The 23rd AIM International Workshop
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GHGs, SLCPs, Air Pollutants Mitigation Scenarios in Asia and World
- Cobenefits and Tradeoffs of Low Carbon Measures -

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ASIA-PACIFIC INTEGRATED MODEL

NIES JAPAN

MOEJ-S12: Promotion of climate policies by assessing environmental impacts of SLCP and seeking LLGHG emission pathways (FY2014 – FY2018)

Goal: To develop an integrated evaluation system for LLGHG and SLCP mitigation policy, by interconnecting emission inventory, integrated assessment models, and climate models.

Theme 1: Air quality change event analysis
- Analysis on regional AQ change
- Development of emission inventory
- Inversion algorithms of emission estimation

Theme 2: Integrated model and future scenarios
- Global socio-economic scenarios
- National & regional emissions scenarios
- Urban & household emissions AQ assessment

Theme 3: SLCP impacts on climate & environment
- Impact assessment of aerosols & GHG
- Assessment of health, agriculture, water cycle, sea level rise

Improved emission inventory

SLCP emissions scenario

Regional Emission Inventories and Chemical Transfer Model

REAS Inventory

Integrated Assessment Model (AIM)

SLCPs, Air pollutants GHGs emissions

imate and ironment Model

Assessment of activities/policies

Feedback of impacts

Chemical transfer model and emission inventory in Asia

AIM/Enduse model
Socio-economical & emissions scenario

Climate model, earth system model
Climate change impact & adaptation

Theme 4: Integrated operation system (Toolkits, data archive)

Science

Stakeholders
Policy makers

Society

Model improvement

System utilization

Information transmission

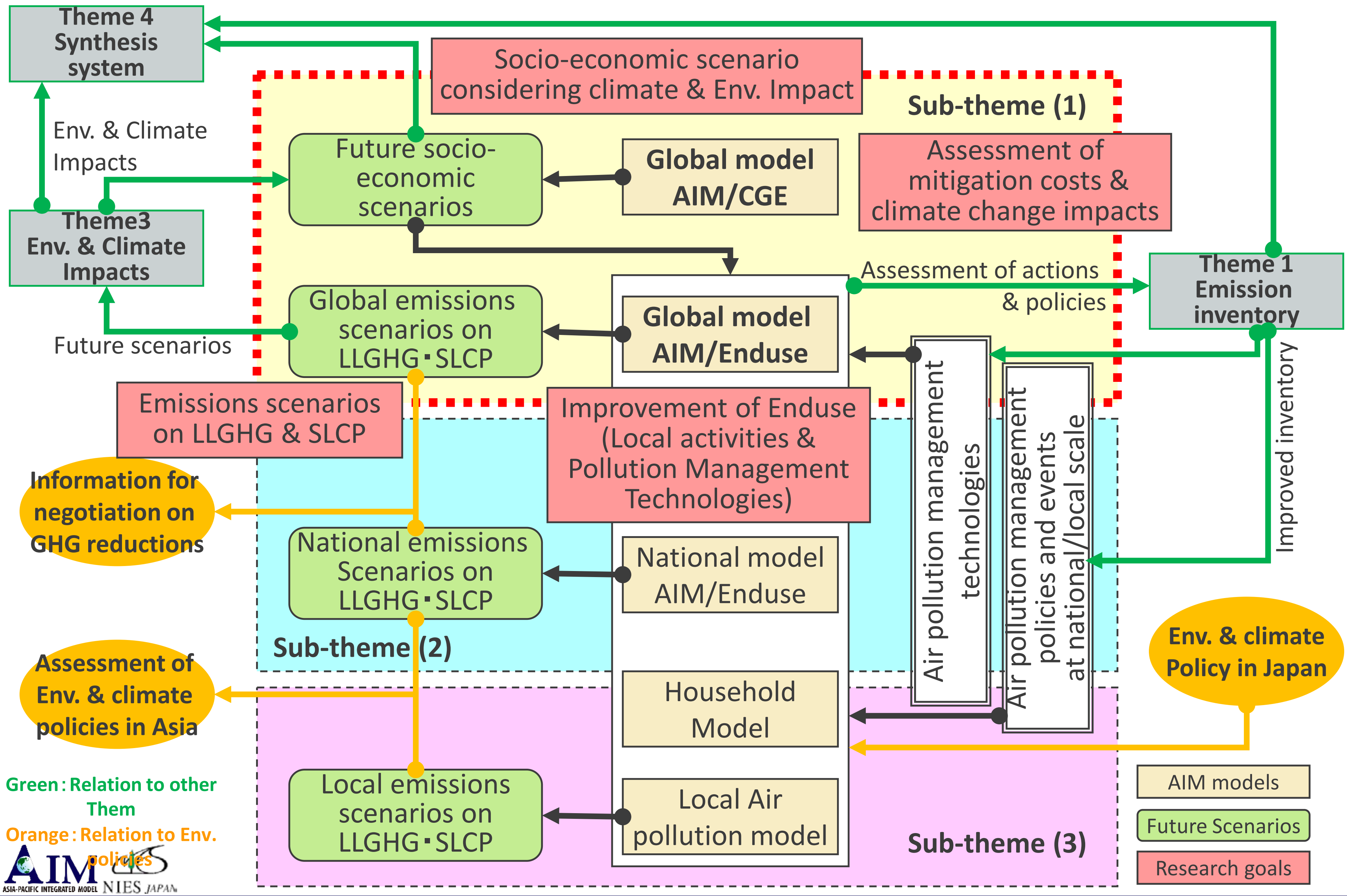
Experiment setup
Database development
Metric definitions

CCAC, UNFCC, IPCC, EANET
Proposal and assessment of climate and air pollution policies

MDG・SDG・Future Earth

Regional strategy
⇅
Global strategy

MOEJ-S12: Promotion of climate policies by assessing environmental impacts of SLCP and seeking LLGHG emissions pathways (FY2014-FY2018)

