

Japan NDC (AIM/Enduse[Japan])

Global emissions trading under NDCs
(AIM/CGE[global])

Shinichiro Fujimori and Ken Oshiro

National Institute for Environmental Studies

20th, July, 2016

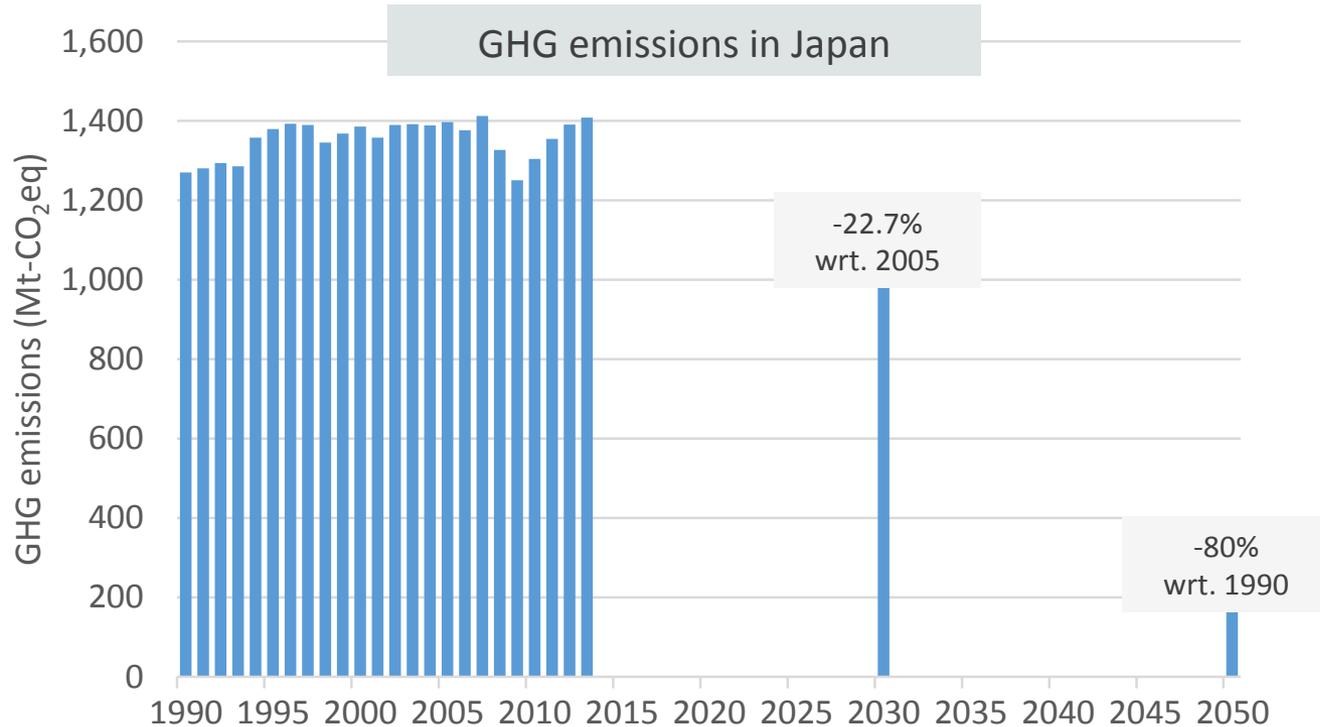
Outline

- Assessment of Japan's INDC and 2050 vision
 - ✓ AIM/Enduse[Japan]
 - ✓ Consideration of energy policy in Japan
- Global emissions trading assessment
 - ✓ AIM/CGE [global]
 - ✓ How much emissions trading would be effective

Assessment of Japan's Post-2020 Targets Using AIM/Enduse [Japan]

Targets

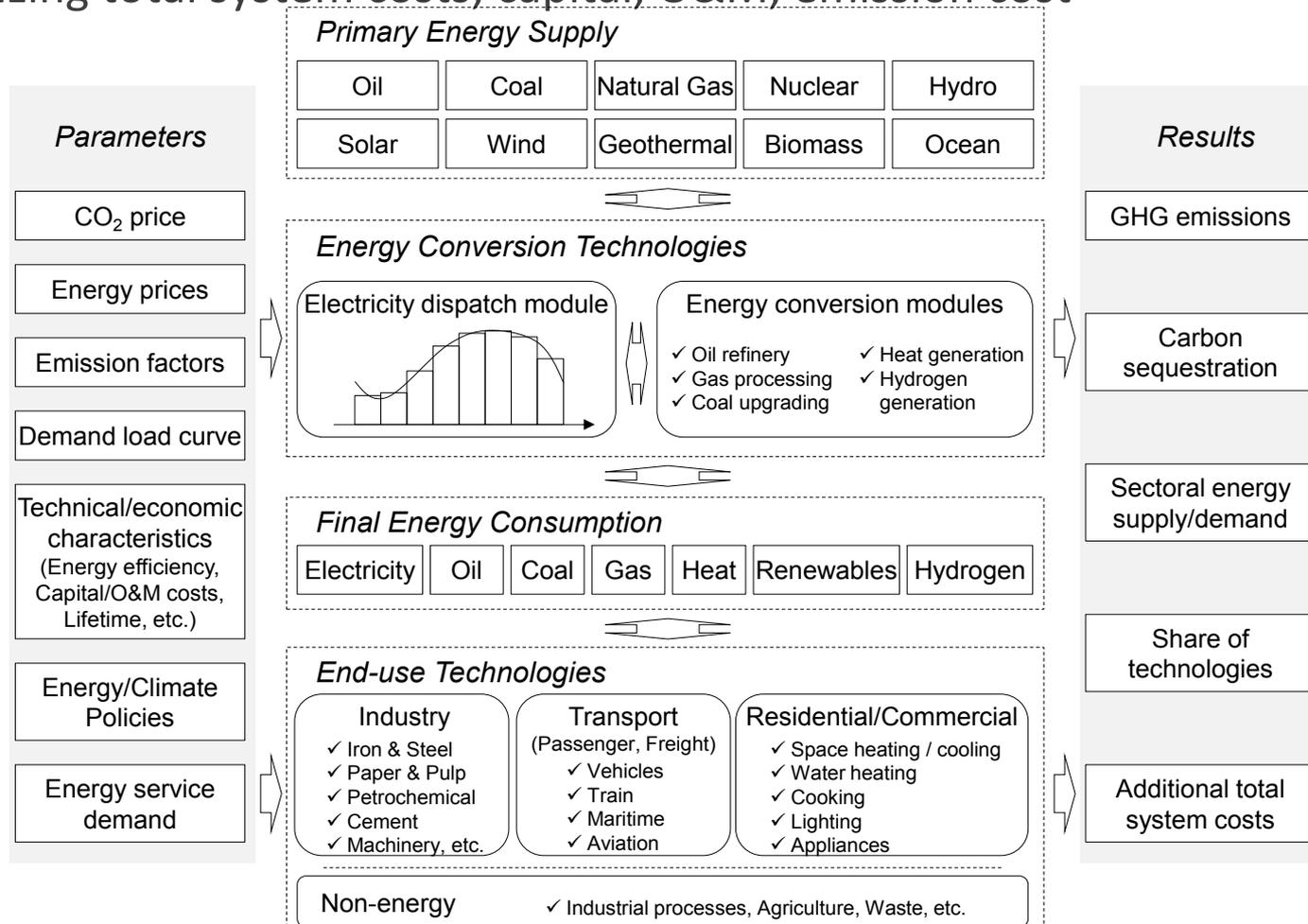
- 2030 target: 25.4% reduction wrt. 2005 based on INDC
 - 22.7% reduction excluding LULUCF
- 2050 target: 80% reduction wrt. 1990 ← Cabinet approval



Source: Greenhouse Gas Inventory Office of Japan, The GHGs Emissions Data of Japan (1990-2013)
* Excluding LULUCF

Basic structure of AIM/Enduse [Japan]

- Bottom-up of end-use sectors, hard-linked with energy supply
- Recursive dynamic, 2010-2050
- Minimizing total system costs; capital, O&M, emission cost



Examples of mitigation options

- Unlike the INDC, most of measures for energy conservation are excluded. (e.g. behavioral change, modal shift to public transport)

