, are low.
Those prices in Europe, Korea, and Japan are high.

Secondary energy prices – electricity prices in 2009-11: for expost review



Although electricity prices depend on generation mix, they could imply levels of mitigation efforts. Electricity prices were relatively high in Europe, and Japan, but relatively low in US, China, and Korea.

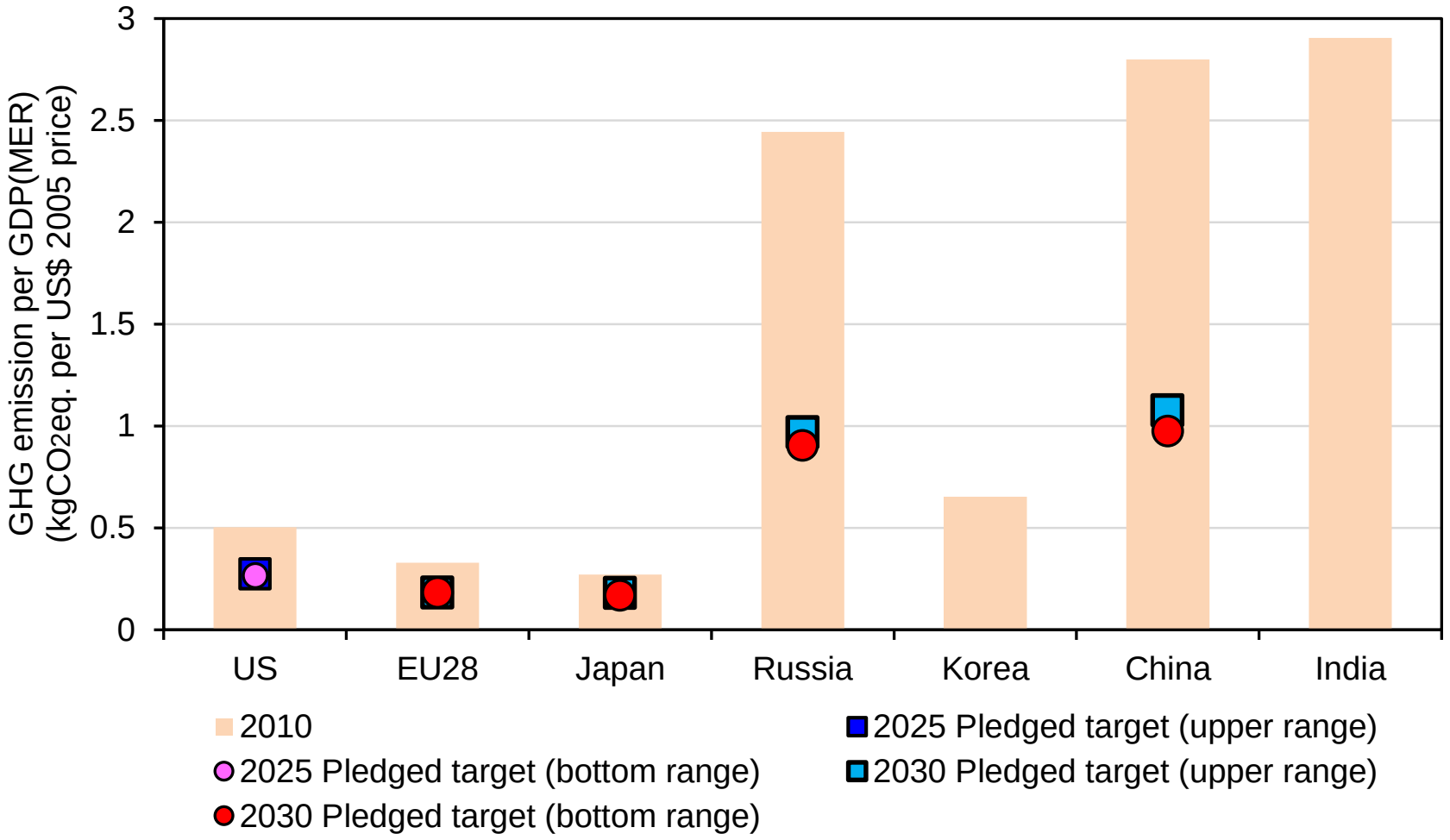
Examples of Exante Evaluations for Tentative INDCs Including Comparisons with Historical Data