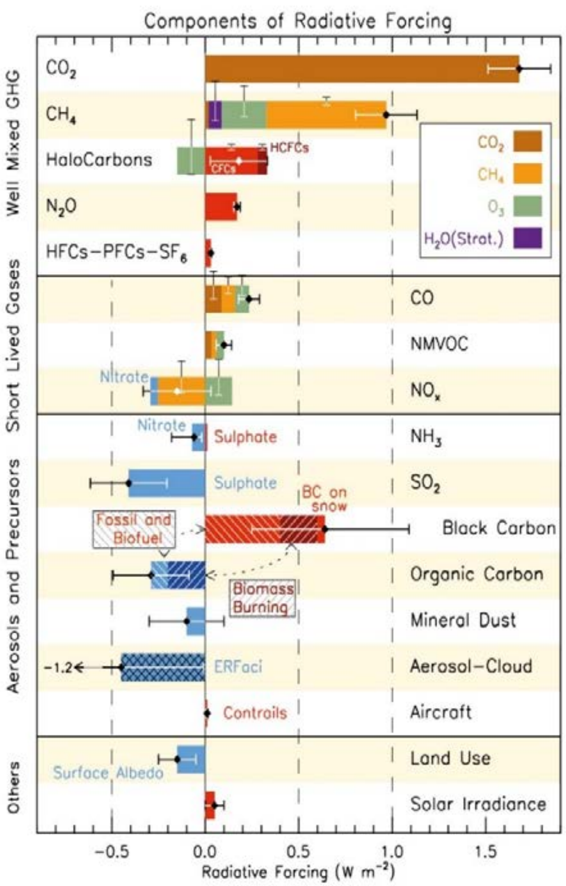


Objectives

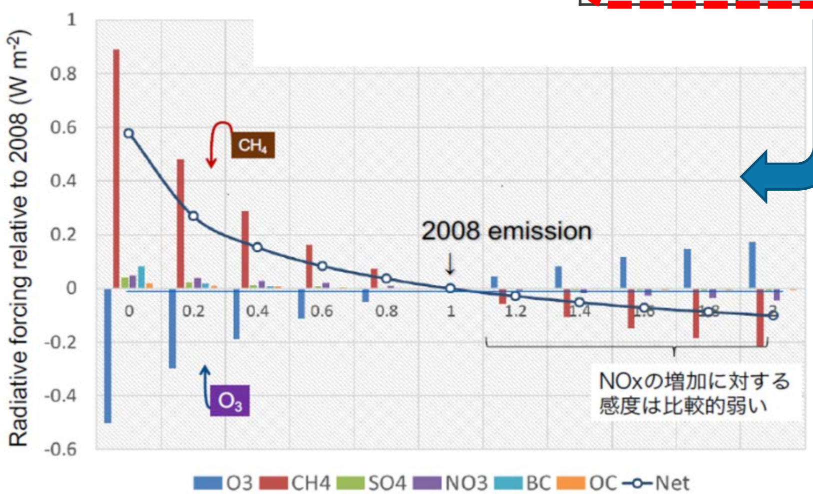
This study analyses appropriate **balanced emissions pathways of GHGs, air pollutants, short-lived climate pollutants (SLCPs) while taking GHG mitigation actions for achieving 2 °C target**

1. estimation of **technological mitigation potentials and costs** of the Kyoto basket of greenhouse gases (GHGs) such as CO_2, CH_4, N_2O, HFCs, PFCs and SF_6
2. How large **cobenefits in reducing of SLCPs and air pollutants** due to effects of different LCS measures equivalent to 2°C
3. How large **tradeoffs of increasing SLCPs and air pollutants** due to effects of different LCS measures equivalent to 2°C
4. How large **effects of air pollutant control measures** in addition to different LCS measures equivalent to 2°C
5. How large effects of **promoting electrification in transport sector and building sector**

SLCPs and Air Pollutants Reductions - Advantage and Disadvantage -



SO_2 reduction	Advantage	➢ Reducing health effects by decreasing sulfate (major component of $PM_{2.5}$)
	Dis-advantage	➢ Reducing regional cooling effects by decreasing sulfate
$BC\&PM_{2.5}$ reduction	Advantage	➢ Reducing health effects by reducing BC and PM2.5 ➢ Reducing climate effects by reducing BC
	Dis-advantage	➢ Reducing regional cooling effects by decreasing OC due to biomass burning.
NMVOC reduction	Advantage	➢ Reducing reginal tropospheric O3 and thus reducing climate effects. ➢ Reducing health effects by decreasing SOA (Secondary Organic Aerosol) (major component of $PM_{2.5}$).
	Dis-advantage	➢ Reducing regional cooling effects by decreasing SOA
NOx reduction	Advantage	➢ Reducing reginal tropospheric O3 and thus reducing health effects. ➢ Reducing health effects by decreasing nitrate (major component of $PM_{2.5}$)
	Dis-advantage	➢ Increasing atmospheric CH_4 concentration and thus warming effects ➢ Reducing regional cooling effects by decreasing nitrate
CO reduction	Advantage	➢ Reducing reginal tropospheric O3 and thus reducing health effects. ➢ Reducing atmospheric CH_4 concentration by reducing NOx at the same time
	Dis-advantage	➢ No disadvantage



If reducing only NOx, atmospheric CH_4 concentration will increase. But if reducing NOx and CO at the same time, atmospheric CH_4 concentration will not increase

