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# Measuring Emission Reduction Efforts of the INDCs and the Expected Global Emission Reductions and Economic Impacts


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for some estimates


# How to measure the comparability of efforts



**The submitted INDCs include the targets of emissions 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 from the same base year**

  **etc.**
- **More advanced metrics (more comprehensive, but require forecasts)**
  - **Emission reduction ratios from baseline emissions**
  - **Emissions per unit of GDP**

  **etc.**
- **Most advanced metrics (most comprehensive, but require modeling)**
  - **Energy price impacts**
  - **Marginal abatement cost (per ton of $CO_2$)**
  - **Abatement costs as a share of GDP**

  **etc.**

# Employed indicators for measuring emissions reduction efforts



| Emissions reduction efforts evaluation method | | Framework | Notes |
|---|---|---|---|
| **Emissions reduction ratio from base year** (only for OECD countries or Annex I countries) | Compared to 2005 | When baseline emissions are expected to stagnate, it is more relevant to simply compare the projected reduction rates (all the more since there are uncertainties regarding the BAU). This is why we use the reduction ratio compared to BAU for OECD countries only - on the other hand, such an approach would be irrelevant for countries where emissions are expected to grow substantially. | Most countries use 2005 as their base year (as a matter of fact, 1990 seems too far in the past to be used as a base year to evaluate the emissions reduction effort for upcoming emissions) |
| | Compared to 2012 (or 2010) | | This seems a relatively good choice to evaluate future efforts as it allows assessing reduction ratios in comparison with recent circumstances. |
| **Emissions per capita** (only for non-OECD countries or non-Annex I countries) | Absolute value | For OECD countries, we adopt the reduction ratio from base year instead of the absolute value of emissions per capita. | As it is highly dependent on the country's level of economic activity and situation in general, it can be difficult to assess emissions reduction efforts through this indicator. |
| **CO2 intensity (GHG emissions per GDP)** | Absolute value | Reveals what level of CO2 emissions corresponds to what degree of economic activity | It can easily reach bad values for countries with a low GDP; it is also highly dependent on the country's industry structure. |
| | Improvement rate (compared to 2012 or 2010) | As it removes the bias due to the fact that economic growth has changed compared to the base year, it reveals the real effort in emission reduction. | For countries with a low GDP, carbon intensity can improve greatly just due to high economic growth. |
| **Emissions reduction ratio compared to BAU** | | It allows taking into account the difference of economic growths, etc. | It puts aside past efforts in energy savings and abatement potential of renewables. |
| **CO2 marginal abatement cost (carbon price)** | | This is a particularly relevant indicator to assess reduction efforts as it contains countries' differences in terms of economic growth, energy savings efforts, abatement potential of renewables. | Past measures such as taxes on energy are out of the scope (however, one must keep in mind that, as energy savings efforts have already been made in the past, this may lead to higher estimates of marginal abatement costs.) |
| **Retail prices of energy (electricity, city gas, gasoline, diesel)** | Weighted average of historical data from 2012 or 2010 | While marginal abatement costs show the additional effort to be made, this indicator also includes the efforts made in the baseline. | Market data is available for ex-post evaluation, but for ex-ante evaluation, only model-based estimates are available which makes uncertainties rather high. |
| **Emission reduction costs per GDP** | | As marginal abatement costs do not take into account the economy's ability to bear such an effort, this indicator does. | Uncertainties are high as this is a model-based estimation. |