Tentative INDCs

	Cancun pledge for 2020	Tentative INDCs for post-2020
Japan	-3.8% relative to 2005*	**Just example simulations for -15 to -20% relative to 2005**
U.S.	around -17% relative to 2005	**-26 to -28% in 2025 relative to 2005**
EU	-20% relative to 1990	**-40% in 2030 relative to 1990**
Russia	-15 to -25% relative to 1990	**-25 to -30% in 2030 relative to 1990**
Korea	-30% relative to BAU	**—**
China	-40 to -45% of per-GDP CO_2 emission relative to 2005	**The peaking of CO_2 emissions around 2030 and to make best efforts to peak early**
India	-20 to -25% of per-GDP CO_2 emission relative to 2005	**—**

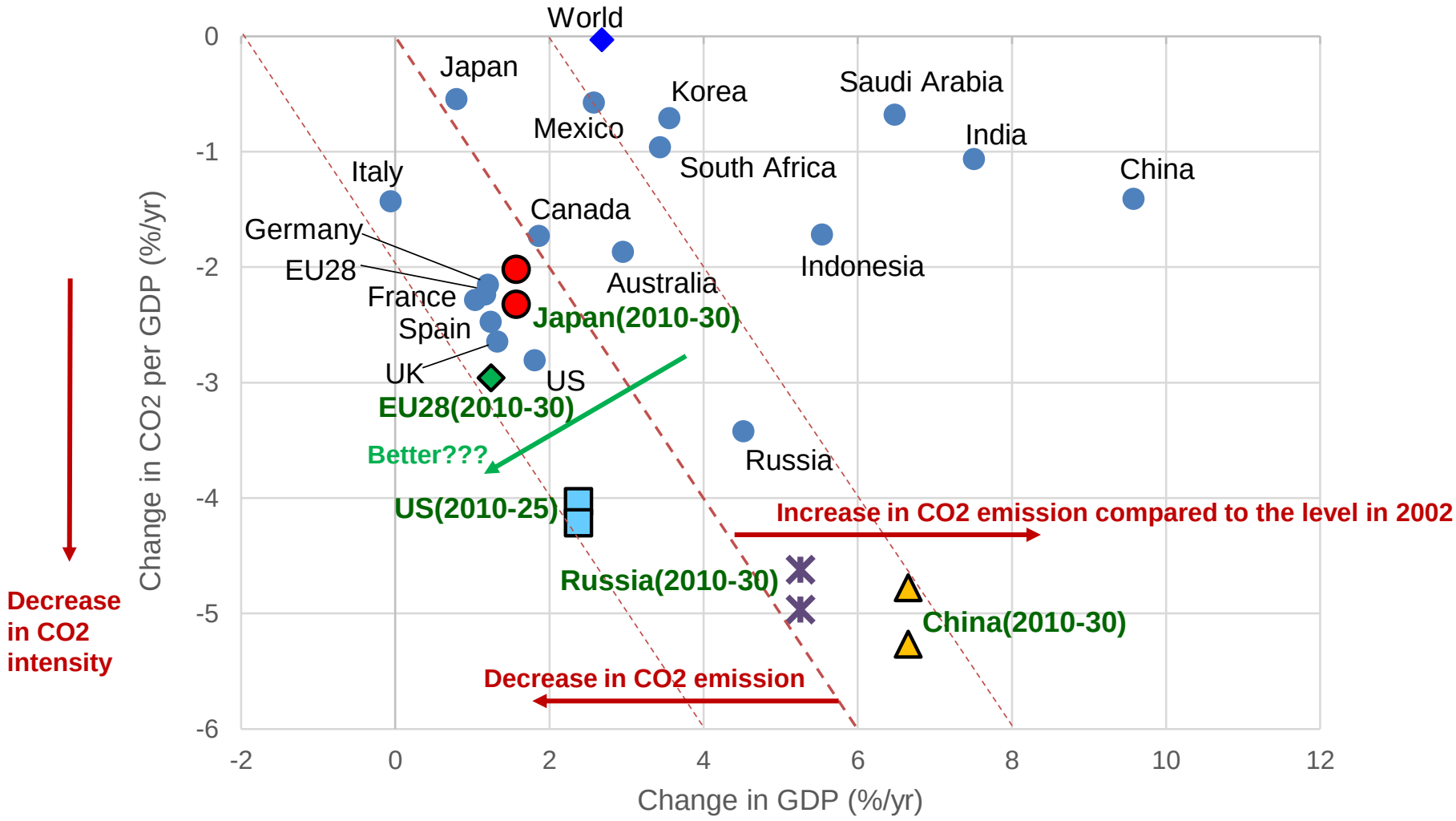
* Excluding of GHG emission reduction effects of nuclear power