Power sector	Efficiency improvement of thermal power plant (e.g. switch from conventional plant to Combined Cycle), Coal and gas plants with CCS, Nuclear power, Onshore/offshore wind power, Solar PV, Geothermal, Bioenergy, Ocean Power, Pumped hydro storage, Reinforcing electricity interconnection, Electrolysis (Hydrogen generation), Flexible resources in the end-use sectors (smart charging of BEV, flexible operation of heat-pump water heater), Reduced transmission & distribution line losses
Industrial sector	Energy efficiency improvement of industrial processes (e.g. High performance pulp washing device, High efficient black liquor boiler, Next generation coke oven, DC electric furnace, Naphtha attached cracking), CCS for iron making and cement lime, Industrial heat pump, Efficiency improvement of boiler and motor, Fuel switching (e.g. from coal to gas), Bioenergy use
Transport sector	Energy efficiency improvement of ICE, Hybrid electric vehicle (HEV), Plug-in hybrid electric vehicle (PHEV), Battery electric vehicle (BEV), Fuel cell electric vehicle (FCEV), Gas-powered HDVs, Biofuels, Efficiency improvement of train, ship, and aircraft
Residential and commercial sectors	Improvement of the energy-efficiency performance of buildings, High-efficiency equipment and appliance (Air-conditioner, water heater, lighting device, home/office appliances, etc.), Electric heat pump water heaters, Fuel cell, Solar thermal water heater, Energy management system

Socio-economic indicators

- 2030: Complying with the Long-term Energy Supply and Demand Outlook (METI, 2015)
- 2050: Estimated based on GDP per capita of SSP5

Assumptions of socio-economic indicators

	2010	2030	2050
Population (Millions)	128	117	97
GDP (trillion US\$ ₂₀₀₅)	4.62	6.41	8.29
Number of household (Millions)	53.4	52.0	44.4
Crude steel production(Mt)	111	120	85
Cement production (Mt)	56.1	55.6	47.4
Commercial floor space (billion m ²)	1.83	1.97	1.91
Passenger transport (trillion pkm)	1.37	1.41	1.17
Freight transport (trillion tkm)	0.45	0.52	0.50

Cases

1. Reference

No carbon price.

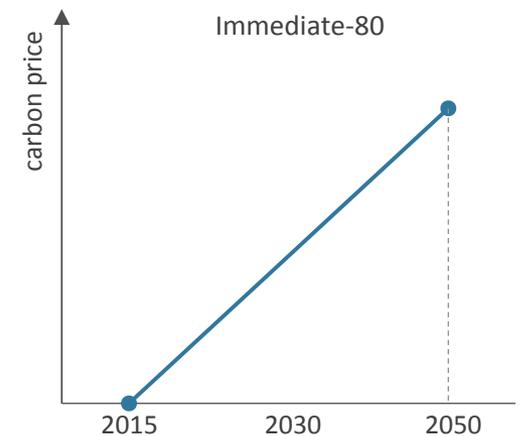
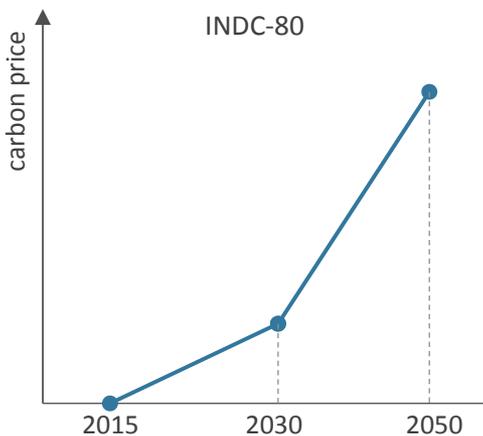
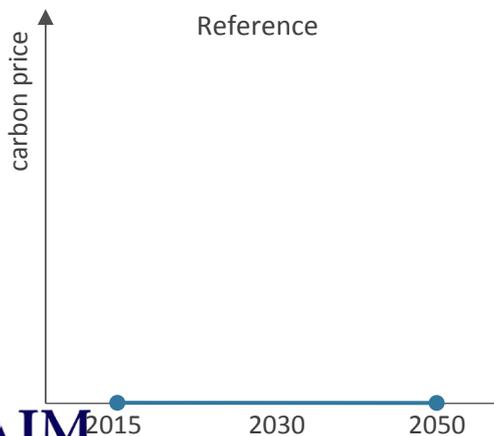
2. INDC-80

Implicit carbon prices are implemented to meet the INDC by 2030, and strengthened thereafter toward the 80% reduction by 2050.

3. Immediate-80

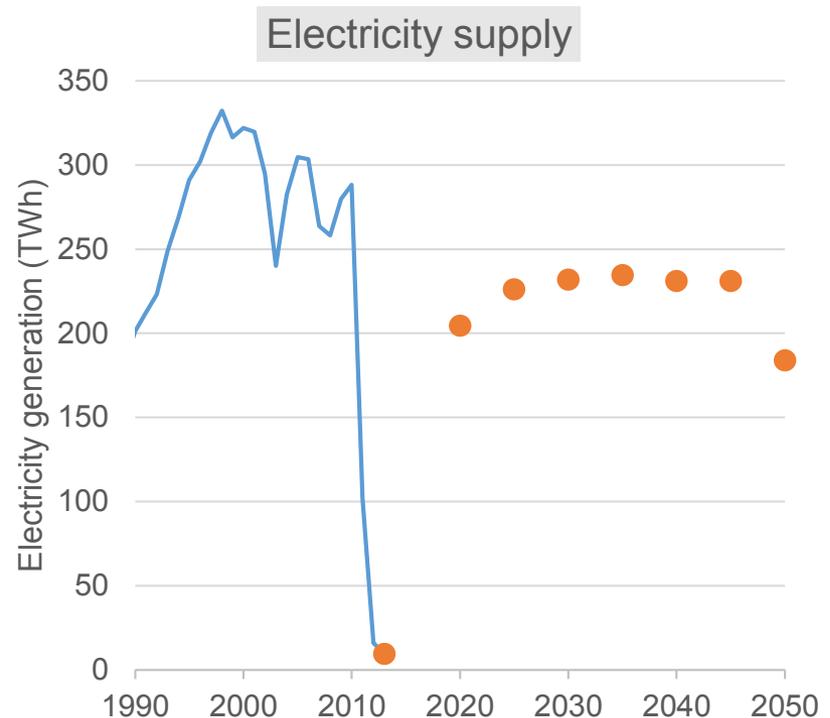
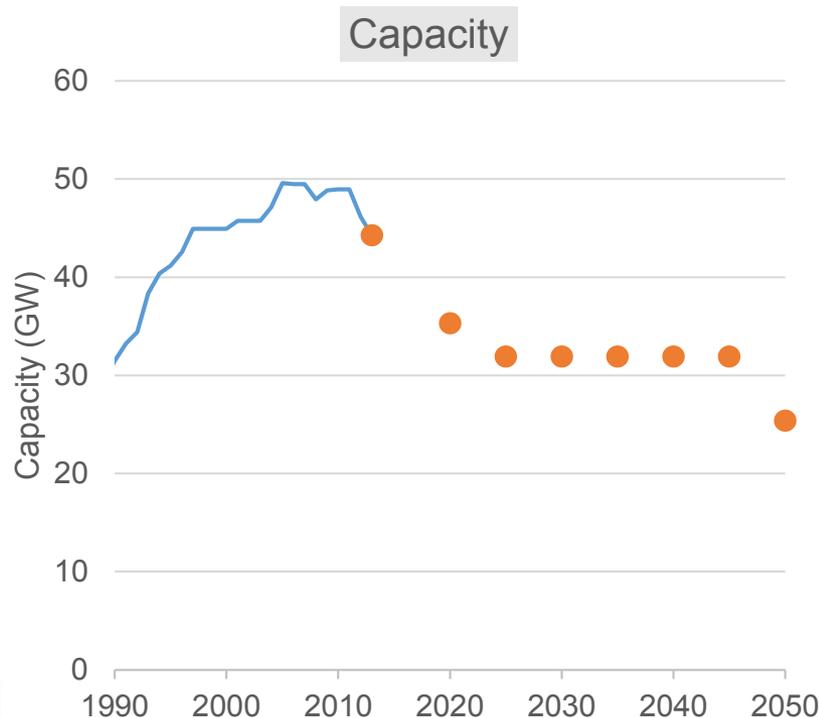
Compared with INDC-80, higher carbon prices are implemented by 2030 to the level of around a half of 2050.