# Evaluated INDCs



**The 119 INDCs submitted as of October 1st, 2015 were evaluated.**

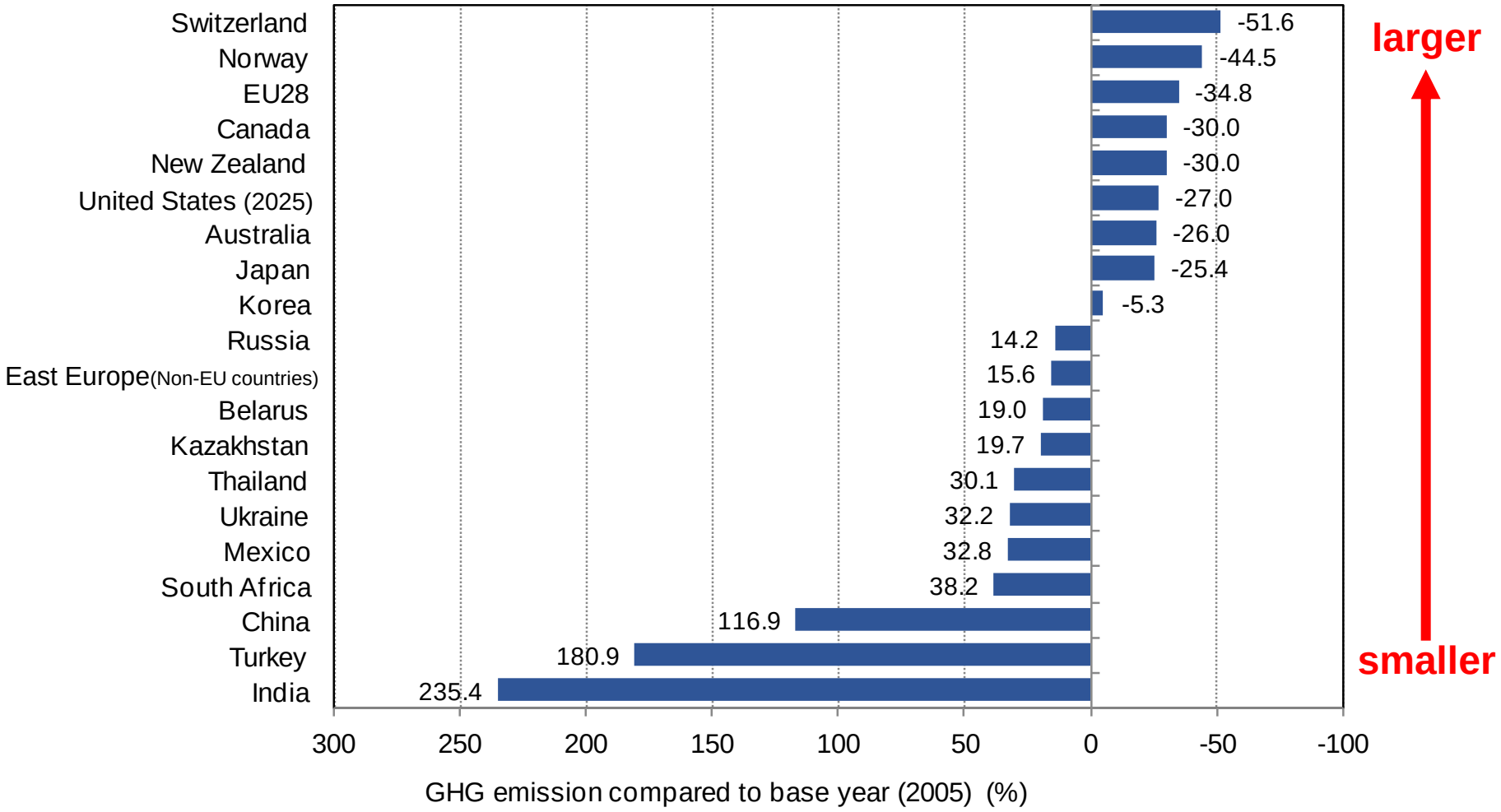
**As of October 1st, 2015, 119 INDCs had been submitted, and representing about 88 per cent of global emissions in 2010.**

**Comprehensive evaluations of emission reduction efforts were only for 20 countries due to the limited regional resolution of the model.**

Note: More ambitious emission reduction targets had been submitted as “conditional“ targets from some countries, but they are not considered in this evaluation.

