The 25rd AIM International Workshop
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Toward Decarbonization and Depollution Pathways in Asian Regions

- AIM/Endues Bottom-up Analyses -

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AIM
ASIA-PACIFIC INTEGRATED MODEL

NIES JAPAN

Research Objectives and Motivations in Asian Regions
- Bottom-up Approaches -

1. Challenges & barriers as well as cobenefits & trade-offs of decarbonization and depollution measures in Asia regions by focusing on short- to mid-term targets

2. Linkages between climate stabilization targets and SDGs targets, focusing on sector-specific, region-specific and issue-specific.
   - Effects of early-actions on all Short-Lived Climate Forcers (from the viewpoint of climate impacts, health impacts, cost effectiveness, feasibility of mid-term targets)
   - Municipal solid waste management (e.g. waste composition and waste recycle, landfill to incineration, waste to energy)
   - Waste water management (e.g. behavior and nutrition food share change, trade-offs between quality of life and GHG increase)
   - Reductions of nitrogen overload (from the viewpoint of reality of anthropogenic measures, climate mitigation, ozone-layer protection, air quality, health impacts)

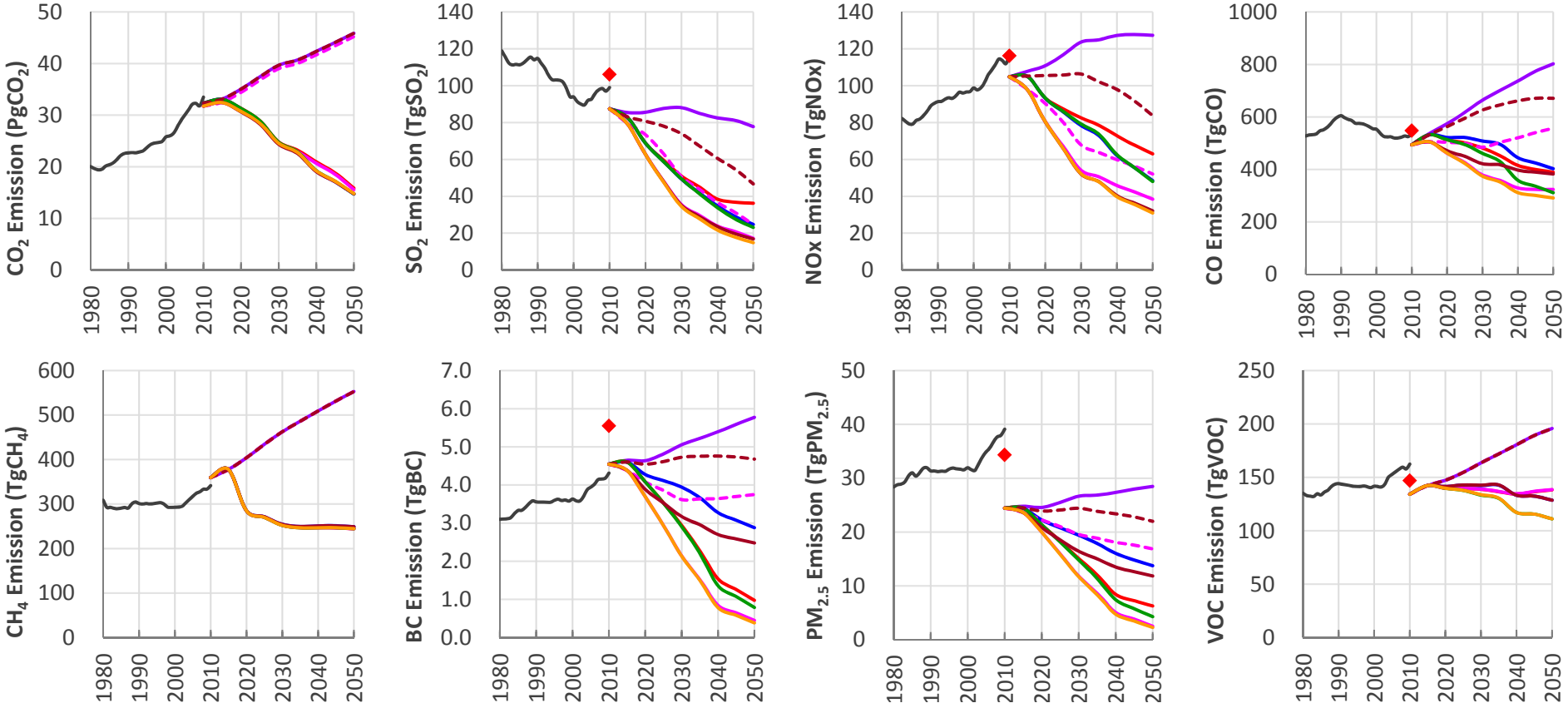
   and so on

3. Inertia of behaviours, socio-economics and technological changes, and transitions of future service demands.

Global CO_2, SLCFs and Air Pollutants Projections
- Exploring Effective SLCFs scenarios -

One of key messages in last year's presentation

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.