Assumptions of carbon price implementation

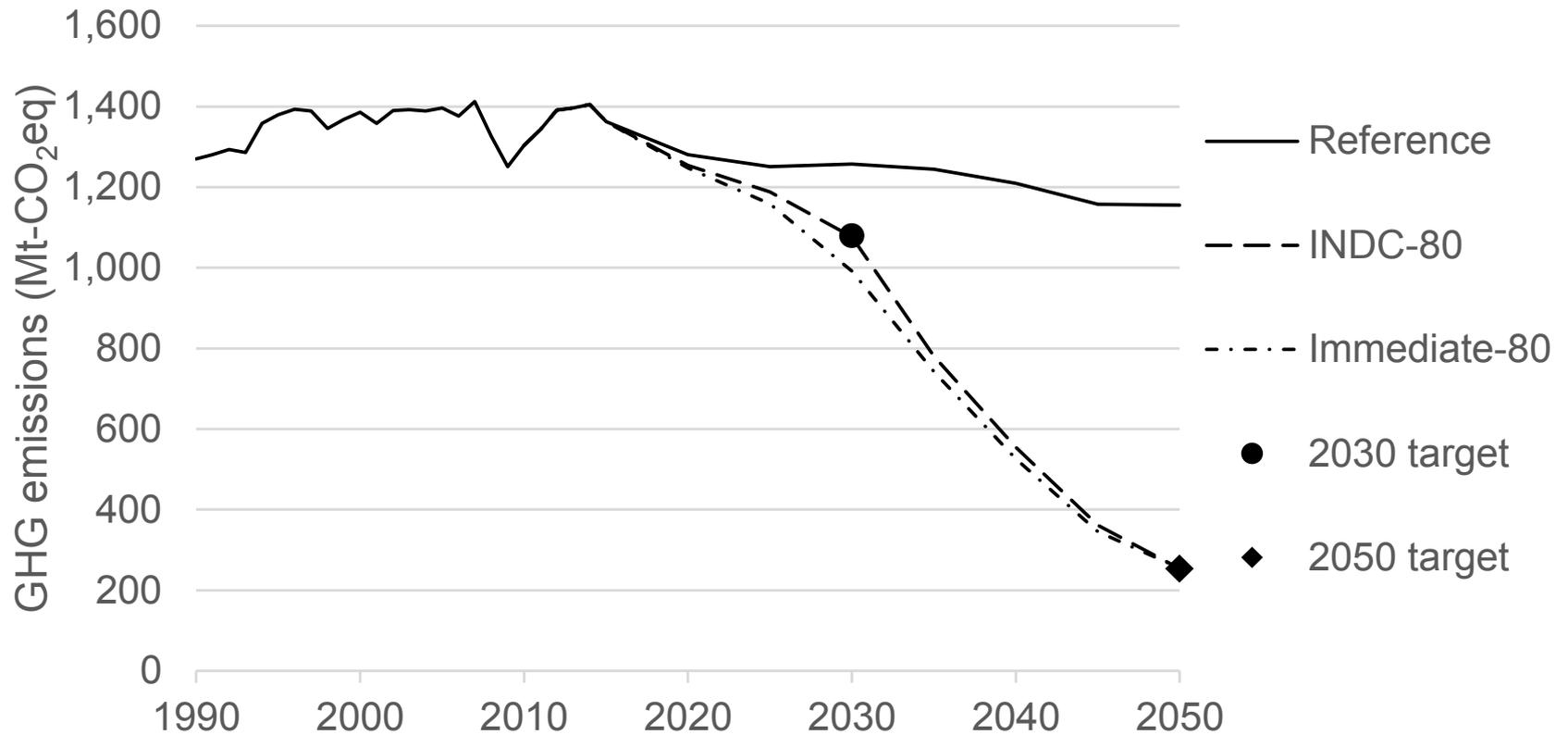


Electricity supply from nuclear power

- Lifetime: Extension to 60 years for the plants built since mid-1980s, 40 years for all others (based on IEA WEO 2014)
- Electricity supply from nuclear power: 232 TWh in 2030, 184 TWh in 2050

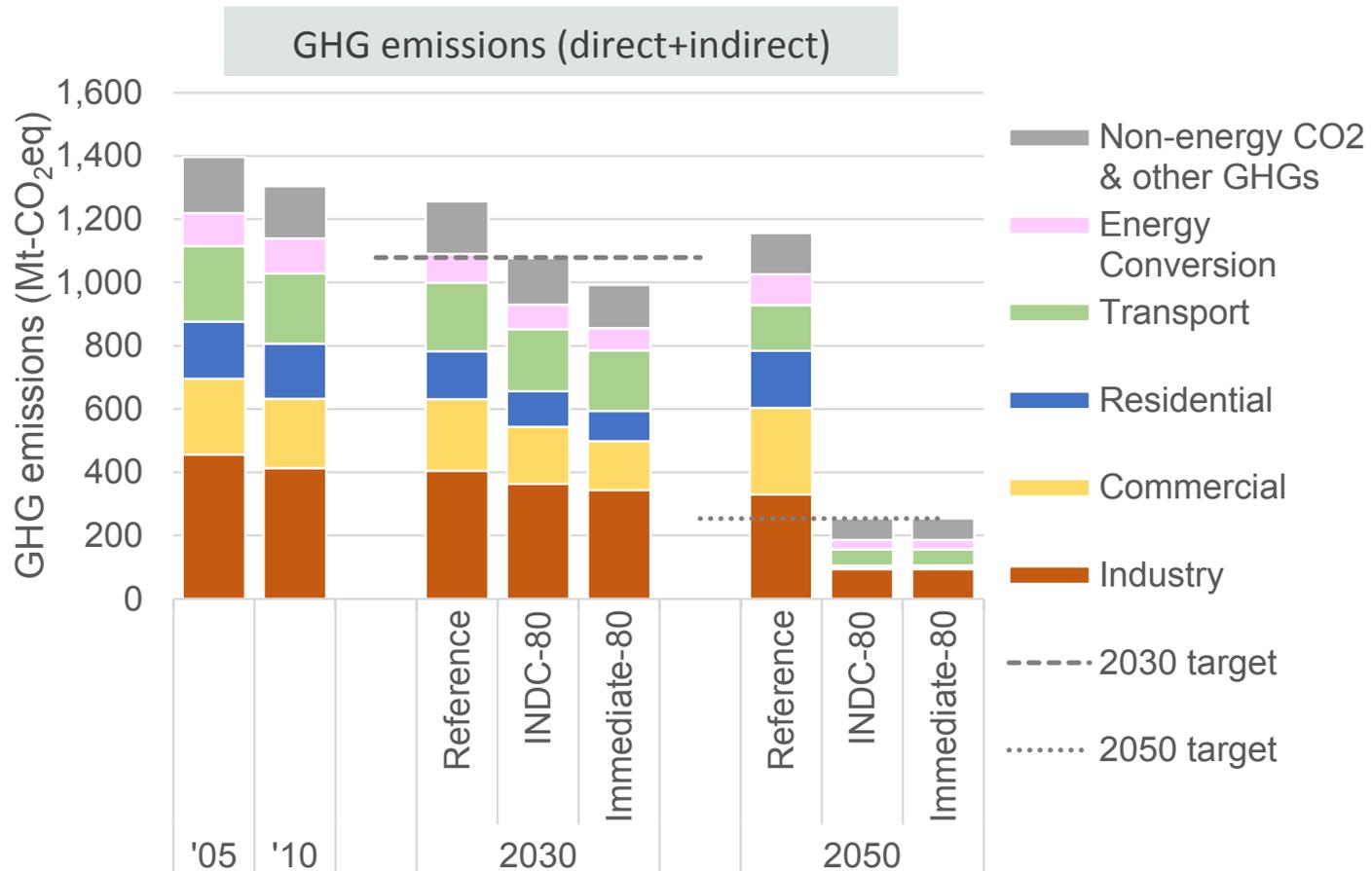


GHG emissions pathways



GHG emissions by sector

- Reference: -10% in 2030, -17% in 2050
- INDC-80: -23% in 2030, -82% in 2050
- Immediate-80: -29% in 2030, -82% in 2050 (wrt. 2005)