Seeking for

- ☐ combination of NOx and CO reduction,
- ☐ Balancing SO_2 and BC reduction

at the same time of decarbonization toward 2℃

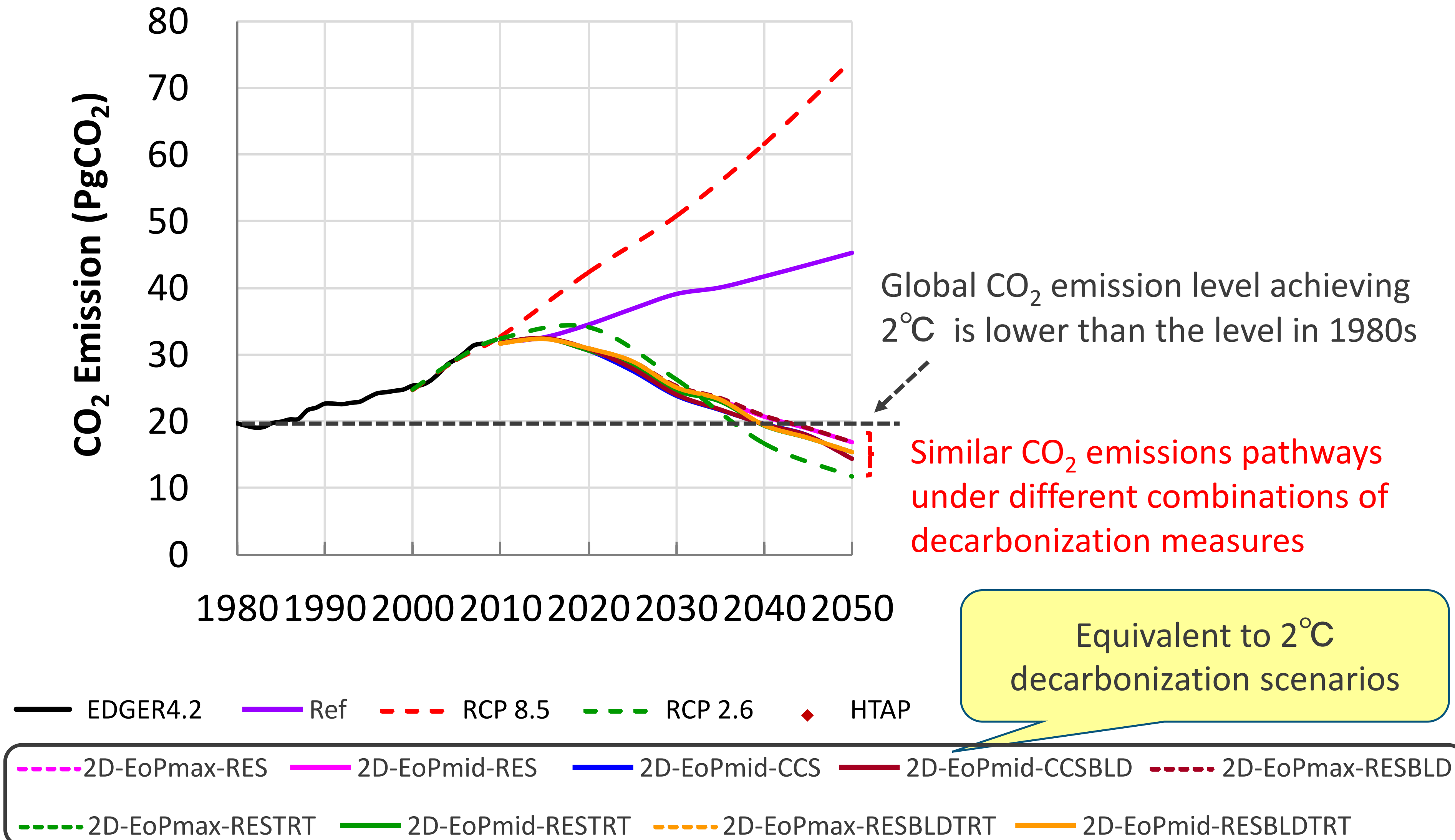
Scenario Settings- Seeking for balance of GHGs, SLCPs, air pollutants-

Scenario	Overview
Reference (=SSP2)	Reference scenario that future mitigation polices & technologies are in the current trends
EoP Max	**100 % end-of-pipe diffusion across the world by 2050** for SO_2, NOx, BC, OC, $PM_{2.5}$, PM_{10}
EoP Mid	**100% EoP diffusion in developed countries & 50% EoP diffusion in developing courtiers by 2050** for SO_2, NOx, BC, OC, $PM_{2.5}$, PM_{10}
2D-EoPmax-RES	Decarbonization toward 2°C target / maximum EoP measures / **energy shift to renewables** rather than fossil fuel with CCS
2D-EoPmid-RES	Decarbonization toward 2°C target / medium EoP measures / **energy shift to renewables** rather than fossil fuel with CCS
2D-EoPmid-CCS	Decarbonization toward 2°C target / medium EoP measures / **energy shift to coal & biomass power with CCS** rather than renewables
2D-EoPmax-RESBLD	Decarbonization toward 2°C target / maximum EoP measures / **energy shift to renewables** / **100% electrification in building sector across the world by 2050**
2D-EoPmid-CCSBLD	Decarbonization toward 2°C target / medium EoP measures /**energy shift to coal & biomass power with CCS** / **100% electrification in building sector across the world by 2050**
2D-EoPmax-RESTRT	Decarbonization toward 2°C target / maximum EoP measures / **energy shift to renewables** / nearly **100% EV in passenger transport sector across the world by 2050**
2D-EoPmid-RESTRT	Decarbonization toward 2°C target / medium EoP measures / **energy shift to renewables** / nearly **100% EV in passenger transport sector across the world by 2050**
2D-EoPmax-RESBLDTRT	Decarbonization toward 2°C target / maximum EoP measures / **energy shift to renewables** / **100% electrification in building sector across the world by 2050**/ nearly **100% EV in passenger transport sector across the world by 2050**
2D-EoPmid-RESBLDTRT	Decarbonization toward 2°C target / medium EoP measures / **energy shift to renewables** / **100% electrification in building sector across the world by 2050**/ nearly **100% EV in passenger transport sector across the world by 2050**

Global Emissions Pathways of CO_2, SLCPs, Air Pollutants

- compared to emission inventory (EDGER, HTAP) & emissions pathways of RCP8.5, RCP2.6 -