All scenarios are 2℃ targets

Source: (Hanaoka, T., Masui, T. Environ Pollut, accepted)

SLCFs and decarbonization scenarios: China and India
- Considering major combinations of mitigation measures -

Please visit Mr. Hirayama's poster

Ref : Reference scenario that future mitigation polices & technologies are in the current trends

EoPmid : **enhancing EoP diffusion by 2050** for SO_2, NOx, BC, OC, $PM_{2.5}$, PM_{10}

EoPmax : **100 % end-of-pipe diffusion by 2050** for SO_2, NOx, BC, OC, $PM_{2.5}$, PM_{10}

2D : Decarbonization mitigation measures toward 2℃ target. **Carbon price in 2050 is 400US$/$tCO_2$**

- ***CCS*** : in 2D scenario, especially **energy shift to coal & biomass power with CCS** rather than renewables
- ***RES*** : in 2D scenario, especially **energy shift to renewables** rather than fossil fuel with CCS
- ***BLD*** : in 2D scenario, especially enhancing **electrification in building sector by 2050**
- ***TRT*** : in 2D scenario, especially enhancing **EV & FCV in passenger transport sector by 2050**

Scenario Group	Scenario code	Major combinations of mitigation measures on GHGs, air pollutants and SLCP					
		EoP enhancement (EoP)	2℃ target measures (2D)	CO_2 Enhancement (CCS)	Renewable enhancement (RES)	Electrification enhancement in buildings (BLD)	Electrification Enhancement in transport (TRT)
Reference	Ref						
End-of-pipe only	EoPmid	Mid					
	EoPmax	Max					
2℃ target & End-of-pipe	2D-EoPmid-CCSBLD	Mid	✔	✔		✔	
	2D-EoPmid-RESTRT	Mid	✔		✔		✔
	2D-EoPmid-RESBLDTRT	Mid	✔		✔	✔	✔
	2D-EoPmax-RESBLDTRT	Max	✔		✔	✔	✔

Source: (Hanaoka, T., Hirayama, T., Hibino, G., Masui, T. ICAE2019), (Hanaoka, T., et al, Appl Energ special issue, paper in preparation)

Emission pathways in China and India

- CO_2 as well as Air Pollutants and SLCPs -

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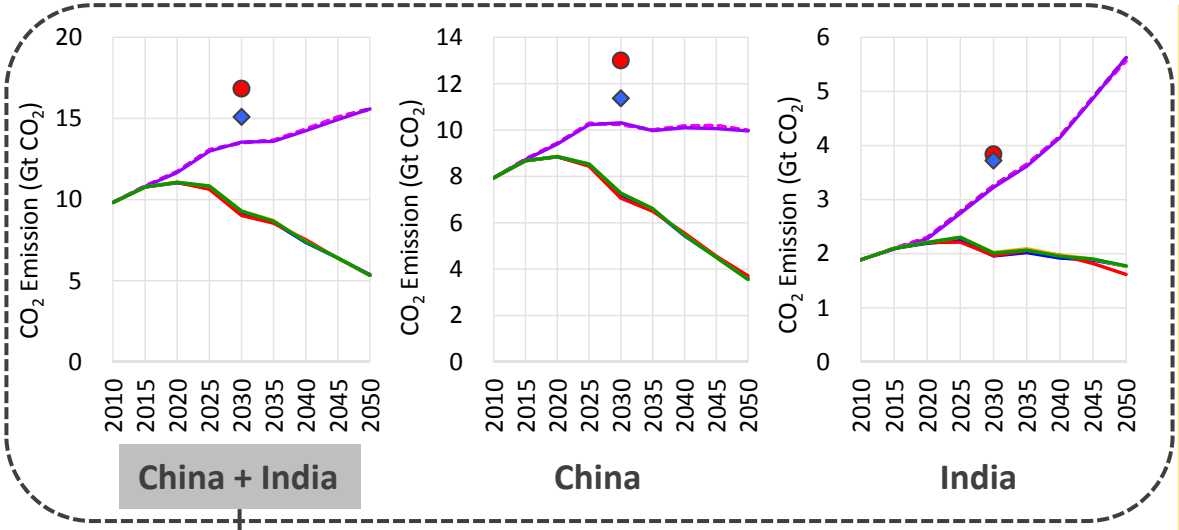
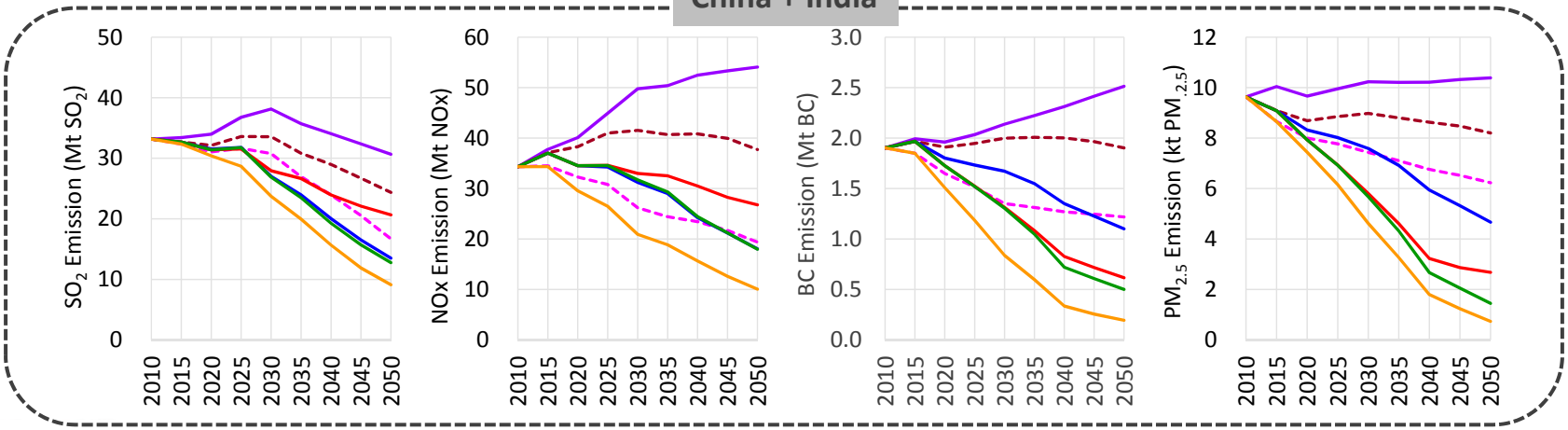
REF · EoPmid · 2D-EoPmid-RESBLDTRT · 2D-EoPmid-RESTRT · 2D-EoPmid-CCSBLD