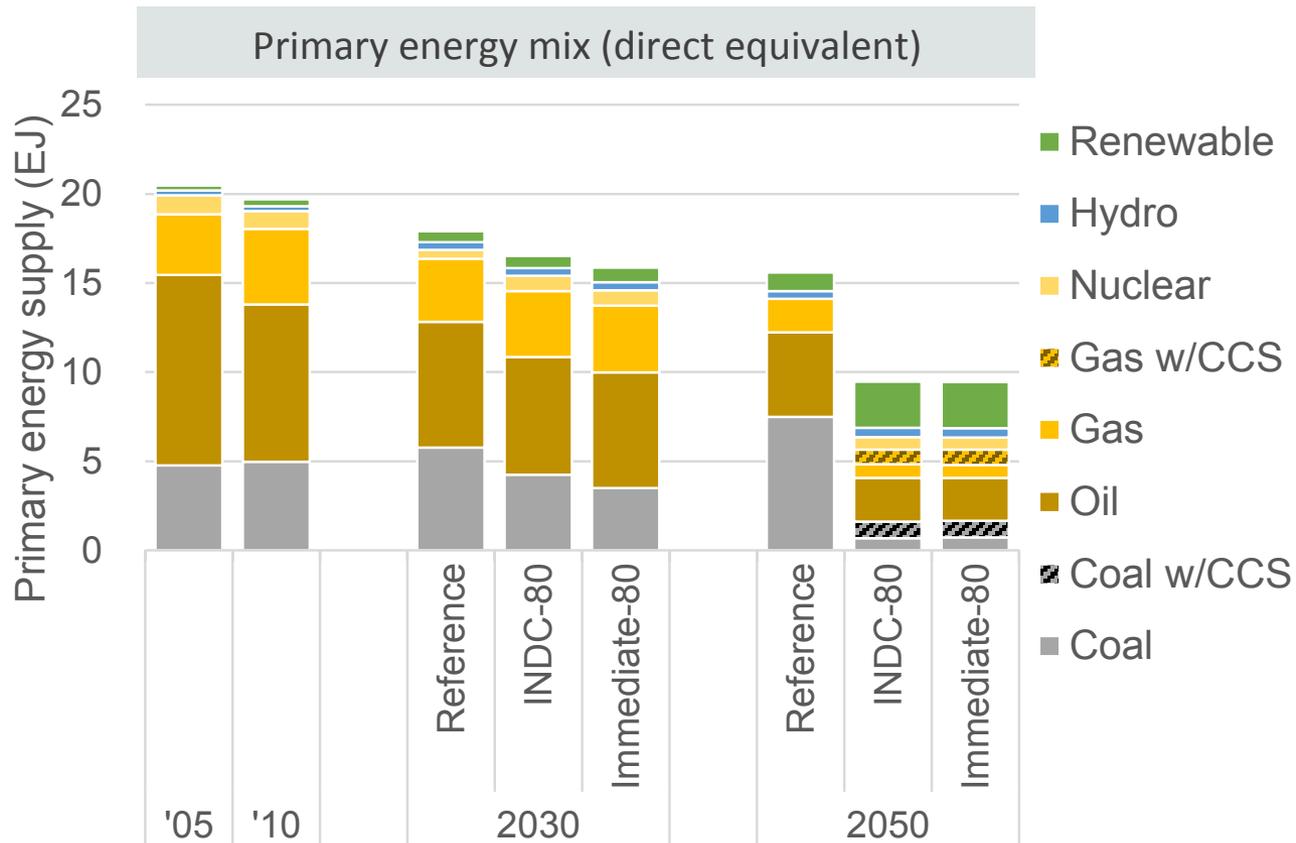
Carbon prices

Carbon Prices (US\$/t-CO₂)

Case	2030	2050
Reference	0	0
INDC-80	165	654
Immediate-80	260	607

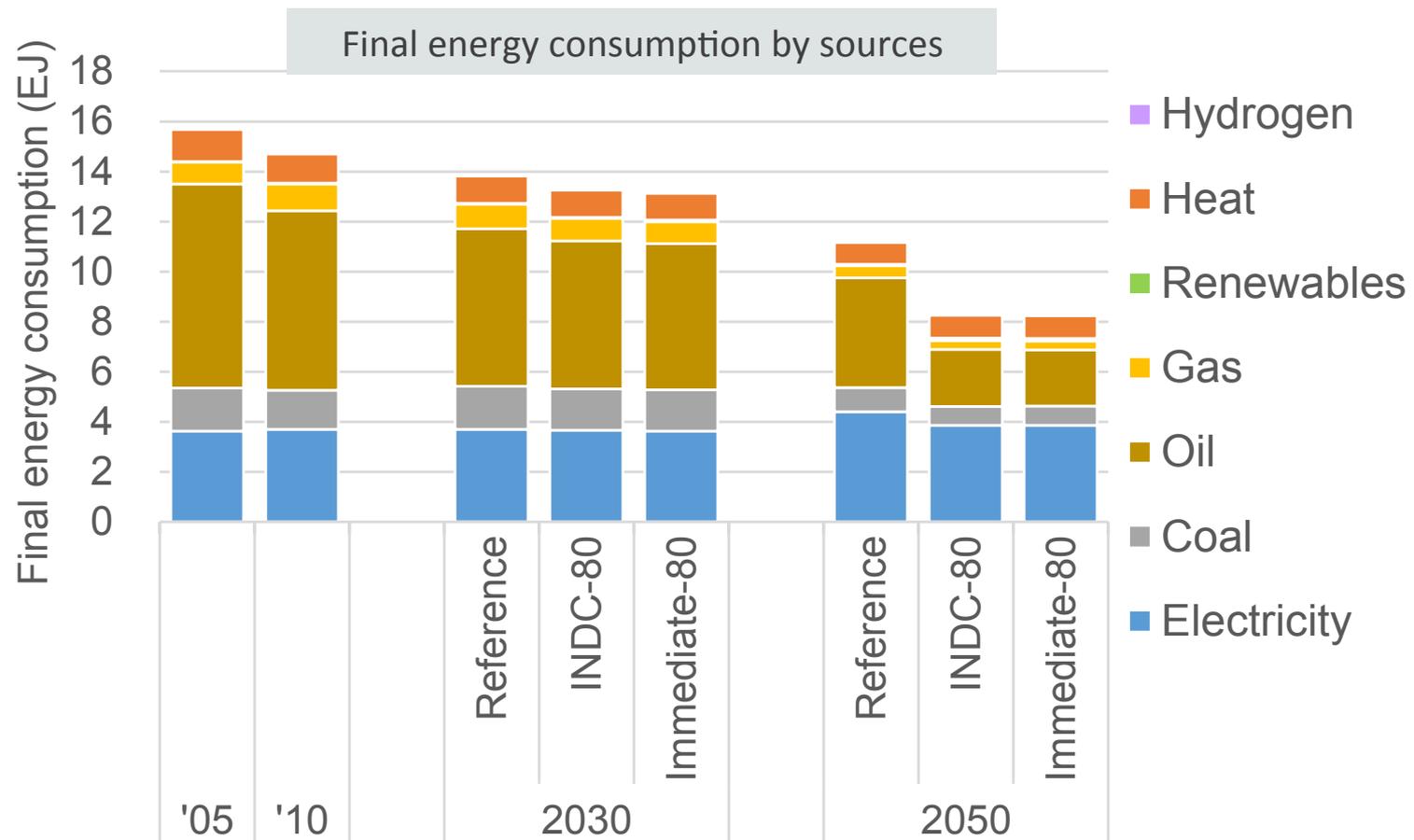
Primary energy mix

- Share of low-carbon energies (INDC-80, Immediate-80):
 - 9% in 2030, 10% in 2050
 - 12-13% in 2030, 59% in 2050



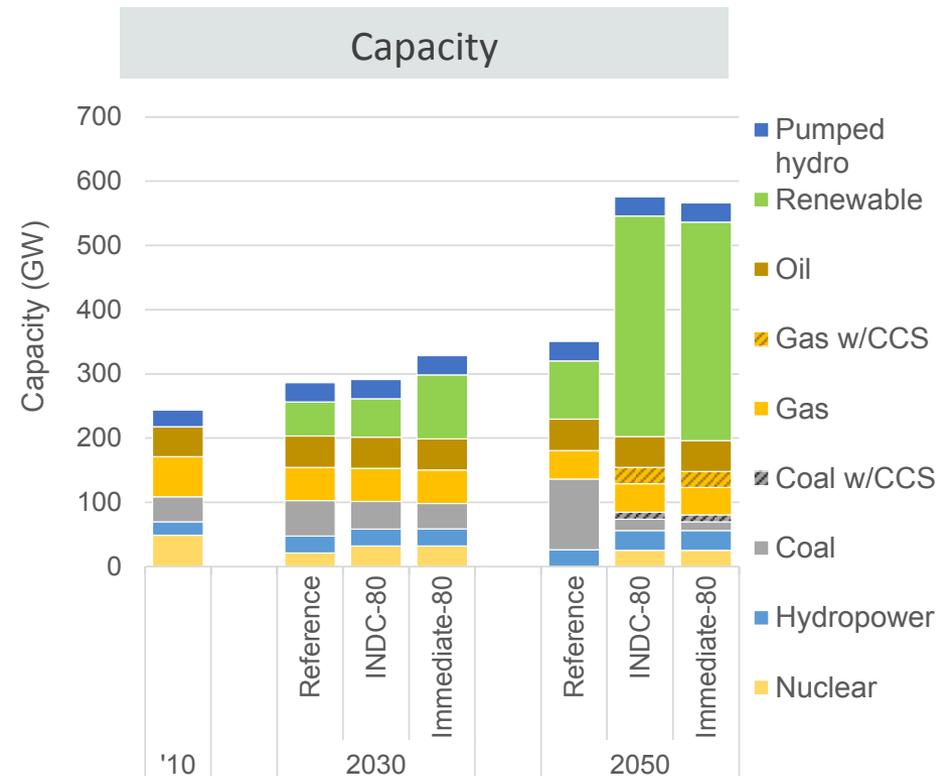
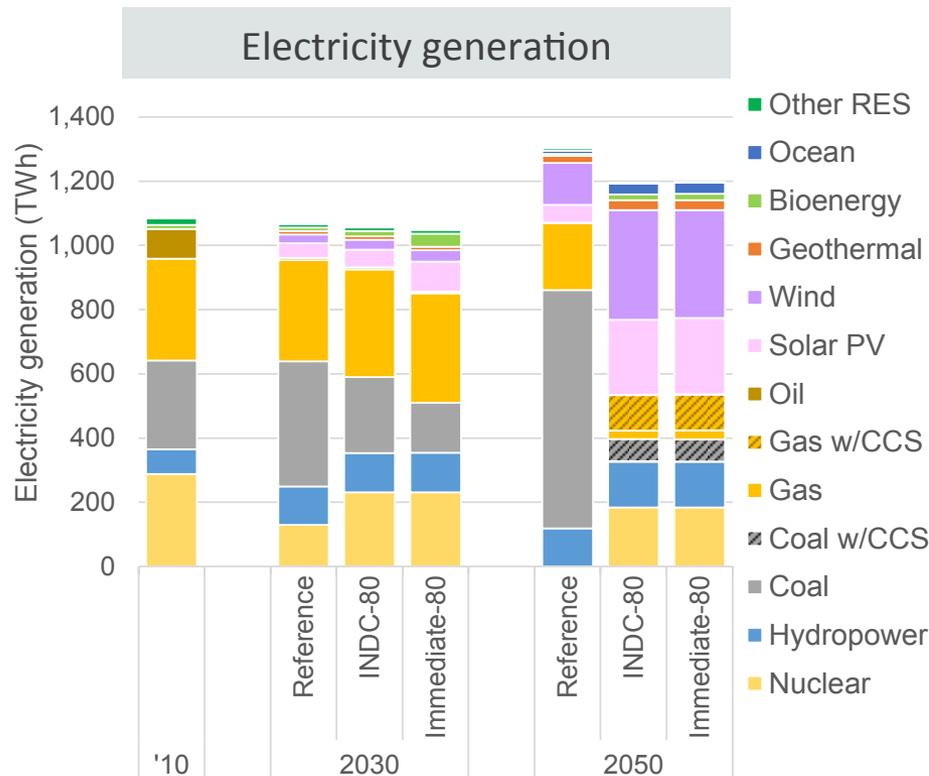
Final energy consumption