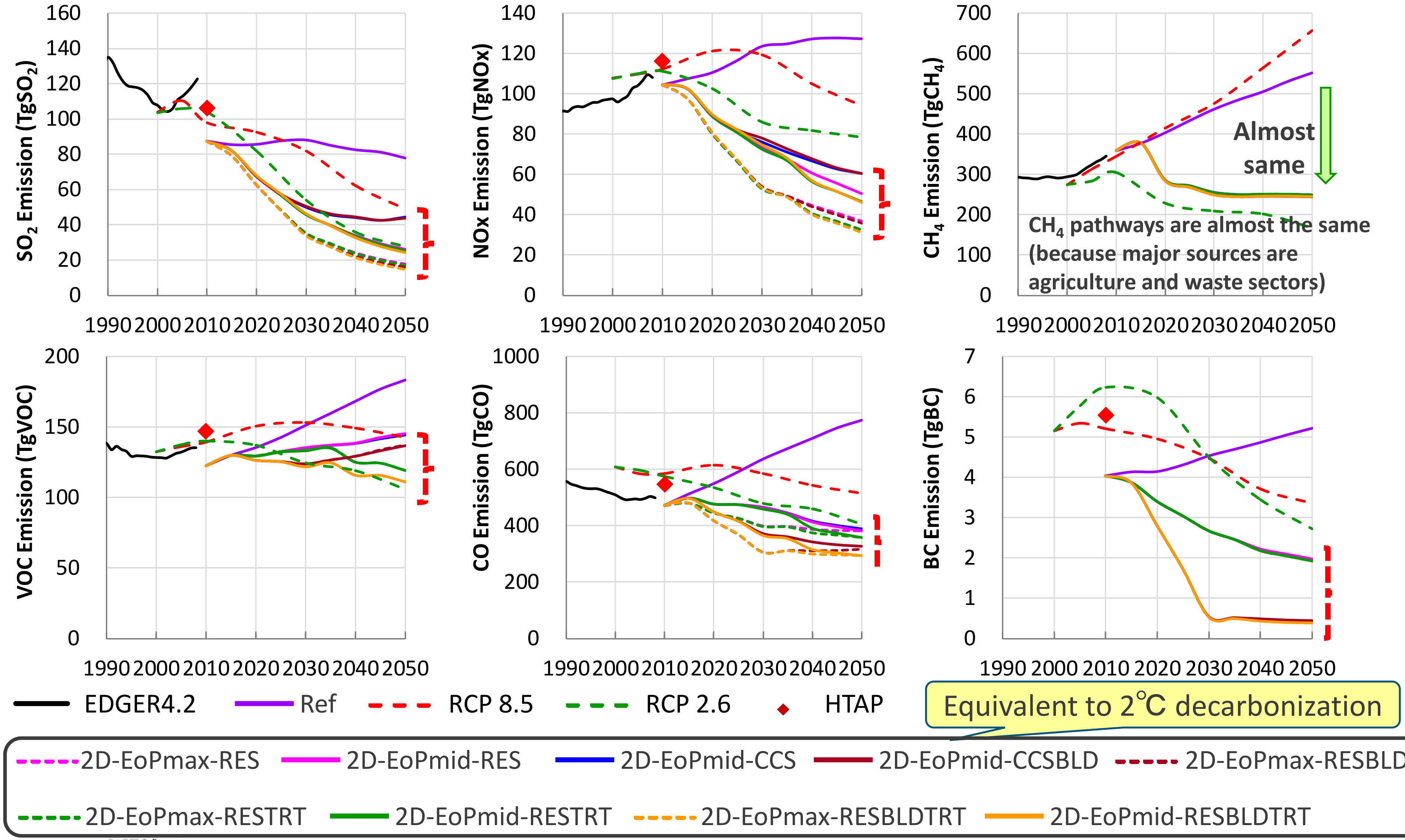
- There are various different combinations of decarbonization measures which can achieve the similar CO_2 emission pathways equivalent to 2 degree target.



Global Emissions Pathways of CO_2, SLCPs, Air Pollutants

- compared to emission inventory (EDGER, HTAP) & emissions pathways of RCP8.5, RCP2.6 -

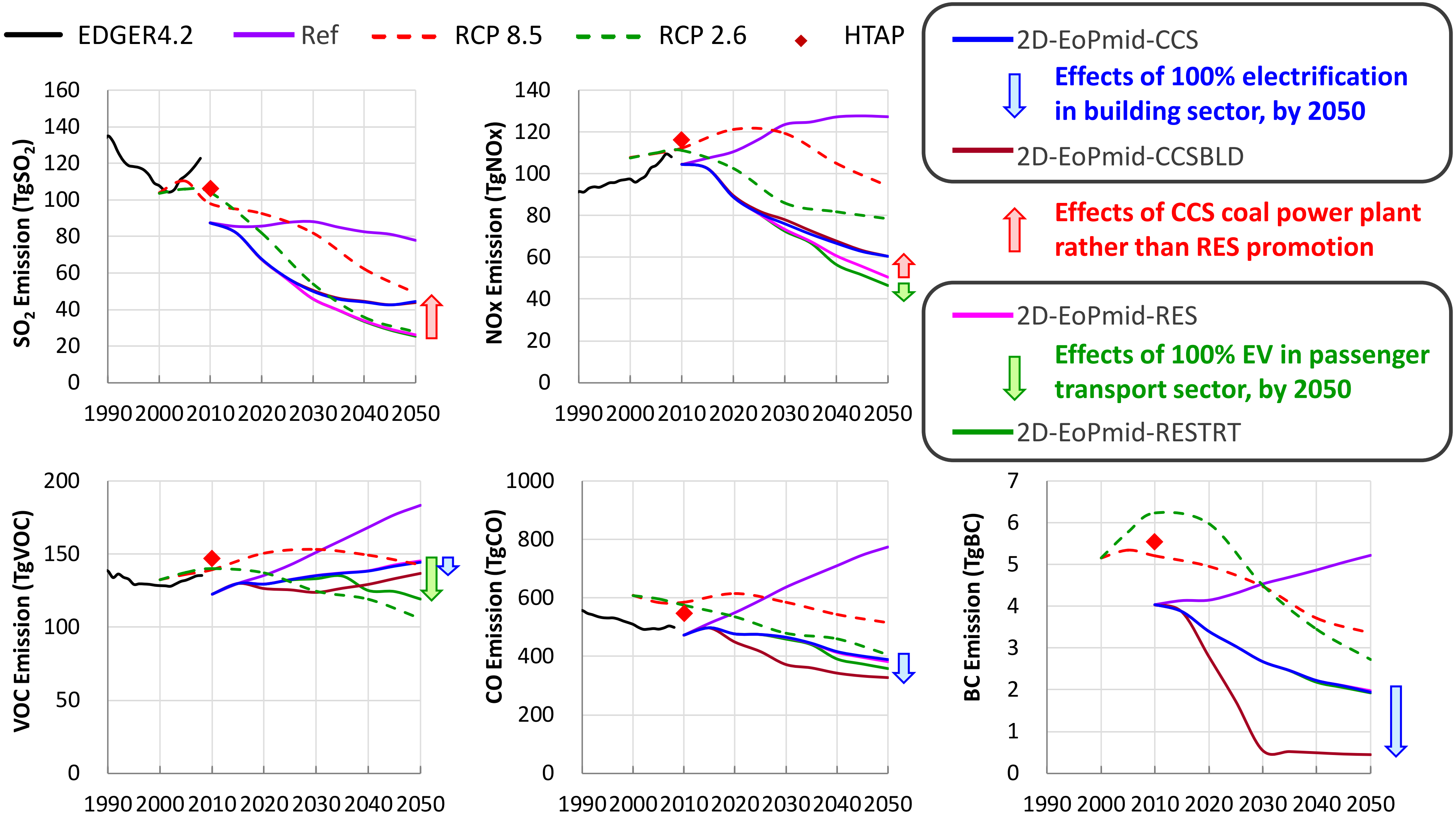
- ☐ Emissions pathways of SLCPs and air pollutants are different due to combinations of low-carbon and end-of-pipe measures, even if CO_2 emission pathways equivalent to 2℃ are similar.