EoPmax · 2D-EoPmax-RESBLDTRT · NDC (CO_2/GDP target: low) · NDC (CO_2/GDP target: High)



- NDC targets can be achieved in line with the current trend (i.e. under reference scenario)
- India's development will be rapid, thus deep decarbonization is not easy by 2050 in India, compared to China.
- Pathways of SLCPs and air pollutants are different due to combinations of low-carbon and end-of-pipe options, even if CO_2 pathways equivalent to 2℃ are similar.



Source: (Hanaoka, T., Hirayama, T., Hibino, G., Masui, T. ICAE2019), (Hanaoka, T., et al, Appl Energ special issue, paper in preparation)

Sector-wise emissions & mitigations: China & India

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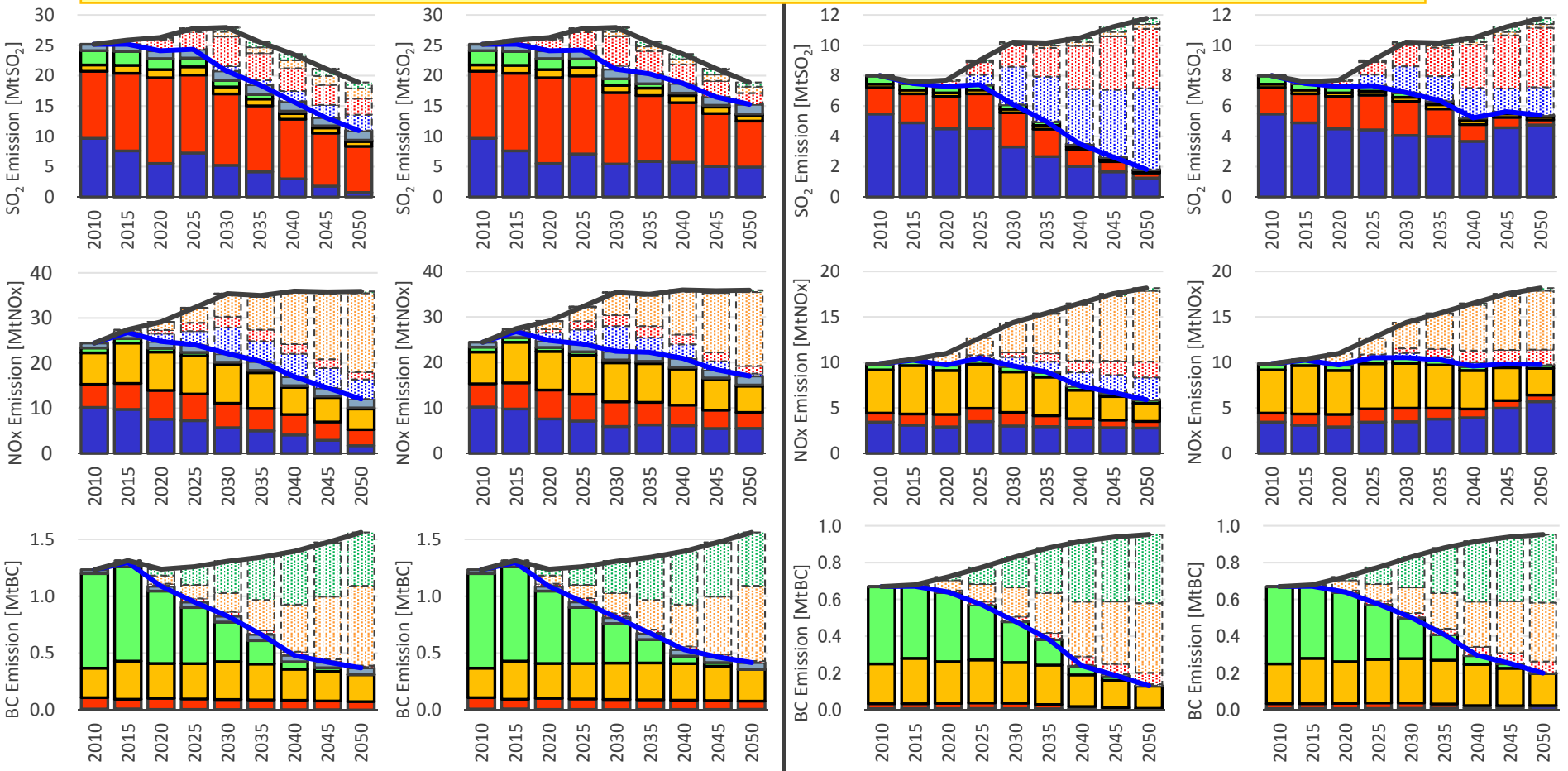
- Major sectors of effective options are different depending on air pollutants and SLCFs