# International comparison of emission reduction ratios from the base year of 2005



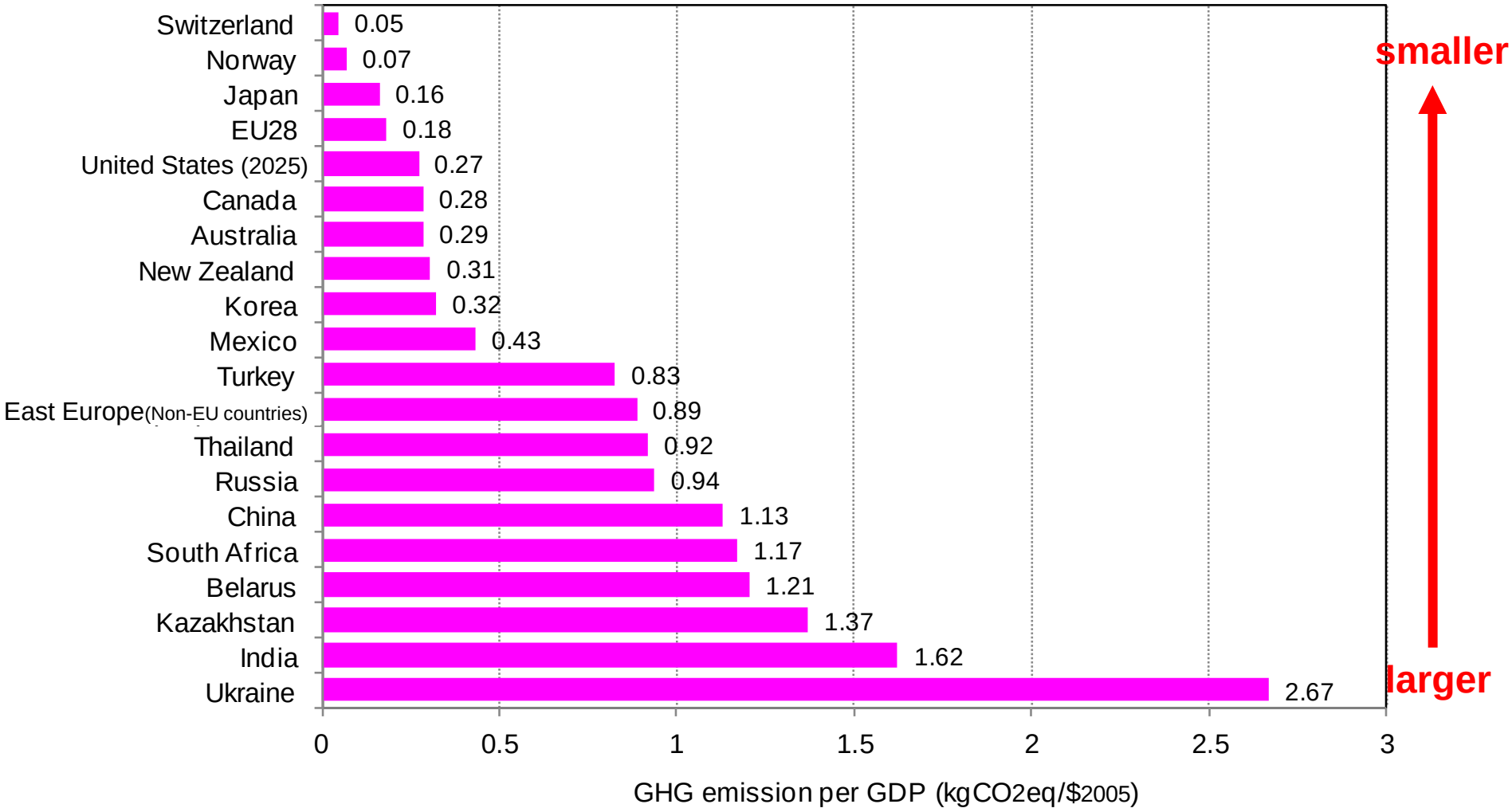



* The average values are shown for the countries submitted the INDC with the upper and lower ranges.

**It is not easy to measure 'emission reduction efforts' by using the emission reduction ratios from a certain base year due to large differences in future economic growth and historical achievements of energy saving improvements and emission reductions, for example.**