- Demand reduction: 10-11% in 2030, 43% in 2050 (wrt. 2010)
- Electrification: 28% in 2030, 46% in 2050 (INDC-80, Immediate-80)



Electricity generation, capacity

- Renewables accounts for 23% in INDC-80, 30% in Immediate-80 in 2030
- Electricity is almost decarbonized in 2050



Conclusions

- The INDC would be effective to consolidate the transition from the baseline trajectory, by improvement of energy efficiency and deployment of low-carbon electricity.
- The 2050 target requires significant electrification in end-use sectors as well as the acceleration of energy efficiency and decarbonization of electricity between 2030 and 2050.
- Rapid transformation of energy systems and rise in carbon prices are challenges.

Does International Emissions Trading Help Achievement of Paris Agreement?

Background

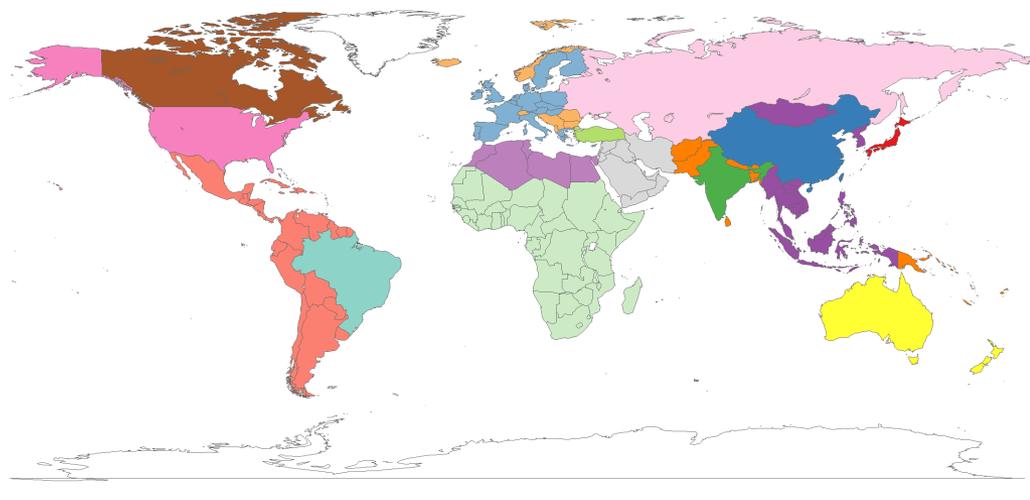
- COP21 confirmed the ultimate climate goal and all countries participation in emissions reduction.
- Emissions trading (ET) is thought as one of the tools to reduce mitigation cost.
- No studies have assessed the benefit of ET under INDCs though there are several studies treating the INDCs in terms of long-terms of mitigation.
- Regarding the market mechanism for transferring the right of carbon (GHG) emissions, UNFCCC will make a rule in the near future.
 - ✓ The market mechanism is generally thought as one of the solutions to reduce mitigation cost
 - ✓ Meanwhile, it is well known that such market mechanism is costly to keep the credibility of emissions reductions
 - ✓ Clarifying the benefit of developing such institution is substantially helpful to balance its cost and benefit.

Objective

- This study clarifies the benefit of market mechanism of transferring GHG emissions right emissions which includes broader sense of emissions trading, The Joint Crediting Mechanism(JCM) and so on.
 - ✓ How much emissions trading would benefit globally?
 - ✓ Who would benefit from that?
- Furthermore, if the more stringent reduction is considered like consistent with 2degree pathways, the mitigation cost would increase.
- This study aims to clarifies how does ET work in such scenarios.

Method (1) : model

- General equilibrium global economic model
- 43 industrial sectors (Energy and agriculture are highly disaggregated) and 17 region.
- Recursive dynamic
- Domestic and international market is assumed
- Emissions; CO₂, CH₄, N₂O, SO_x, NO_x, CO, BC, OC, VOC, NH₃
- Simplified climate model MAGICC is used to make climate information



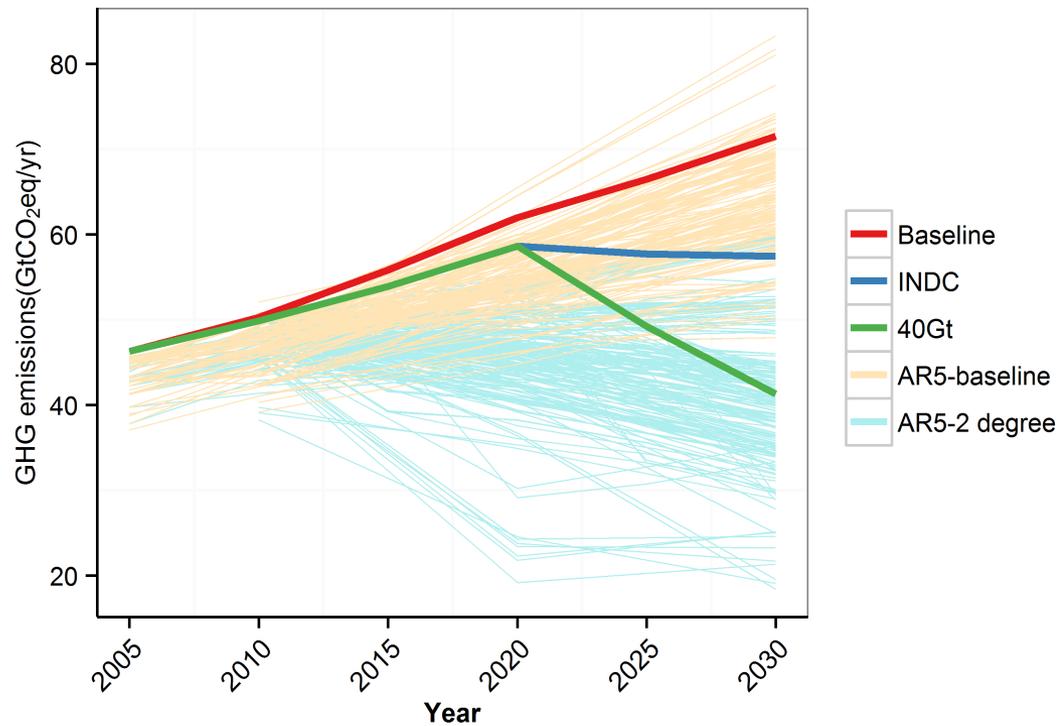
- There are two options in the representation of final energy demand
 - Conventional CGE type production function
 - AIM/Enduse technological detail information