Source: (Hanaoka, T., Hirayama, T., Hibino, G., Masui, T. ICAE2019), (Hanaoka, T., et al, Appl Energ special issue, paper in preparation)

Cumulative additional investment and sector-wise effects

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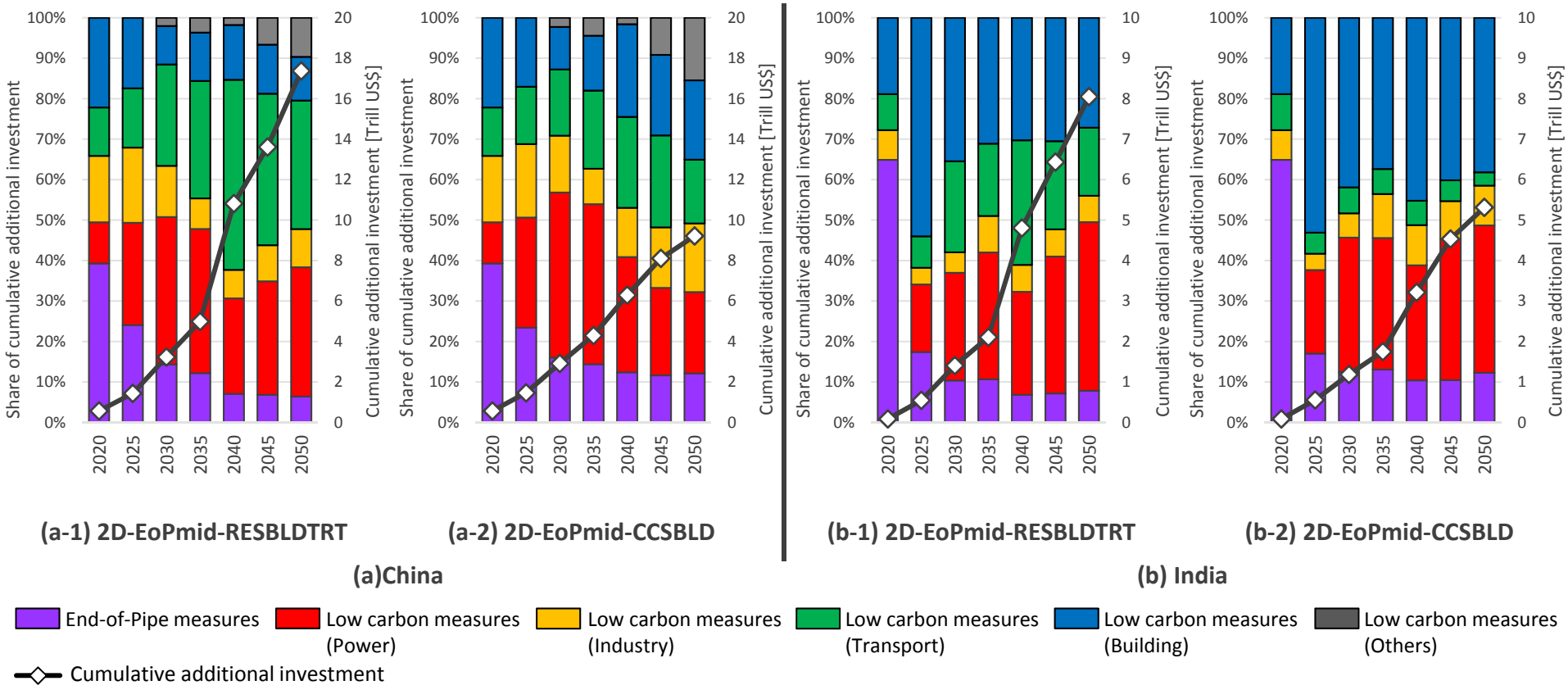
- Cumulative additional investments are also largely different, depending on combinations of low carbon measures. Cumulative costs of 2D-EoPmid-RESBLDTRT is higher compared to cumulative costs of 2D-EoPmid-CCSBLD by 2050, nearly double in China for example.
- EoP measures are very cheap but they are effective for reducing specific gases only.
- Low carbon measures have multiple effect for reducing large amount of air pollutants and SLCPs. But they cost more than EoP.