# International comparison of GHG emissions per GDP



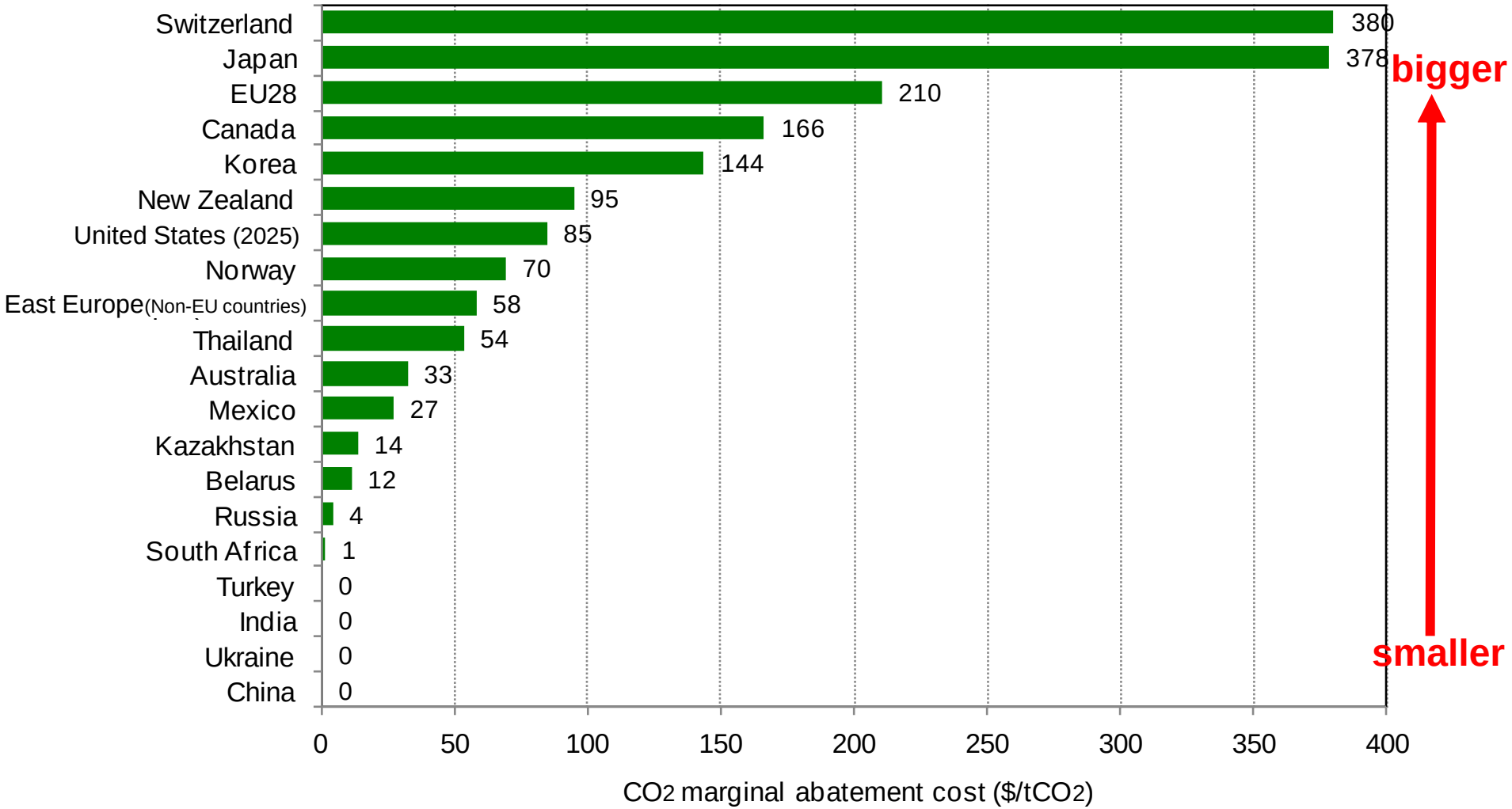



* The average values are shown for the countries submitted the INDC with the upper and lower ranges.

**GHG emission per GDP indicates economic efficiency of GHG emission in general, but it depends on the industrial structures and low-carbon energy supply potentials.**