Comparison of GHG Emission Intensity of GDP(MER) in 2010 and Evaluations of the Preliminary Pledged Targets



The GHG emissions per capita of temporal INDCs for US, EU28, China, Russia, and that in the case of 10 to 15% reductions relative to 2005 for Japan are estimated as shown here.

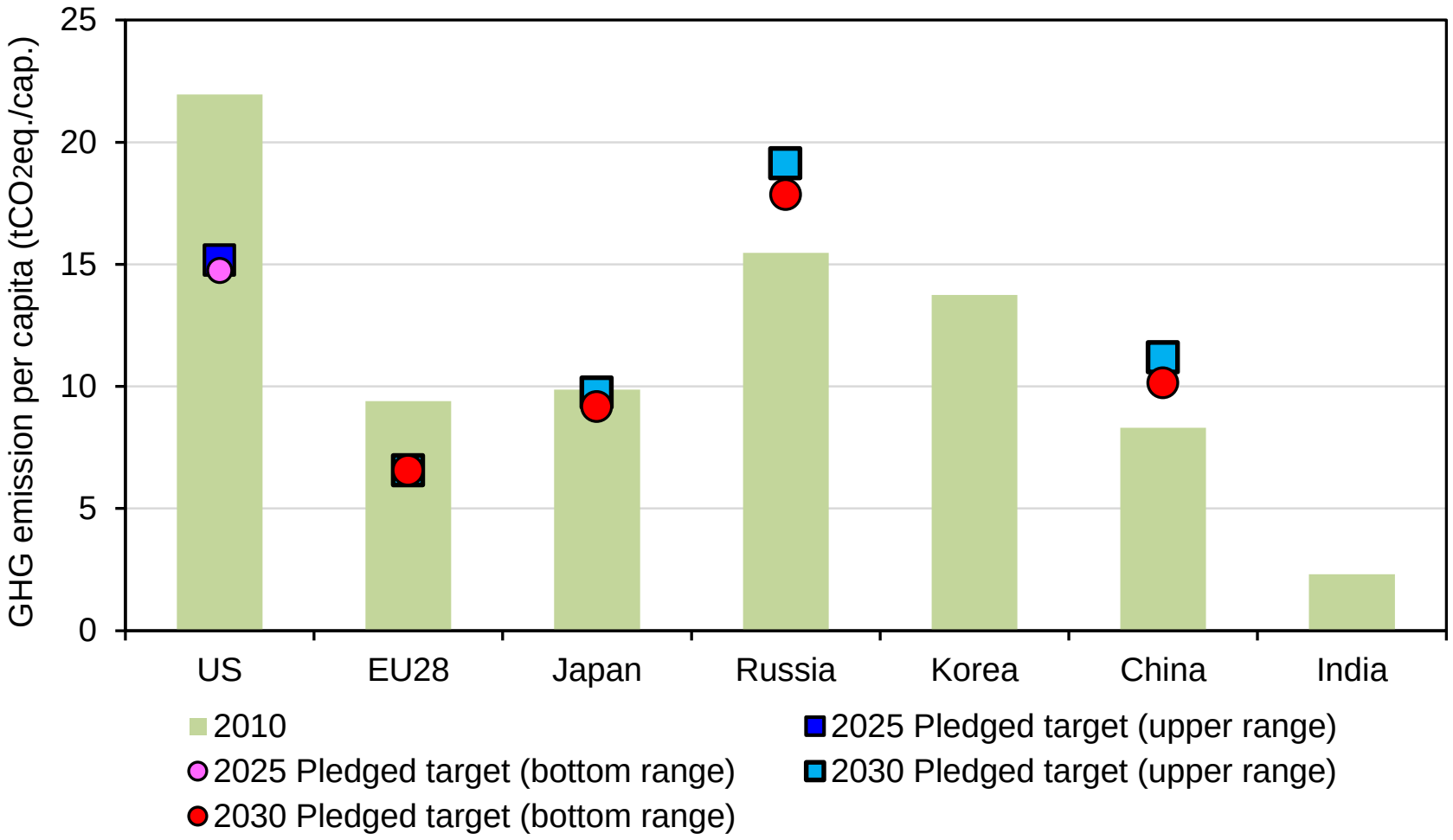
Changes in GDP vs CO_2 Intensity of GDP
Between 2002 and 2012 (past 10 years)