Global Emissions Pathways of CO_2, SLCPs, Air Pollutants

- compared to emission inventory (EDGER, HTAP) & emissions pathways of RCP8.5, RCP2.6 -

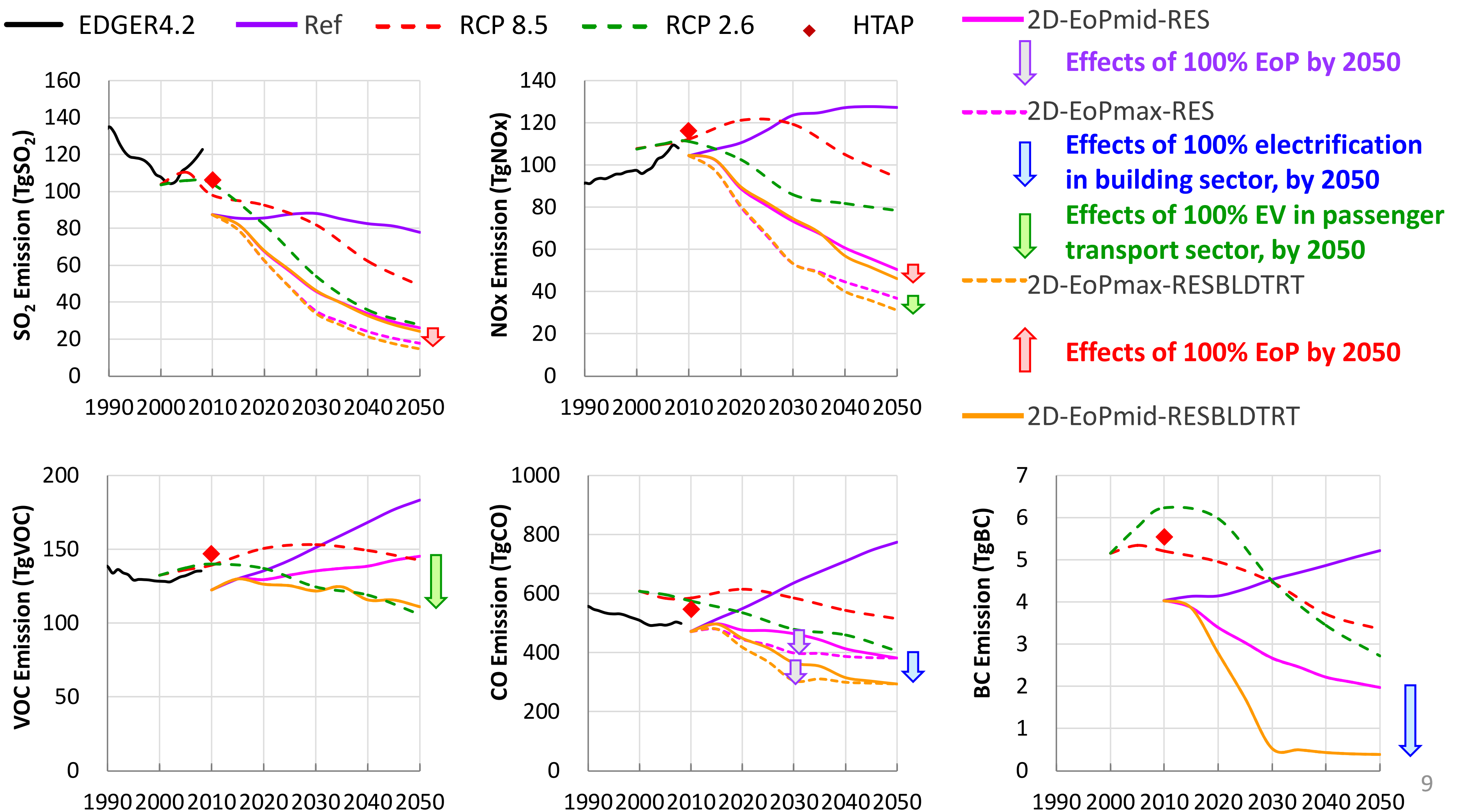
- 100% electrification in building sector is effective for reducing BC, PM2.5 drastically and CO
- 100% EV in passenger transport is effective for reducing NMVOC largely and NOx
- Coal for power and industry plants with CCS has emission rebounds for SO_2 and NOx



Global Emissions Pathways of CO_2, SLCPs, Air Pollutants

- compared to emission inventory (EDGER, HTAP) & emissions pathways of RCP8.5, RCP2.6 -