Method: scenarios

Scenario name	Emissions target	Emissions trading	Global emissions
Baseline	-	-	
INDC_w/oET	Based on INDCs	-	Around 57GtCO ₂ eq in 2030
INDC_w/ET		X	
40Gt_CUM_w/oET	Additional reductions to INDCs are based on cumulative emissions	-	Around 40GtCO ₂ eq in 2030
40Gt_CUM_w/ET		X	
40Gt_GDP_w/oET	Additional reductions to INDCs are based on GDP	-	
40Gt_GDP_w/ET		X	
40Gt_POP_w/oET	Additional reductions to INDCs are based on Population	-	
40Gt_POP_w/ET		X	
40Gt_EMI_w/oET	Additional reductions to INDCs are based on baseline emissions	-	
40Gt_EMI_w/ET		X	

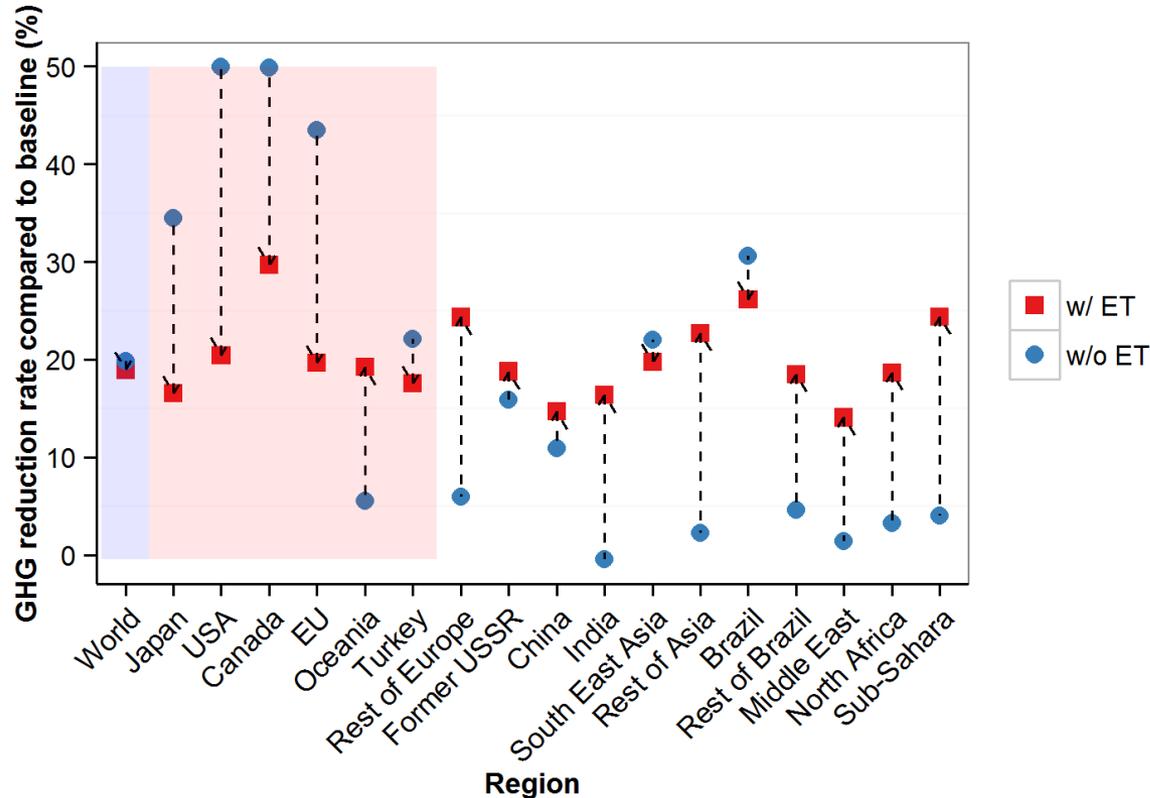
- Cumulative is most heavy burden for OECDs
- GDP is least burden for OECDs
- POP is ??
- Emission is same reduction rate for all countries.

Global GHG emissions



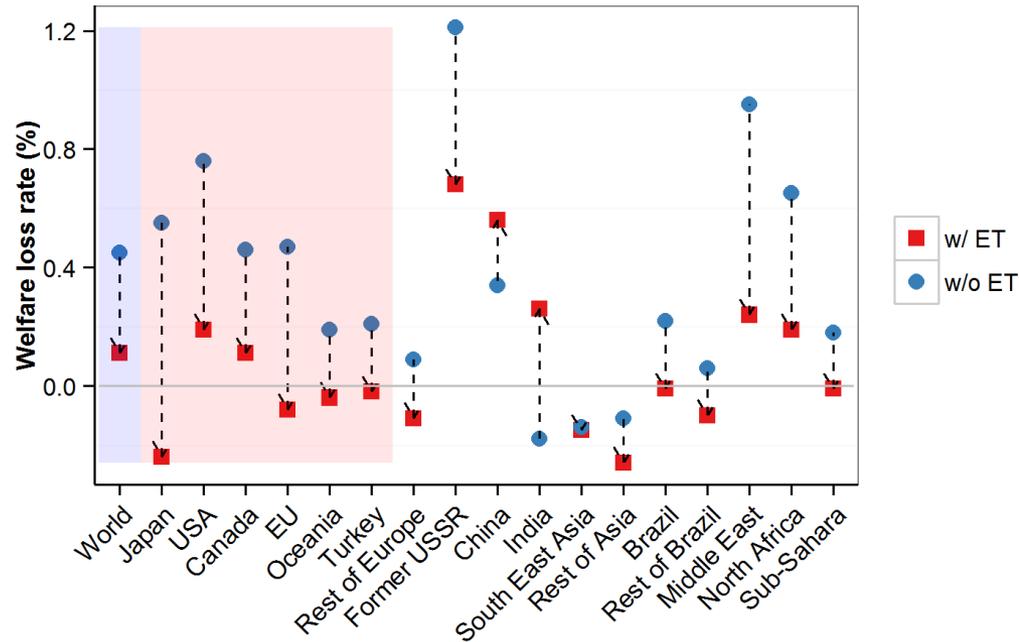
- 2020 is bound by Cancuun pledge.
- 2030 are INDC or 40GtCO₂

Regional emissions reduction rate



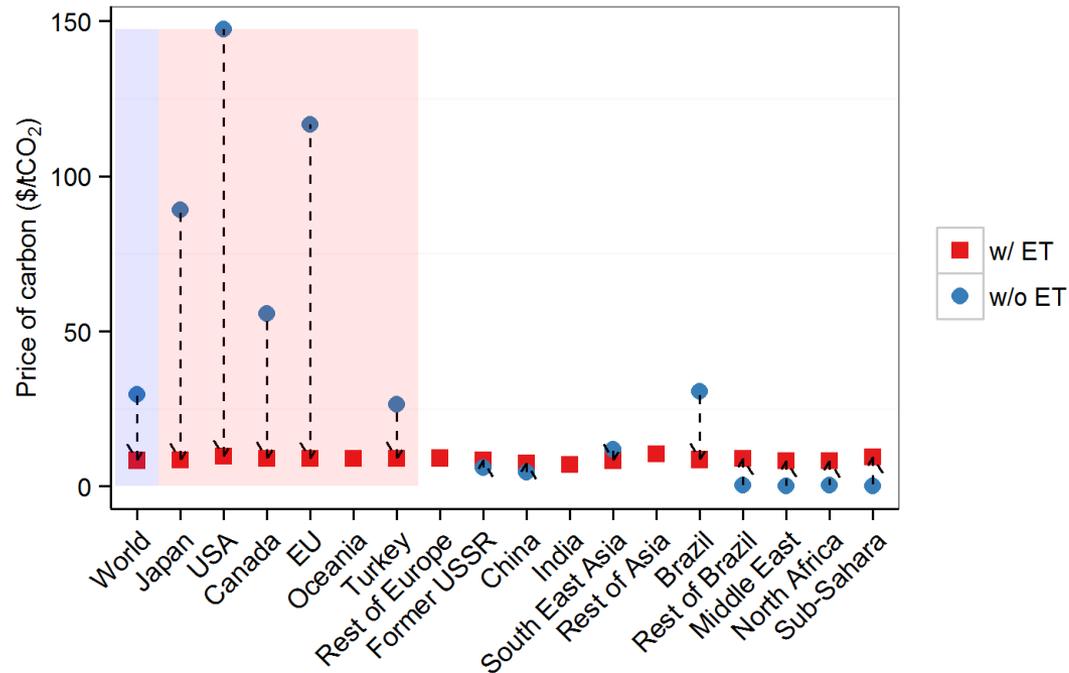
- OECD countries have stronger emissions reduction (see w/o ET)
- ET remarkably reduces OECD reduction rate while non-OECD tend to be opposite. Some countries do not follow such rule