# International comparison of $CO_2$ marginal abatement costs (RITE DNE21+ model)



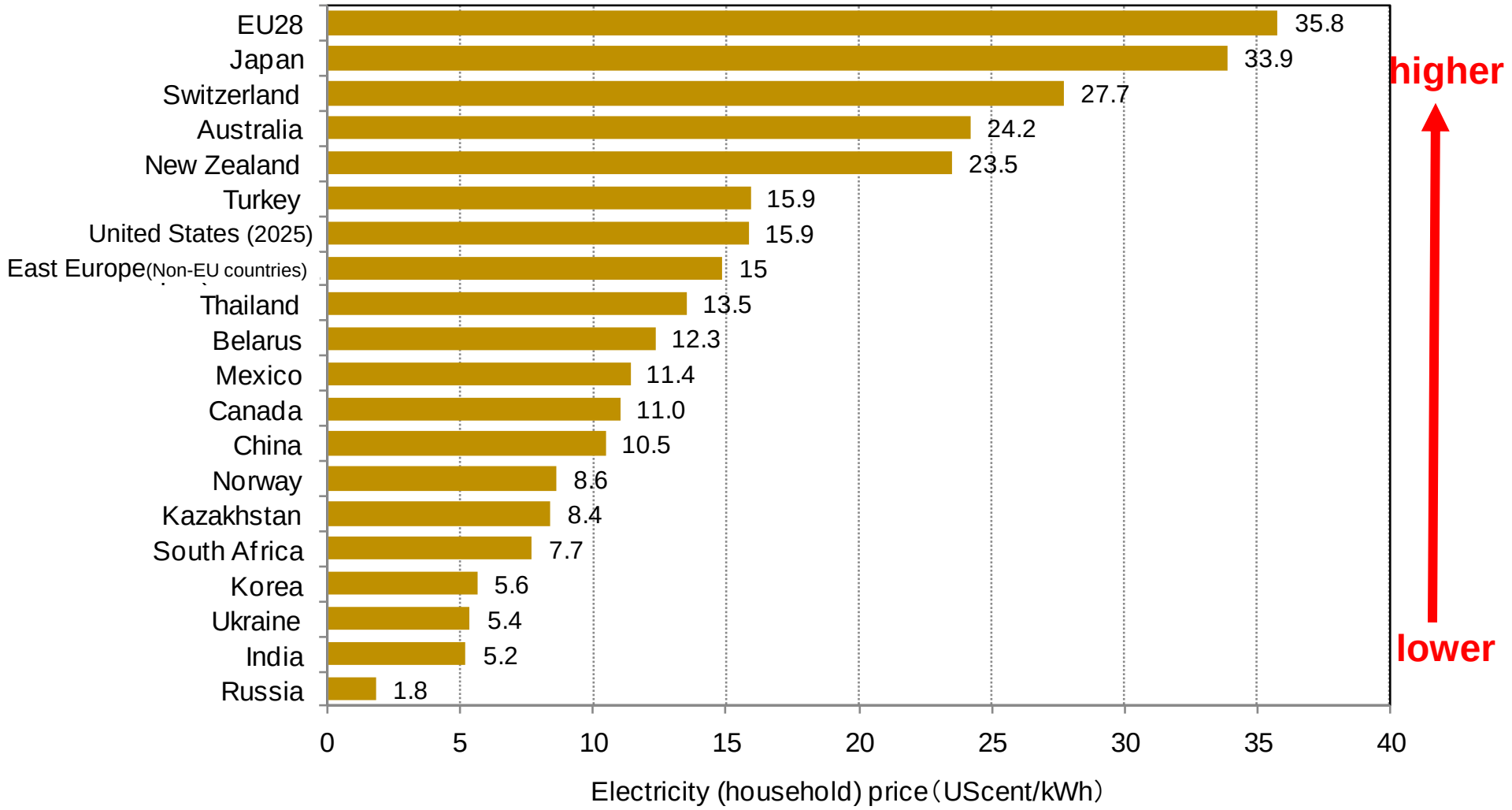



* The average values are shown for the countries submitted the INDC with the upper and lower ranges.

**Large differences in marginal abatement costs are estimated across countries. The large differences raise concern about inducing the carbon leakage and the ineffectiveness of global emission reductions.**

# International comparison of retail prices of energy (electricity) (RITE DNE21+ model)



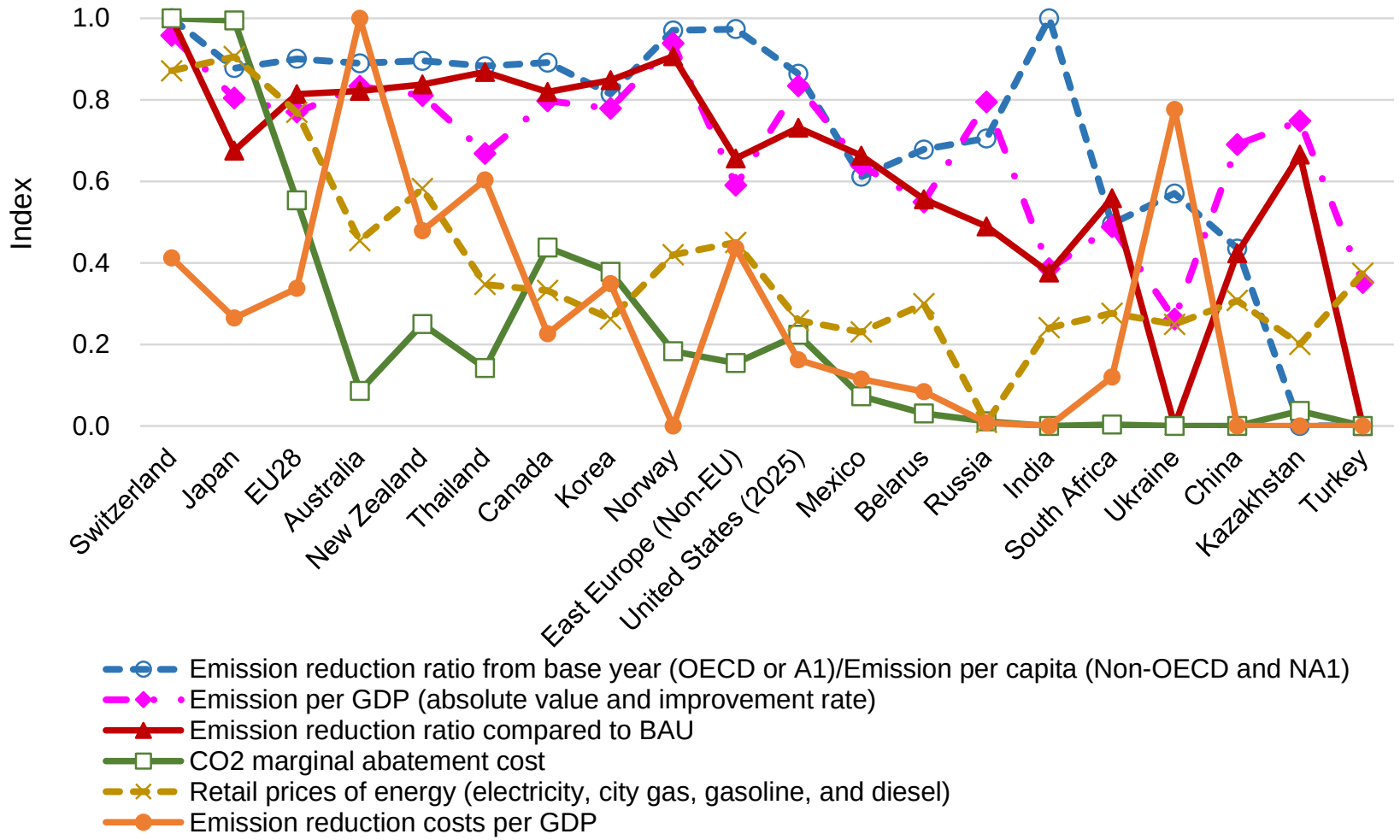



* The average values are shown for the countries submitted the INDC with the upper and lower ranges.