Note: The CO2 intensity of Japan in 2012 was strongly affected by nuclear power plant stops.

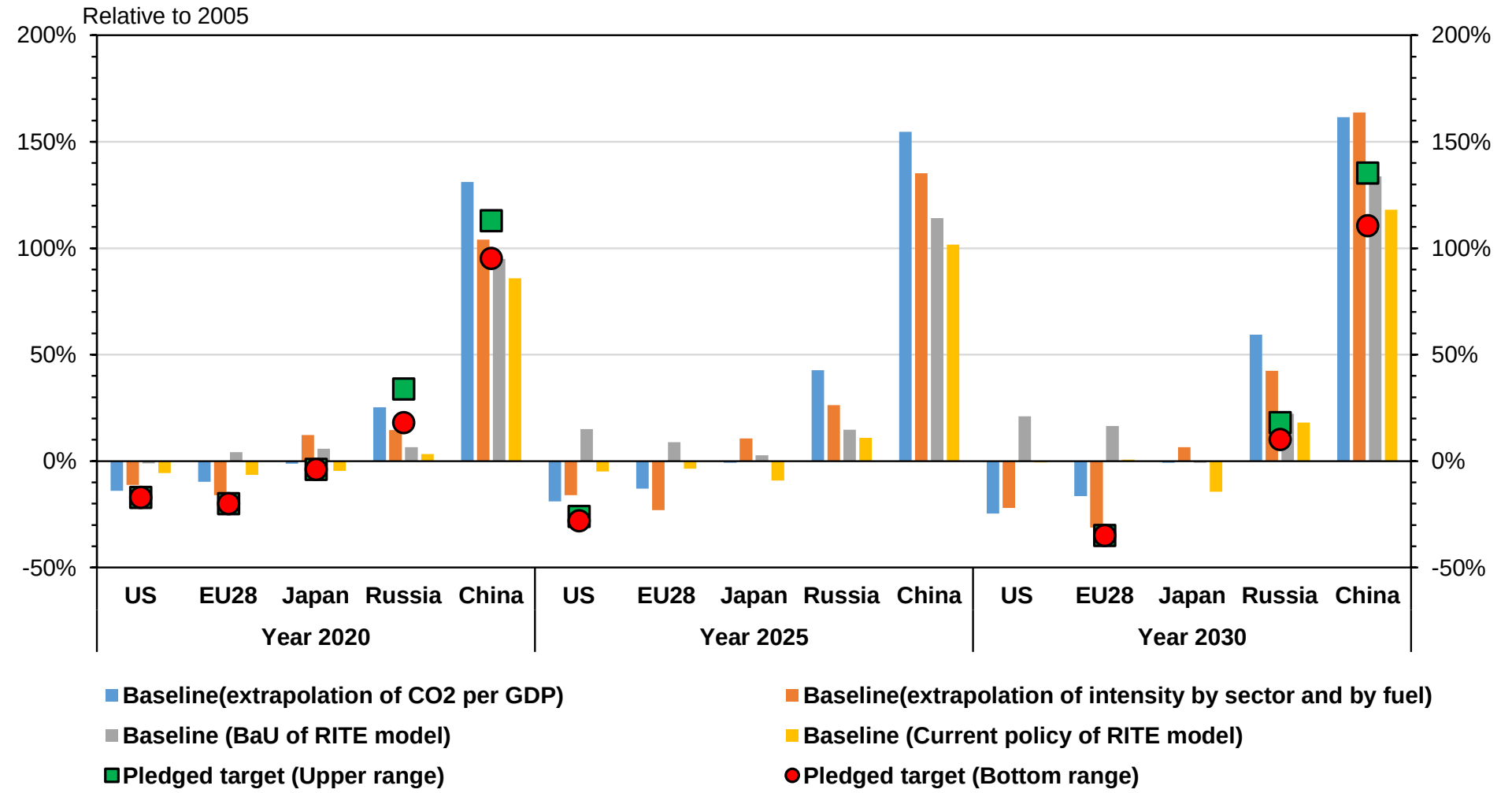
The CO_2 intensity of GDP of tentative INDCs for US, EU28, China, Russia between 2010 and 2025/2030 can be mapped here.