Welfare loss in 2030 under INDC



- Global mitigation cost decreases by 0.4%
- Winners are OECD countries
- Developing countries situation vary depending on the carbon price, its response and international competitiveness

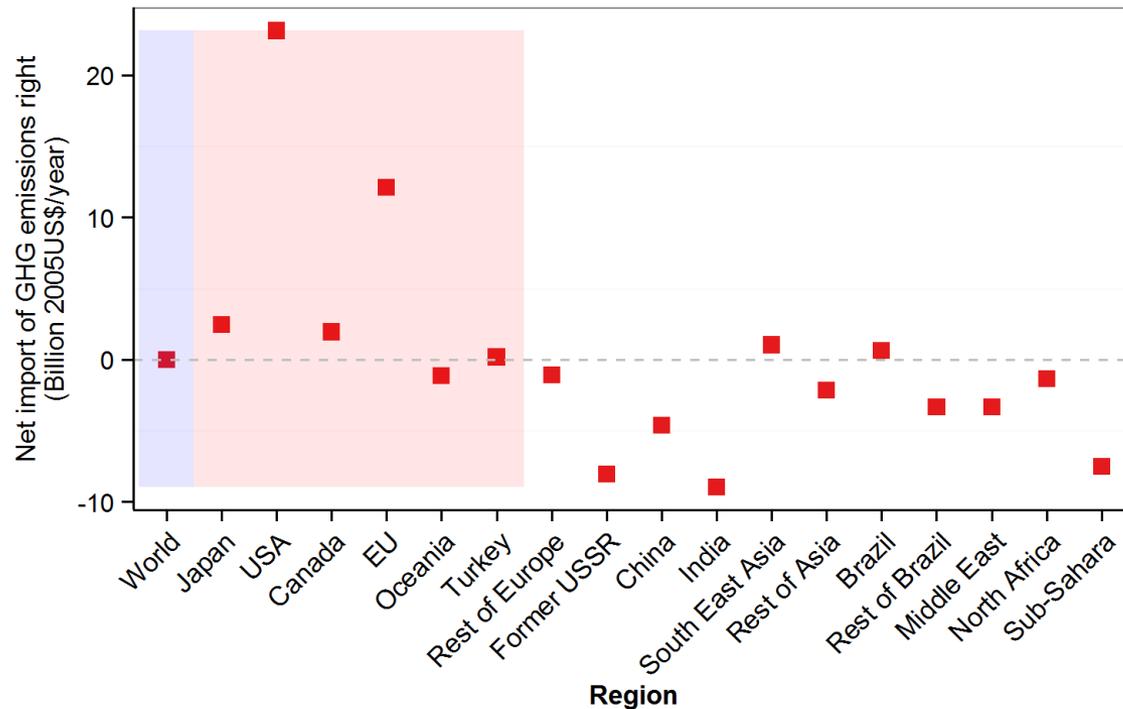
Carbon price



INDC world is calculated by weighted average and GHG emission is used for the weight.

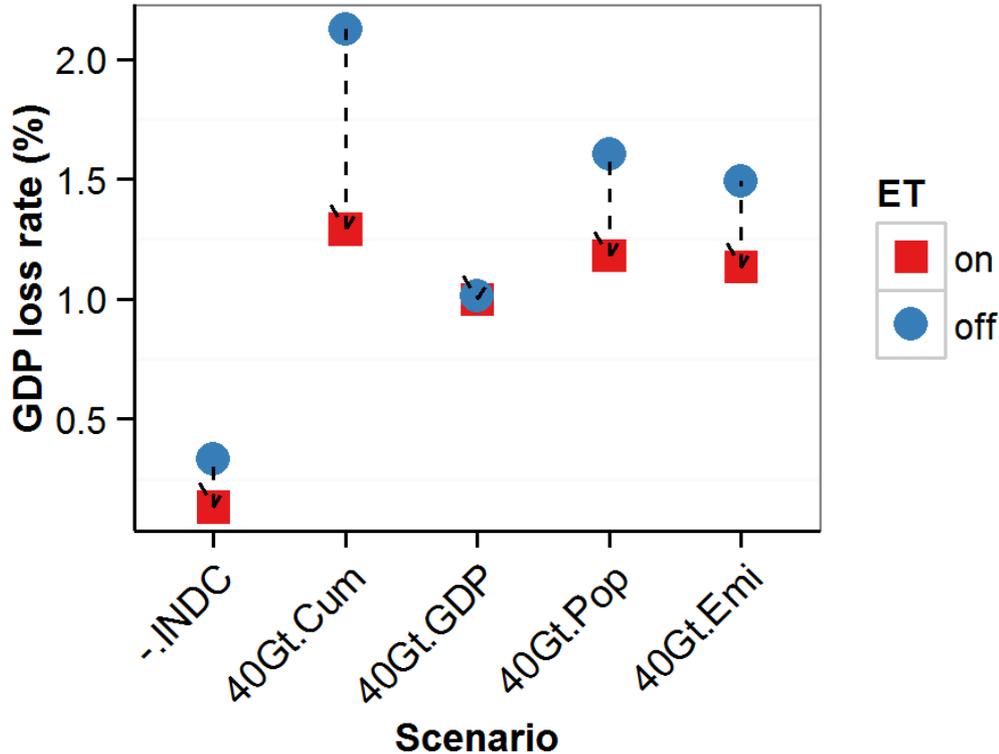
- INDC has regional variety and OECD countries tend to have high carbon price
- ET is much lower than INDC (<10\$/tCO₂)

Emissions trading monetary flow



- About 40 billion US\$ direct from OECDs to the rest
- Referring to Paris Agreement which decided 100 billion US\$ will be funded from developed to developing regions as climate mitigation and adaptation aid, it is comparable.

GDP loss in the stringent mitigation scenarios

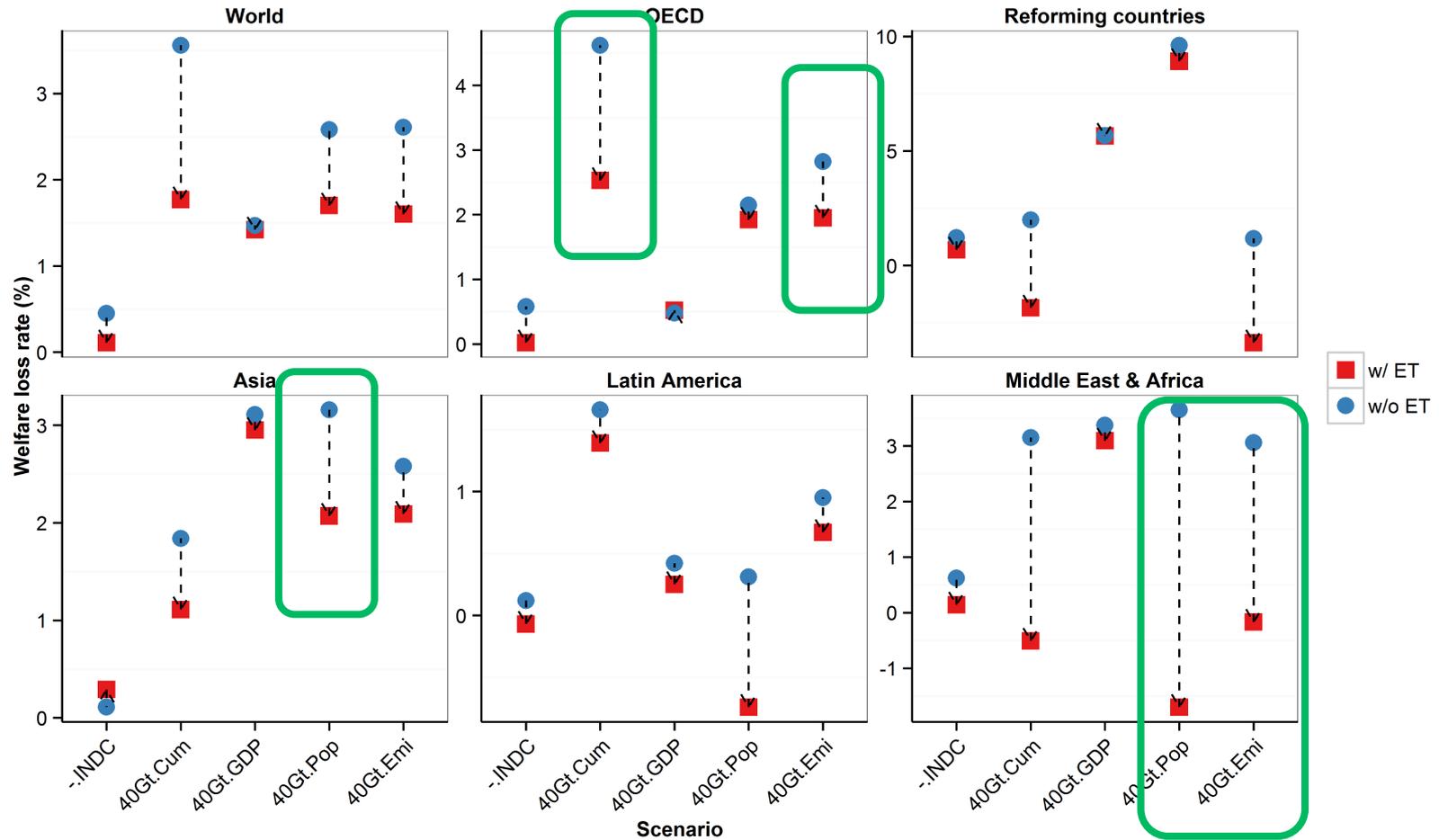


- Mitigation cost becomes 1.0 to 2.0% in w/o WT scenarios by additional emissions reduction.
- The range represents the burden sharing scheme
- The effectiveness of ET varies (Cum > Pop > Emi > GDP)