**Since marginal abatement costs show the additional effort to be made, the retail prices of energy are also important indicators for measuring the total efforts including baseline's.**

# Ranking index of emissions reduction efforts (ambition) of INDCs by indicator

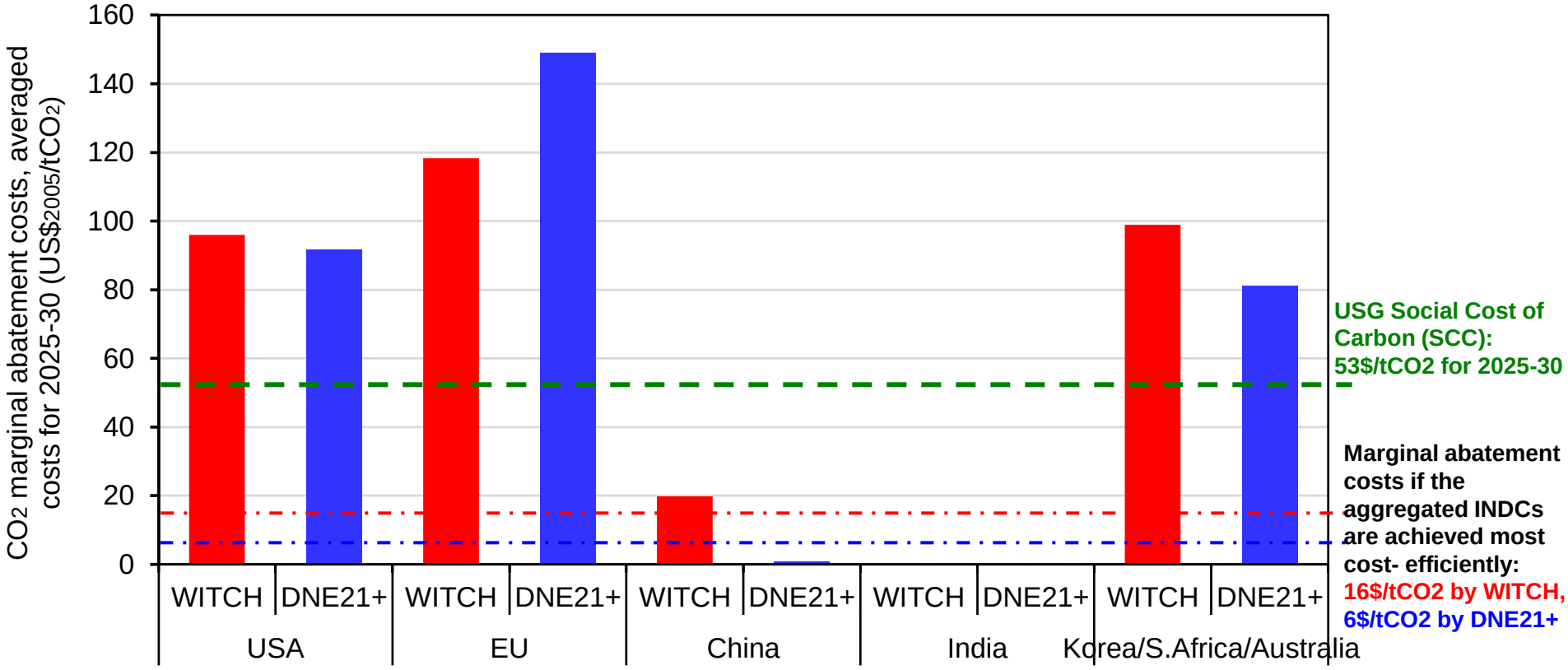





**Many indicators (excepting emission reduction costs per GDP) of Switzerland, Japan, and EU were ranked high. $CO_2$ marginal abatement cost of Australia is not high, but the emission reduction cost per GDP is large. On the other hand, some countries having poor rankings in many of the indicators are also observed.**