Source: (Hanaoka, T., Hirayama, T., Hibino, G., Masui, T. ICAE2019), (Hanaoka, T., et al, Appl Energ special issue, paper in preparation)

Challenges toward Net Zero Emission

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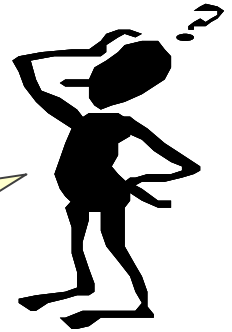
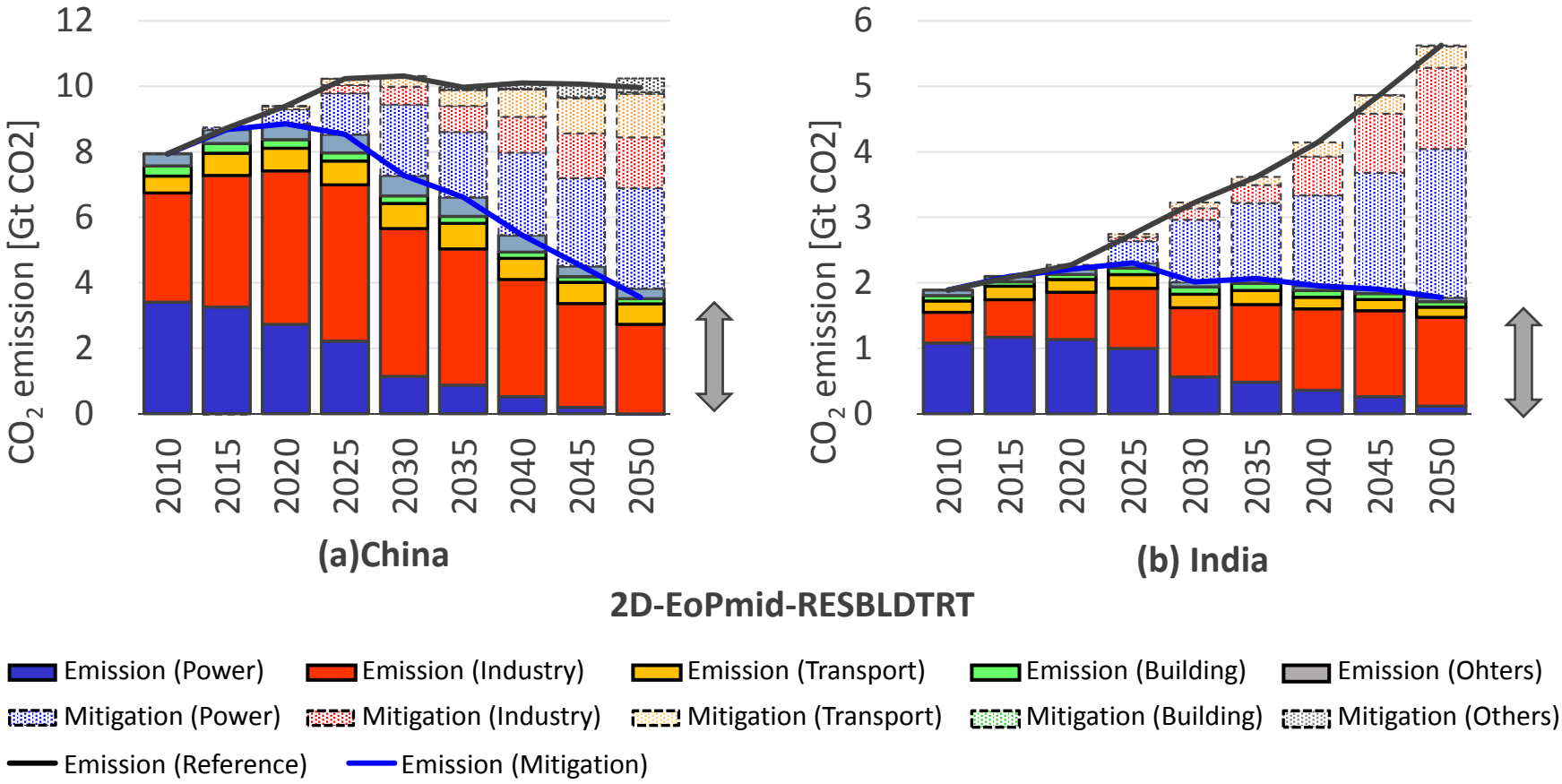
How to reduce remaining emissions in the demand side toward net Zero?