Discussion

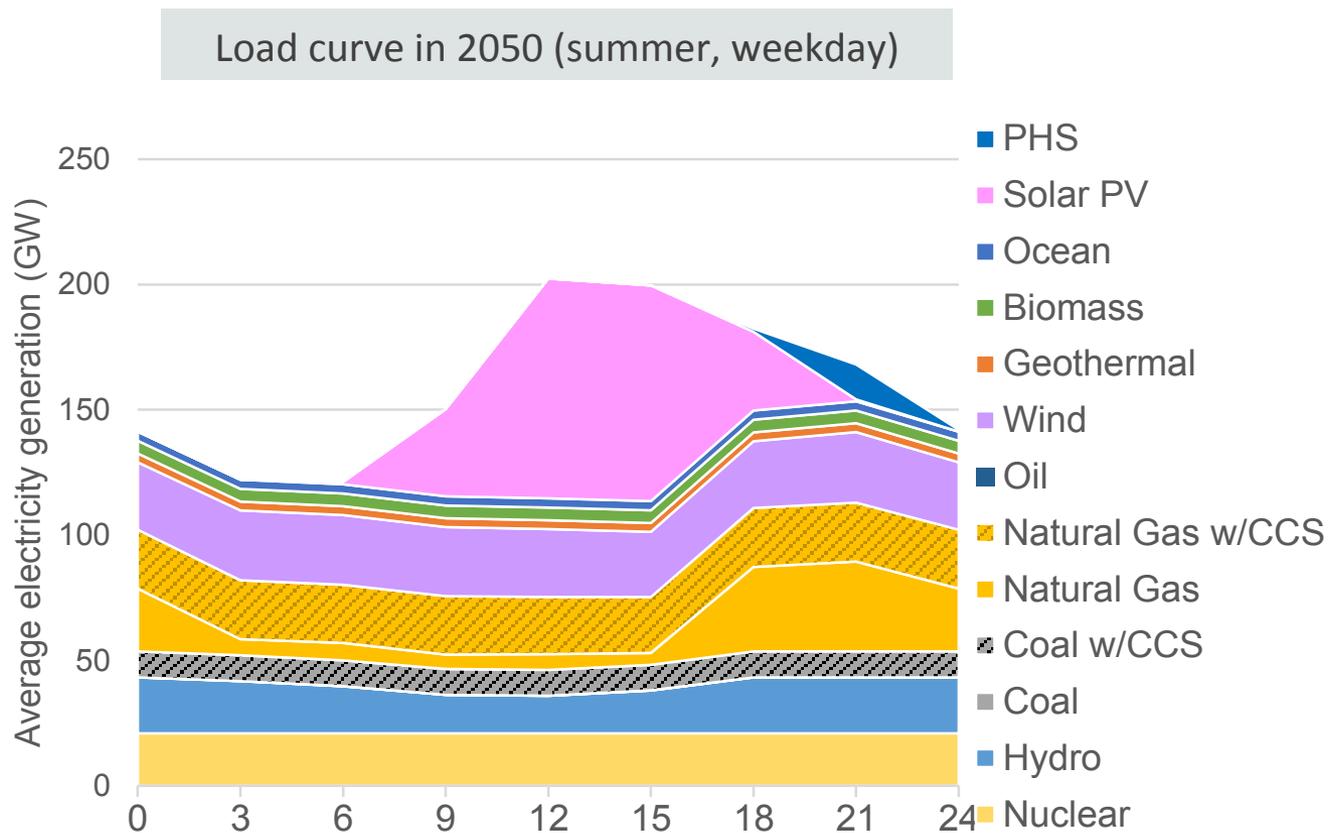
- ET works well in order to realize economically efficient GHG emissions reduction in global total.
 - ✓ In all cases, we could reach this conclusion.
- Emissions trading is beneficial globally but some questions would raise.
 - ✓ OECDs emissions reduction amount decrease thanks to ET and may lose the incentive to implement strong movement to the transformation of the energy system.
 - ✓ Some developing countries would lose.
- Increasing the emissions reduction to the 2 °C target must have larger mitigation cost and ET seems to be necessity.
 - ✓ OECDs showed already high carbon price in INDCs w/o ET and the more reduction creates the incredibly higher carbon price which would seem unpractical level
 - ✓ Additional reduction looks challenging and it is unsure whether sticking to large reduction in near-term is good to realize climate stabilization indeed.
 - ✓ BUT if international institution could implement ET, it could be realistic.

Regional breakdown

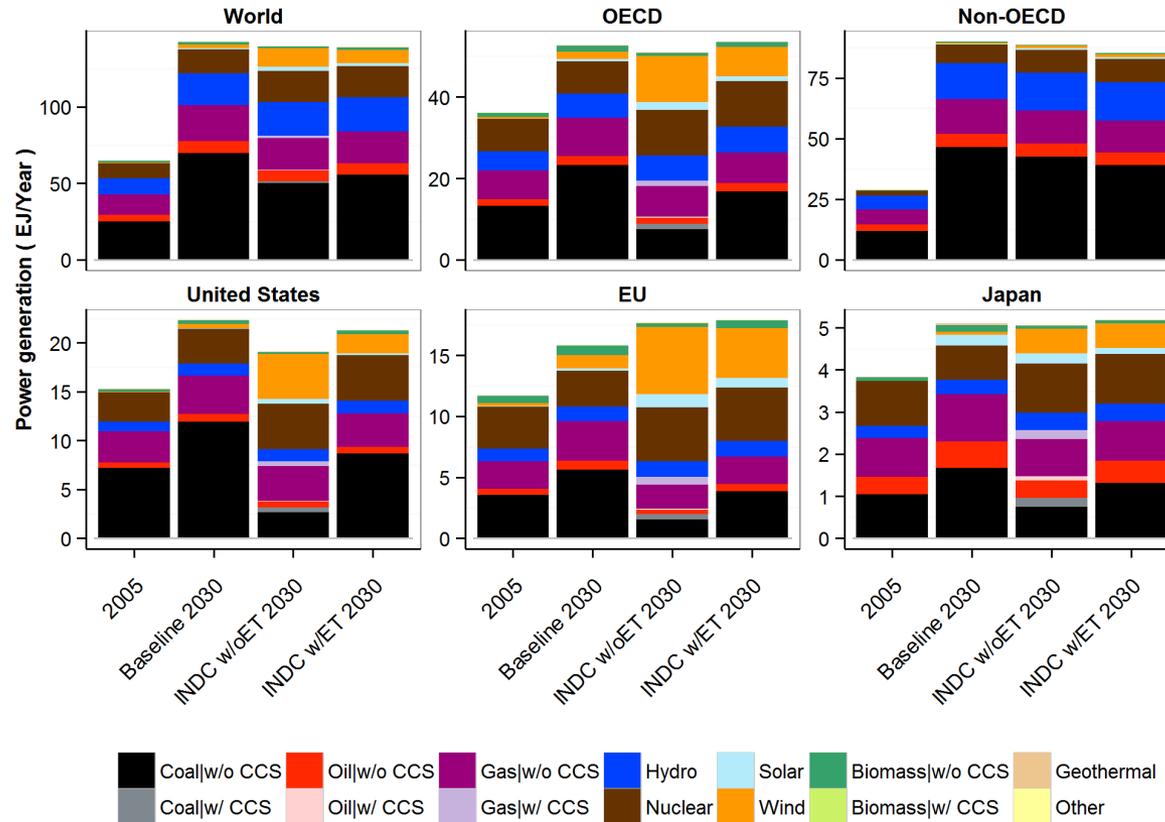


Hourly electricity generation

- Integration of variable renewable energies (VREs) is challenge in 2050



Energy system change by INDC



- OECD is largely affected
- Renewable energy is implemented in INDC
- ET makes the impact lower.