Comparison of GHG Emission per Capita in 2010



The GHG emissions per capita of temporal INDCs for US, EU28, China, Russia, and that in the case of 10 to 15% reductions relative to 2005 for Japan are estimated as shown here.

Baseline Emissions and Pledged Targets



Note1: The pledged target of Japan for 2020 is the emission when emission reduction effects of nuclear power are excluded.
Note2: The emission targets of China are estimated by RITE to meet the peak-out of CO2 emissions in 2030.
Note3: All the emission targets after 2020 are preliminarily.

Future baseline emissions have large uncertainties, and further studies are needed. However, the difference between the baseline and pledged emissions is also an important information for measuring emission reduction efforts.

Evaluations of Emission Reductions of Pledged Targets from Baseline

	Year 2025	Year 2030		
	US	EU28	Russia	China
Pledged emission target: upper range				
Relative to Baseline (extrapolation of CO2 per GDP)	-7%	-18%	-41%	-26%
Relative to Baseline (extrapolation of intensity by sector and by fuel)	-10%	-4%	-24%	-28%
Relative to Baseline (BaU of RITE model)	-32%	-51%	-4%	2%
Relative to Baseline (Current policy of RITE model)	-23%	-34%	0%	17%
Pledged emission target: bottom range				
Relative to Baseline (extrapolation of CO2 per GDP)	-9%	-18%	-49%	-51%
Relative to Baseline (extrapolation of intensity by sector and by fuel)	-12%	-4%	-32%	-53%
Relative to Baseline (BaU of RITE model)	-34%	-51%	-12%	-23%
Relative to Baseline (Current policy of RITE model)	-25%	-34%	-8%	-7%

Note: percent point change (relative to 2005)

The emission reduction ratios of tentative INDCs of US, EU, Russia, and China from their baseline emissions are shown here. The emission reduction ratios are very different according to the baseline definitions.

Evaluations of Emission Reduction Costs (MAC) for Achieving the Tentative INDCs

The following marginal abatement costs were estimated preliminary by using a technology-oriented energy systems model, DNE21+ developed by RITE.