Source: (Hanaoka, T., Hirayama, T., Hibino, G., Masui, T. ICAE2019), (Hanaoka, T., et al, AE special issue, paper in preparation)

Challenges toward Low Carbon of Iron & Steel Industry in China
- Emission Projections and Allocations Considering Plant Location and Capacity

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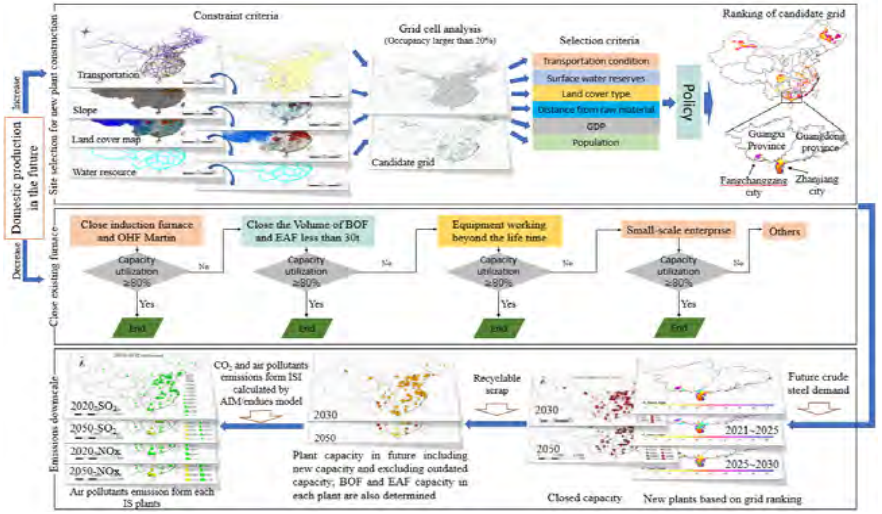
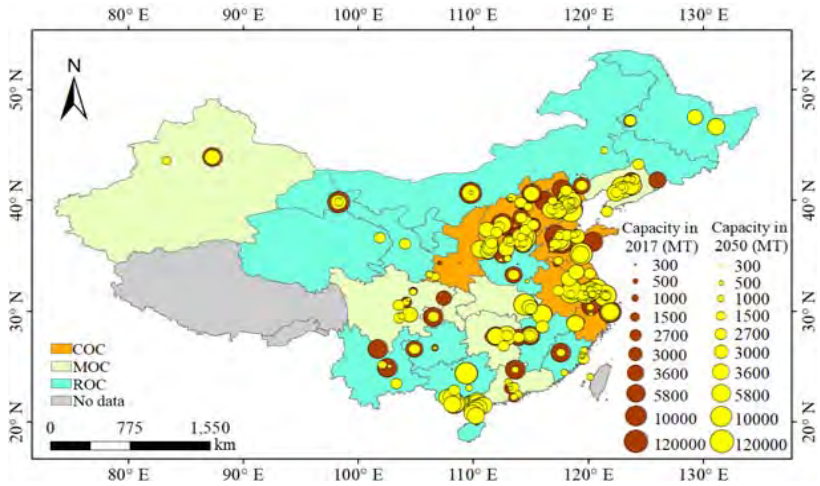
In details, please visit Dr. Li's poster