# Marginal abatement costs by two models (RITE DNE21+ and FEEM WITCH)



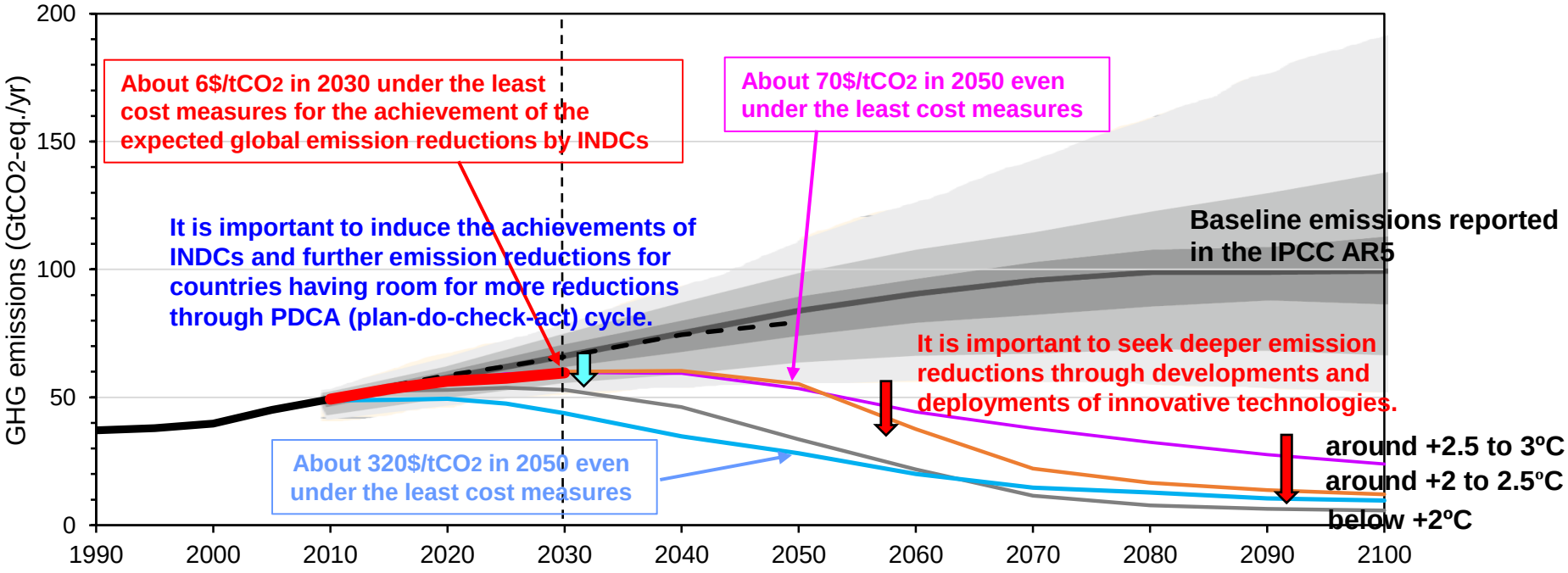



Source: B. Pizer, J. Aldy, R. Kopp, K. Akimoto, F. Sano, M. Tavoni

- The marginal abatement costs widely across models for some countries, but can be comparable for many countries/regions.
- The $CO_2$ marginal abatement costs of the INDCs of OECD countries are much higher than the marginal cost for the case that the total reductions are achieved most cost-efficiently (globally uniform marginal abatement cost).

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






Historical emissions

Emission outlook under current policies

+2.5 ºC stabilization under climate sensitivity of 2.5 ºC (around +2.6 ºC in 2100 and +3.0 ºC in 2200 under C.S. of 3.0 ºC）

+2 ºC stabilization under climate sensitivity of 2.5 ºC; temporary overshoot of 580 ppm (+2.5 ºC stabilization under C.S. of 3.0 ºC)

Below +2 ºC in 2100 under climate sensitivity of 3.0 ºC; temporary overshoot of 530 ppm

+2 ºC stabilization under climate sensitivity of 3.0 ºC; temporary overshoot of 500 ppm and around 450 ppm in 2300