	Marginal abatement cost ($/tCO2eq)	
	For upper range	For bottom range
US: -26 to -28% in 2025 relative to 2005	57	76
EU28: -40% in 2030 relative to 1990	168	
Russia: -25 to -30% in 2030 relative to 1990	0	12
China: peak-out in 2030 (RITE outlook emissions)	0	9

Note: The cost ranges include not only the rage of target but also the model assumptions for LULUCF.

The estimates of mitigation costs accompany large uncertainties, but the mitigation costs are very important to measure emission reduction efforts under different conditions across countries. Marginal abatement costs are important particularly for similar economy levels of countries to keep international competitiveness.

Toward COP21

Toward COP21 in Paris: INDCs

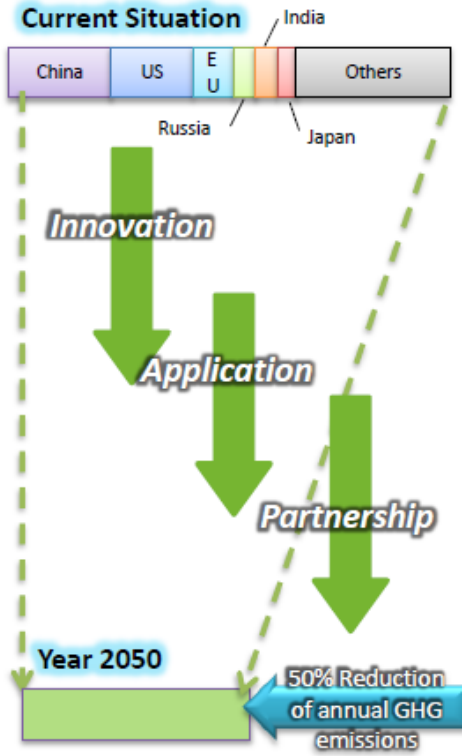
- **Past discussions on fair and equitable indicators under the KP-like top-down framework tended to seek emission allocations among countries. However, this approach falls into a zero-sum game. There exists no single indicator that is capable of measuring fair and equitable allocations does not exist. The post-2020 framework will be pledge and review (P&R) type, and a new method and processes should be developed.**
- **These indicators which we showed here are NOT for emission allocations, but do intend to be used just for evaluating INDCs and inducing deeper emission reductions after COP21 through peer-reviews in the PDCA cycle.**
- **For the indicators intended for emission allocations with legal bindings, use of only certain statistic data will be justified. On the other hand, such data cannot measure fair and equitable emission reduction efforts. The indicators with smaller certainty can be adopted for the review under a P&R type emission reduction framework, as long as they meet logicality and validity requirements.**