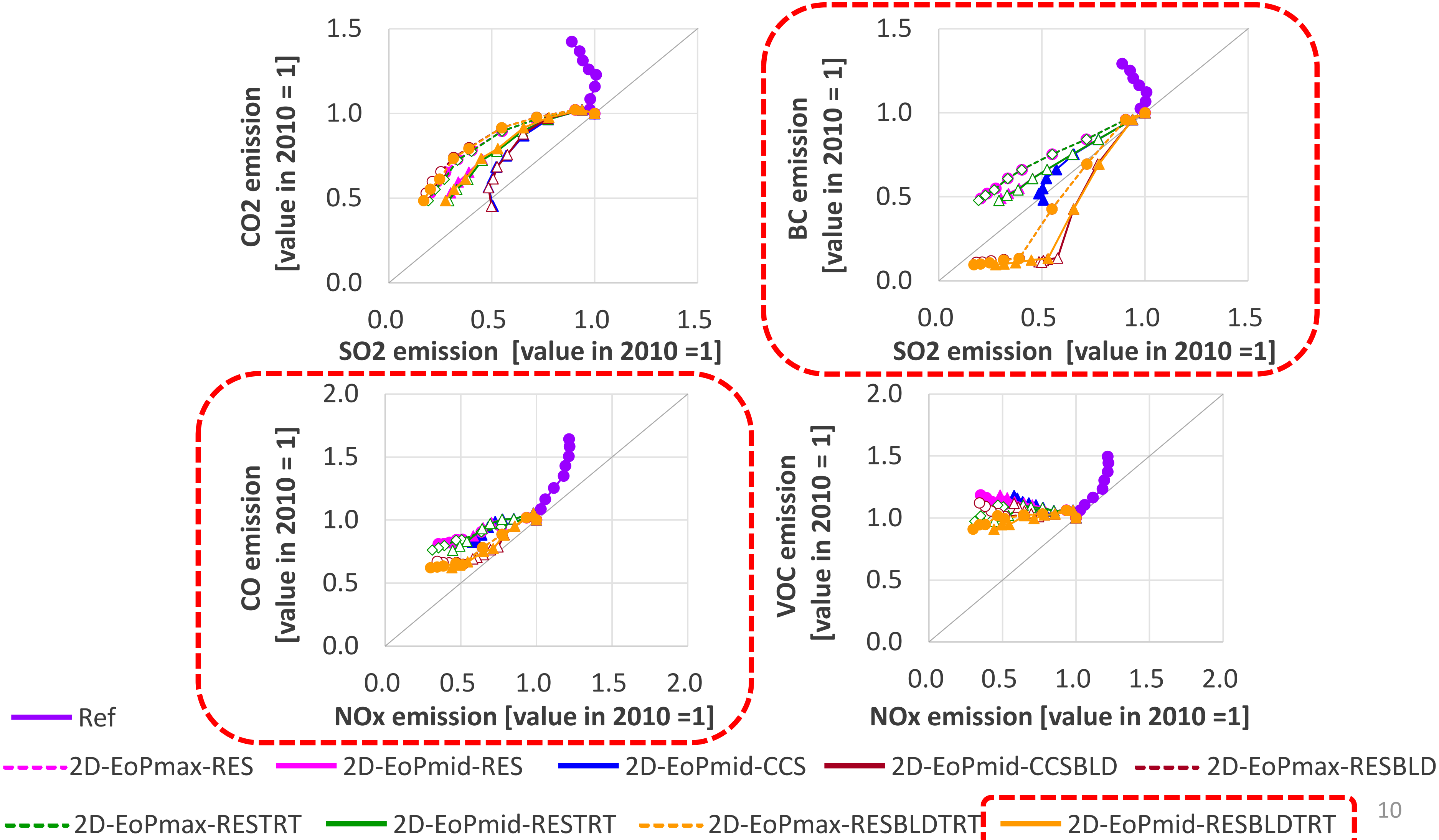
- ☐ After enhancing renewables, effects of diffusing End-of-Pipe measures are very limited
- ☐ Combinations of renewables with 100% electrification in building and transport sector have effective for drastically reducing BC, PM2.5 and largely reducing NMVOC and CO.



Diagnosis of Emissions Pathways Directions

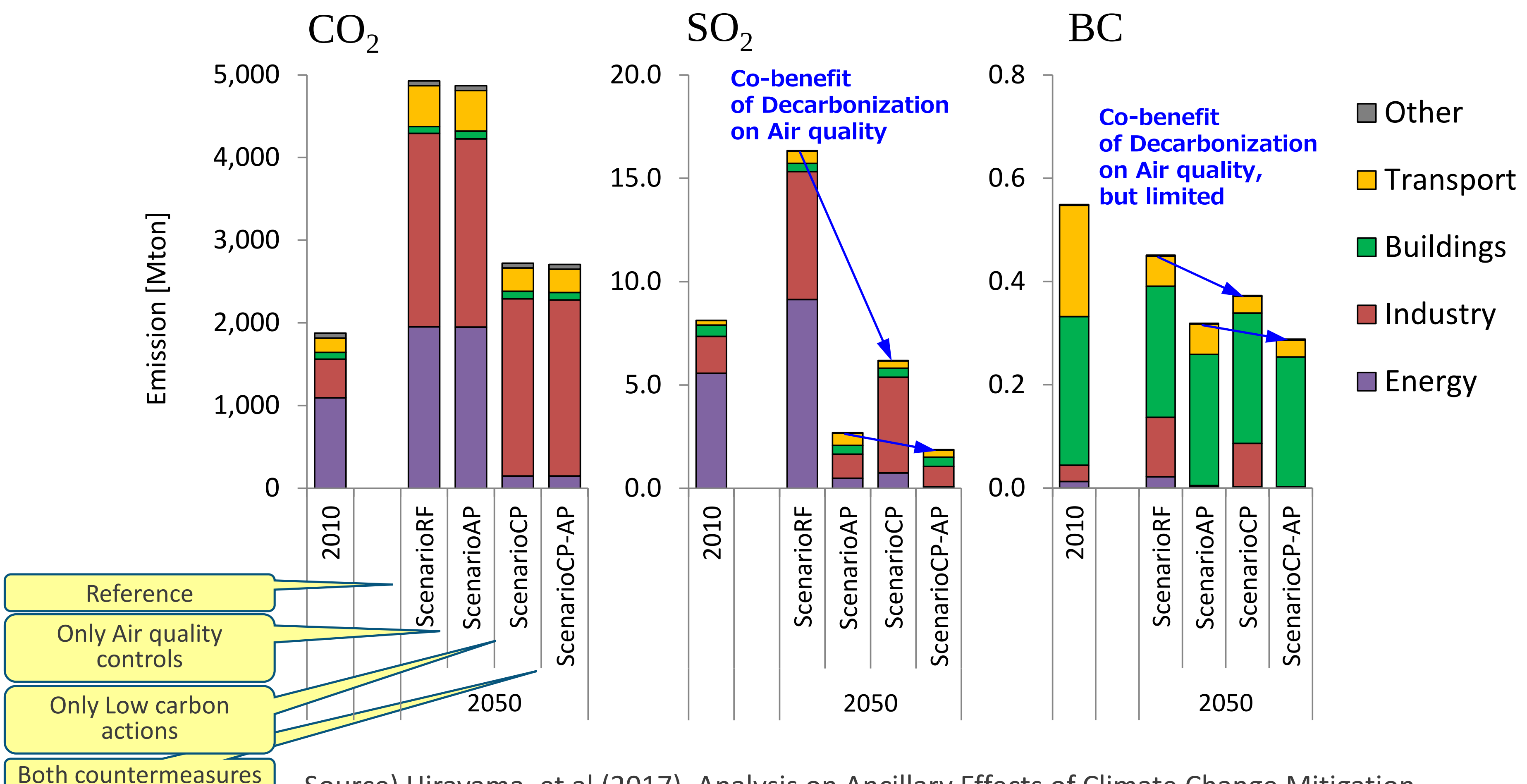
- reduction ratio among GHGs, SLCPs and Air pollutions -