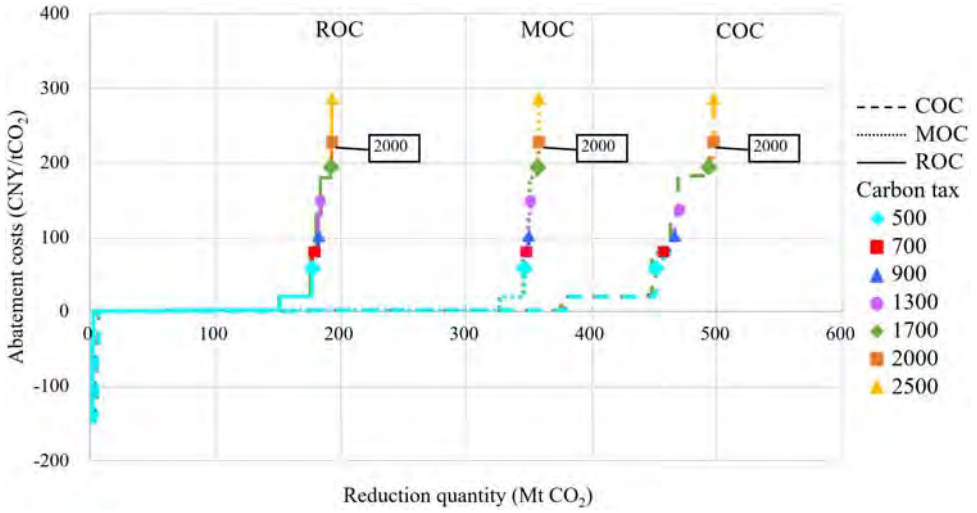
- China's crude steel production is dominant in the world, which account for 49.6 % of world productions in 2015.
- China will reach to the over-capacity of crude steel production in the coming decade, thus it is necessary to consider scrap&build (i.e. phasing out old & inefficient plants and investing advanced plants) and appropriate locations and capacity based on China's Policies
- Mitigation potentials are large in Central China, but mitigation costs will become steep from a certain level of mitigations, because of limitations of mitigation options.



Method of Scrap&Build LPS and Emission Allocation



LPS location and capacity in 2017 & 2050



Emission Reductions and Abatement Costs in 2050 in COC(Central China), Middle China(MOC) and Rest of China(ROC)

Source: (Li, Z., Hanaoka, T., Resour Conserv Recy, under review), (Li, Z., Hanaoka, T., ICAE2019), (Li, Z., Hanaoka, T., paper in preparation)

Decarbonization in Province-wise Residential & Commercial in China
- Contribution to China's NDC and Cobenefit of Reducing Indoor Air Pollution -