ACE: Action for Cool Earth

Japan's Aggressive Diplomatic Strategy for Climate Change Responses

Basic Concept

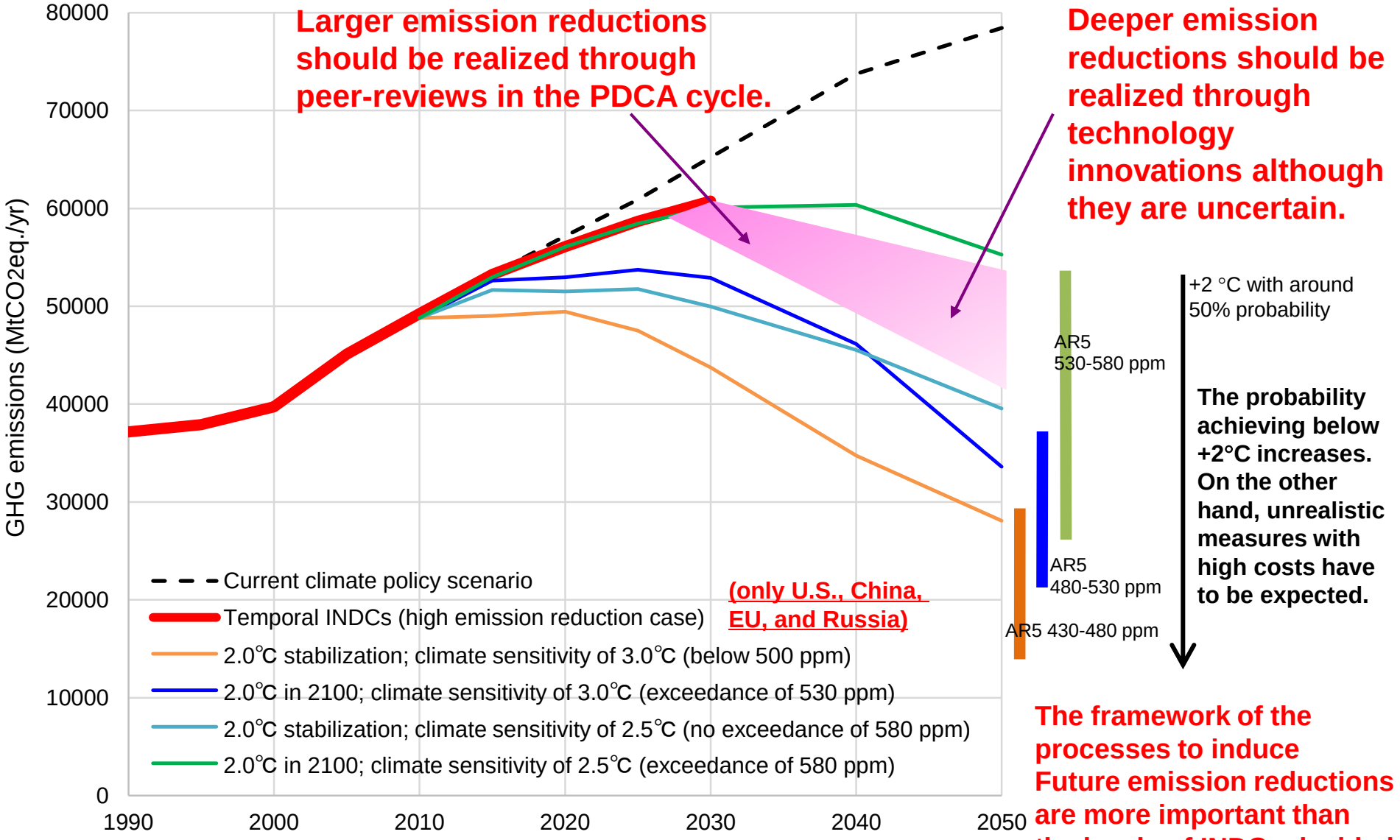
- Warming of the climate system is unequivocal.
  (IPCC Fifth Assessment Report)
- Concrete actions are needed for:
  - **50% reduction of global GHG emissions**
  - **80% reduction for developed countries by 2050**
- Actions for "Cool Earth" are:
  - Innovation of Low Carbon Technologies
  - Application of existing technologies
  - Partnership with various stakeholders
- Overcoming the aftermath of the Great East Japan Earthquake and the nuclear accident.



Contributing to realizing Cool Earth by technologies

OVERVIEW: November 2013, Ministry of Foreign Affairs, Ministry of Economy, Trade and Industry, Ministry of Environment, JAPAN

The relationship between climate sensitivity and globa emission pathways for 2°C target, and outlook of INDCs



The framework of the processes to induce Future emission reductions are more important than the levels of INDCs decided in COP21.

Conclusion

- **Achievable post-2020 targets should be decided in the real world, while ambitious targets are desirable. The 25% reduction target of Japan by 2020 relative to 1990 rather led to stagnant climate change response measures in Japan. The 450 ppm CO2eq stabilization target may also lead to stagnant climate change response measures if we have the adherence of the target. The long-term target should also be treated with flexibility considering uncertainties in climate sensitivity etc.**
- **A specific number of emission reduction rate is not necessarily important. The establishment of review processes for inducing sustainable emission reduction efforts are more important.**
- **Deeper emission reductions should be realized in long-term through wide deployments and diffusions of high energy efficiency and low-carbon technologies, and technology innovations and their deployments.**

Appendix

Comparison of CO_2 Emission per Capita