- Need to seek for balancing health benefits (e.g. reducing $PM_{2.5}$, BC, SO_2, NOx), climate benefits (e.g. reducing CO_2, BC, CH_4), and climate disadvantage (e.g. reducing OC, SO_2, NOx, VOC).



Emissions under decarbonization and air quality control
- Example in India -

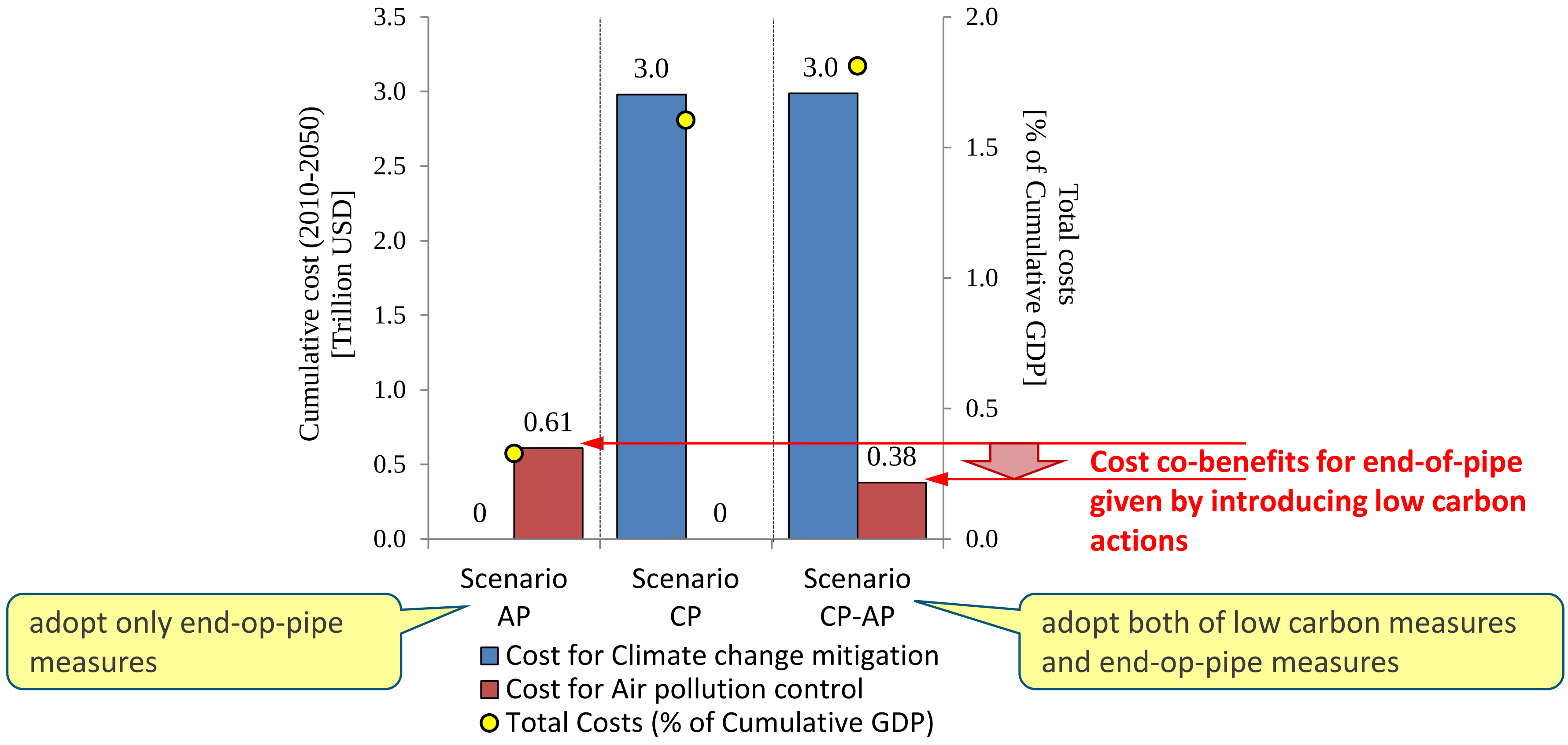
- Decarbonization measures provide SO_2 emission abatement as a co-benefit.
- Decarbonization measures have a impact on BC reductions, but the amount of the BC reduction is limited, because the increase of biomass is cheaper than electrification in building sector.
- Diffusion of drastic End-of-Pipe measures have large impacts on reducing SO_2



Source) Hirayama, et al (2017), Analysis on Ancillary Effects of Climate Change Mitigation Actions on Air Pollutants and SLCP: Case study in India, Environmental Systems Research

Mitigation Costs of decarbonization and air quality control
- Example in India -

- the cost of diffusing air pollution control measures can be saved by introducing decarbonization measures, which can be regarded as "cost co-benefits".