INDC submitted by October 1 (119 countries) assumed to be implemented

Source) Estimate by RITE

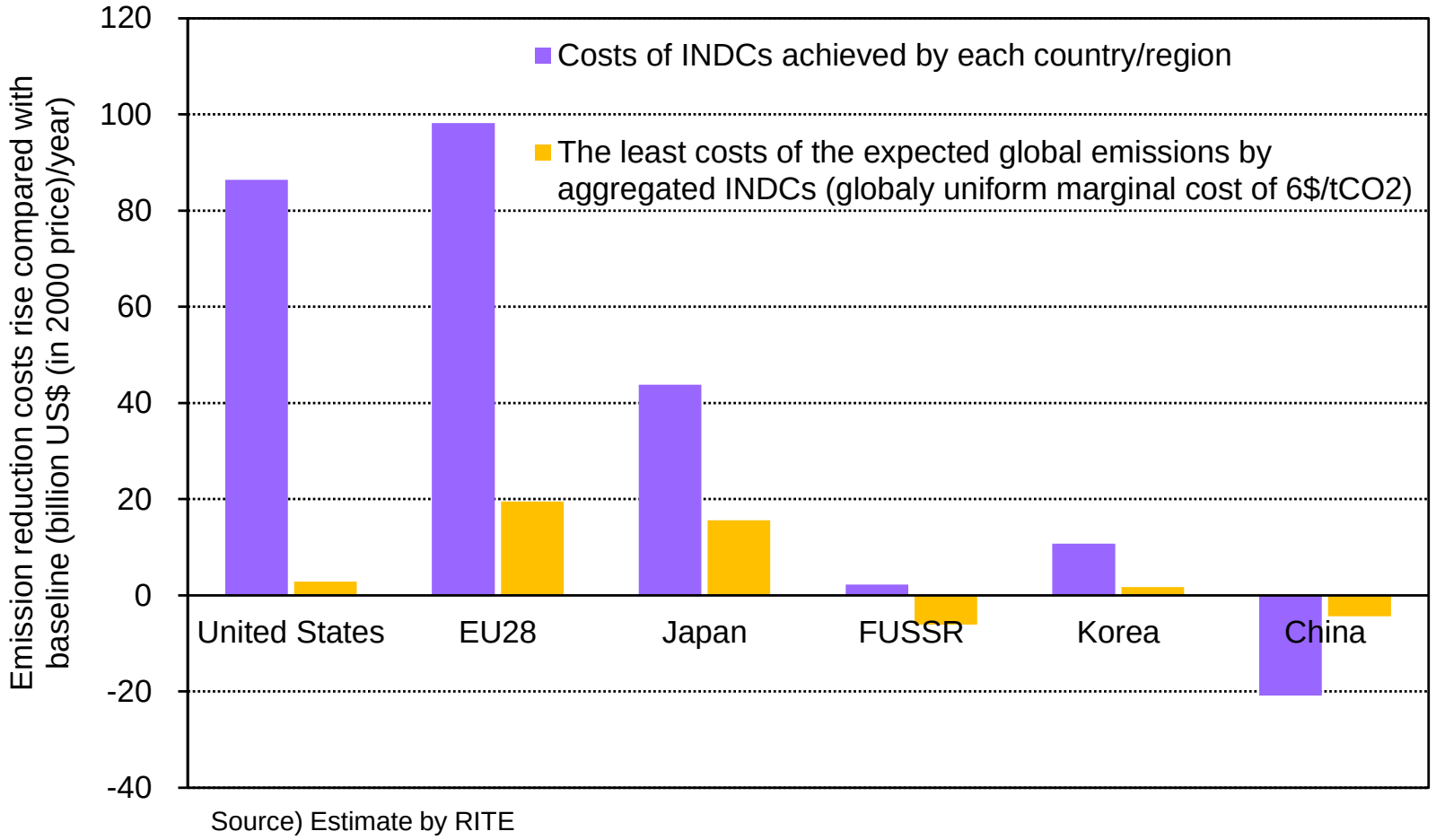
**- The expected global GHG emission in 2030 is about 59.5 GtCO2eq. when all the submitted INDCs are successfully achieved. Emissions reductions from the baseline are estimated to be about 6.4 GtCO2eq, in which about 0.5 GtCO2eq reductions are offset due to carbon leakages from nations with INDCs of high marginal abatement costs to those with zero or low costs through induced lower fossil fuel prices.**

**- The expected temperature change in 2100 is +2 to +3 °C from preindustrial levels. The range depends on the uncertainties of climate sensitivity, and on future deep emission reductions through developments and deployments of innovative technologies.**

# Emission reduction costs rise by INDCs

## - Comparison between the achievement by each country/region and the global least cost -






Source) Estimate by RITE

**- Due to large differences in marginal abatement costs across countries, we observe on the one hand severe economic impacts for some countries with high marginal abatement costs for the INDCs, and on the other hand positive impacts for countries with zero or low marginal abatement costs.**
**- In reality, achieving the INDCs could require much higher costs per country than the global least-cost emission reduction as the IPCC scenarios show.**

# Conclusions



- How to measure the ‘emission reduction efforts (degree of ambition)’ of INDCs is hard work but can be approached by employing multiple good indicators. Measuring the efforts is important for inducing effective emission reductions of the submitted INDCs and deeper emission reductions through a PDCA (Plan-Do-Check-Act) cycle.
- According to the evaluations on the submitted INDCs, marginal abatement costs were evaluated as zero for several nations such as China and India, meaning their INDCs are to be realized in BAU. Large differences in marginal abatement costs across nations induce carbon leakage and the less effectiveness of global emission reduction.
- Global emissions will be 60 $GtCO_2eq$ in 2030 if all the nations realize their submitted INDCs. (Current emissions are 52–53$GtCO_2eq$) The 2030 emissions are considered to stay on the pathways of 2–3 °C temperature rise in 2100 relative to the pre-industrial level.
- Global emission reductions are estimated to become smaller than the simple sum of all the INDCs due to the carbon leakage effect that is caused when marginal abatement costs are substantially different across nations. All nations need to make equitable emission reduction efforts in order to effective global emission reductions.