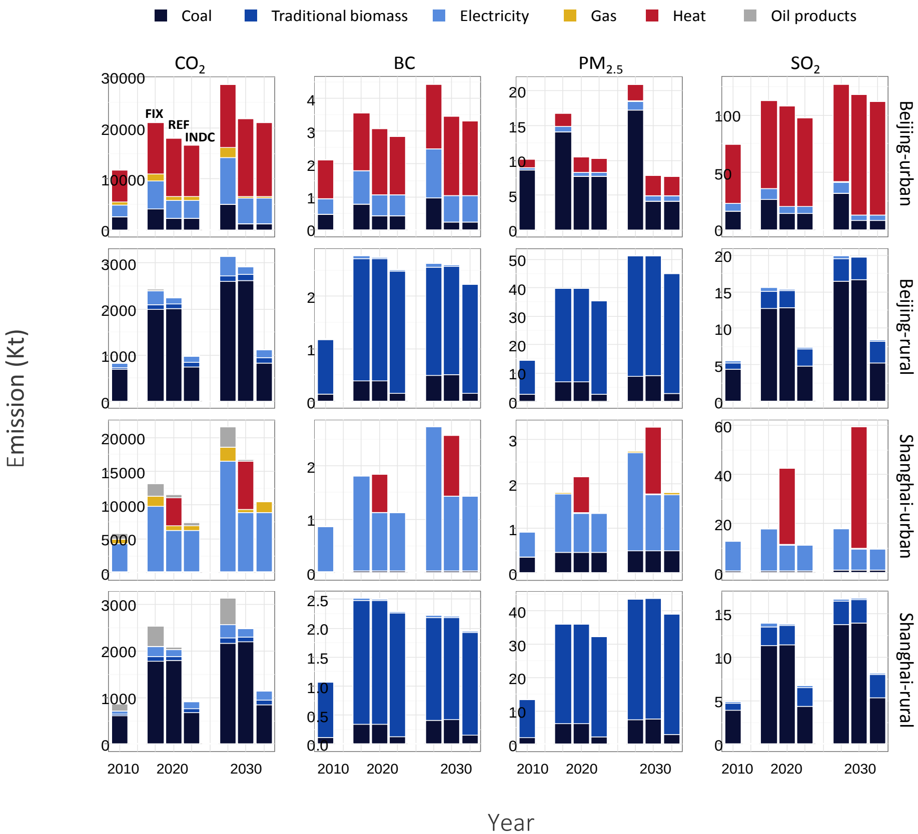


Source) Hirayama, et al (2017), Analysis on Ancillary Effects of Climate Change Mitigation Actions on Air Pollutants and SLCP: Case study in India, Environmental Systems Research

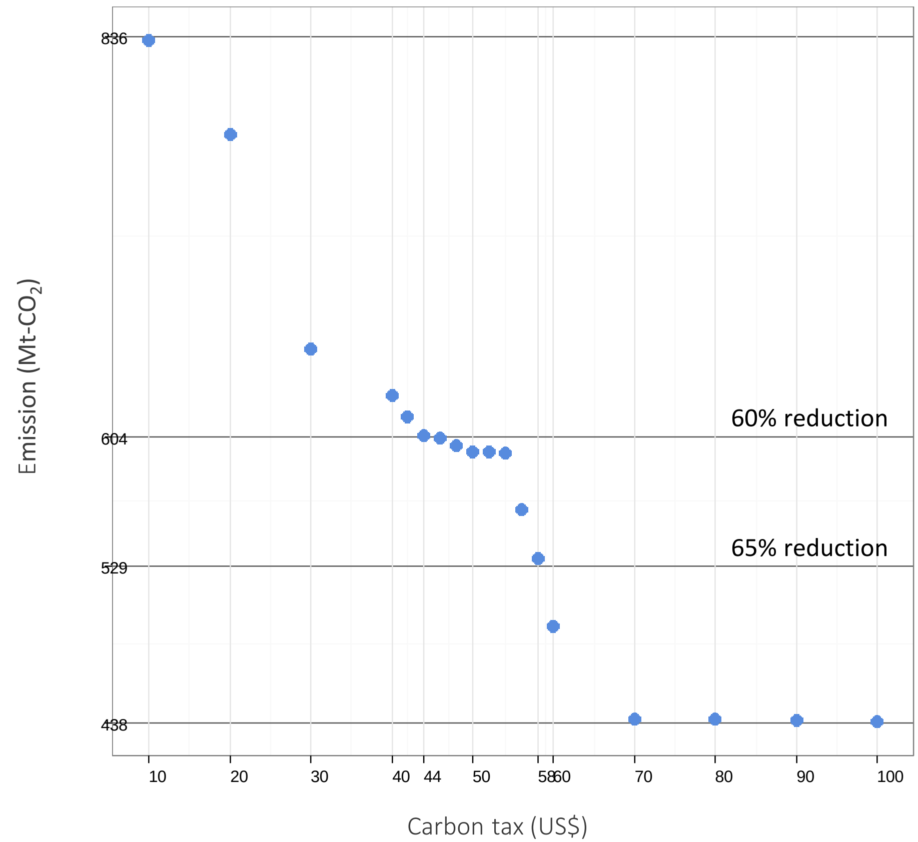
Mitigation Costs of achieving INDC target
- Example of residential sector in 31 provincial analysis in China -

- Emission profiles of CO_2, BC, $PM_{2.5}$ and SO_2, and energy compositions of coal, biomass, gas, heat and electricity are largely different among urban / rural, depend on large / small provinces.
- Carbon prices in residential sector range from 44 – 58 US$/t$CO_2$ for achieving the INDC target

Regional gas emissions



Carbon price in residential sector to achieve INDC



Source) Xing R et al. (2017), *Achieving China's Intended Nationally Determined Contribution: Role of the Residential Sector*, Journal of Cleaner Production, doi: 10.1016/j.jclepro.2017.11.114

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Thank you for your attention