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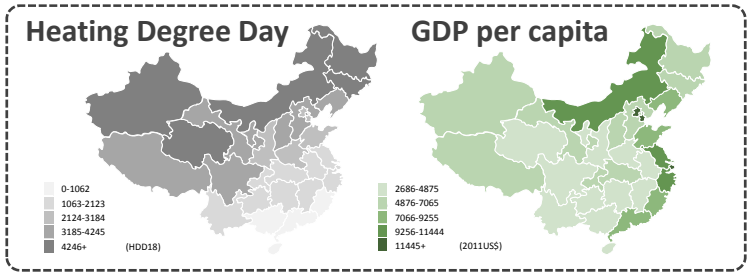
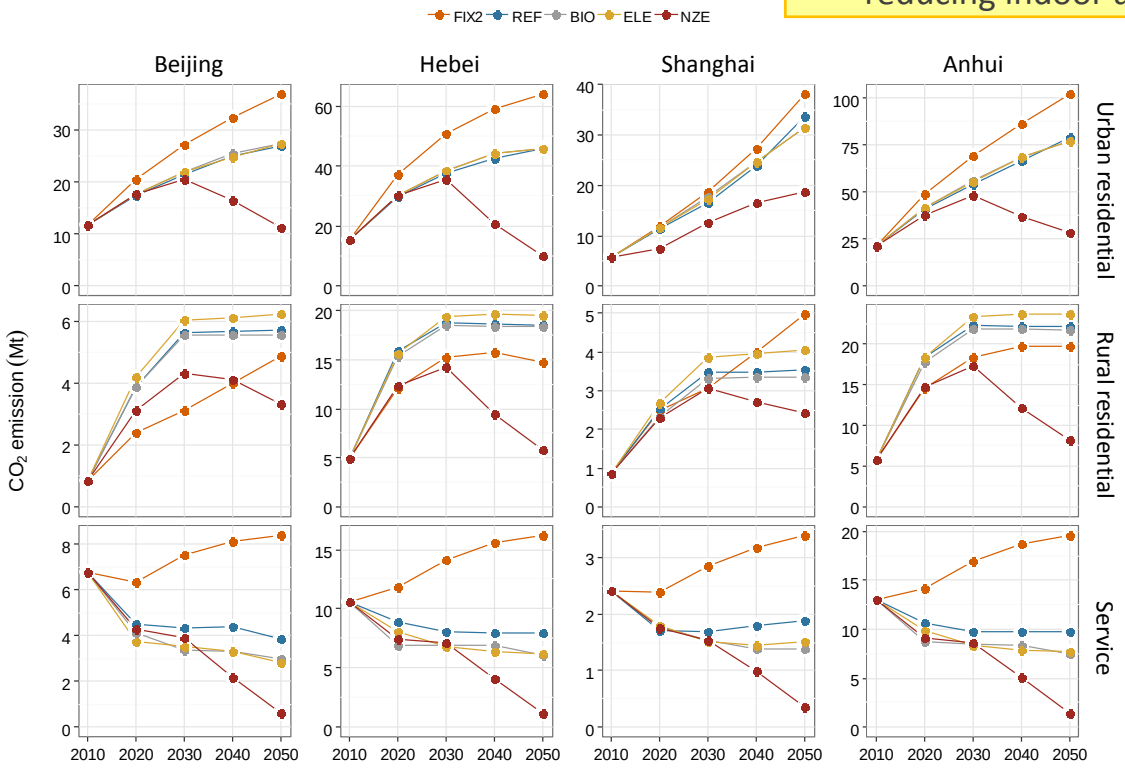
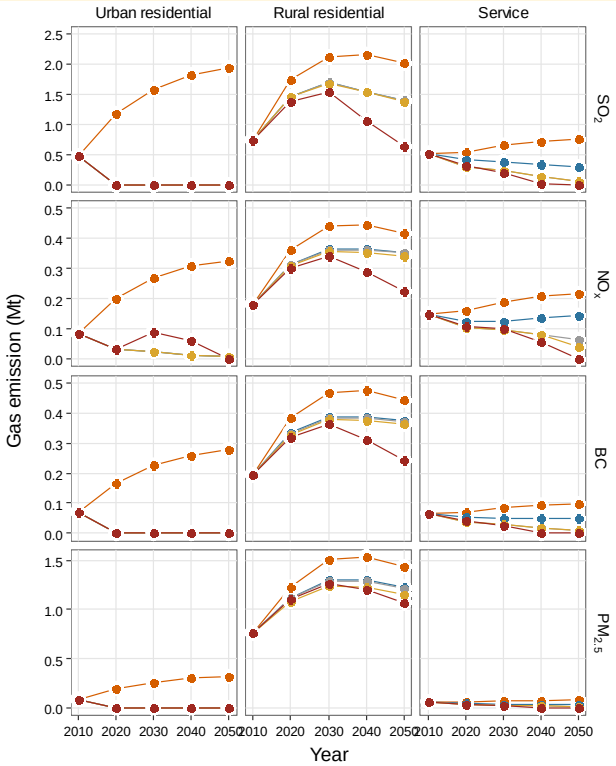


Current Socio-economic & Environmental Diversities

- Province-wise socio-economic and environmental diversities have effects on rural&urban province-wise energy profiles as well as potentials to diffuse advanced technologies, which become barriers toward deep decarbonization in the building sector.
- By considering barriers, it is difficult to achieve Zero Energy Building or Zero Emission Building in China, especially in rural residential, but decarbonization policy will have cobenefits on reducing indoor air pollution in urban residential and service



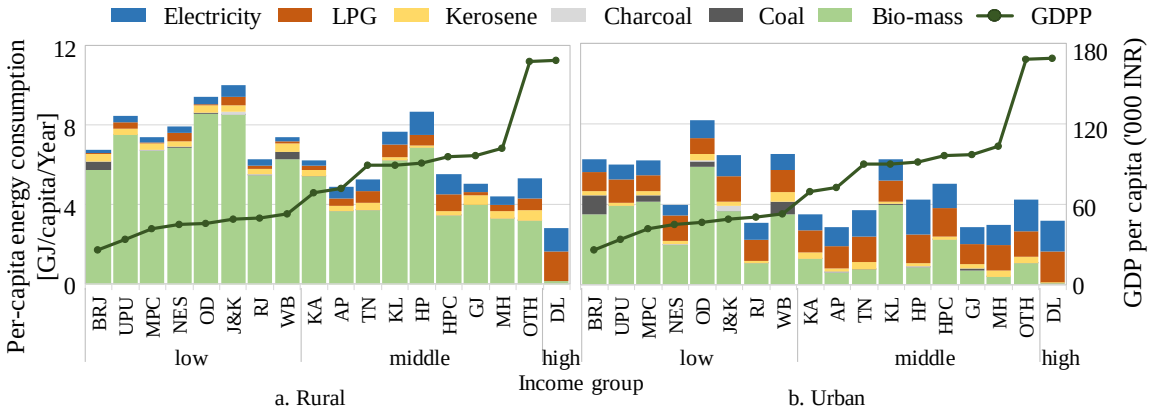
Province-wise Rural & Urban CO_2 Emissions



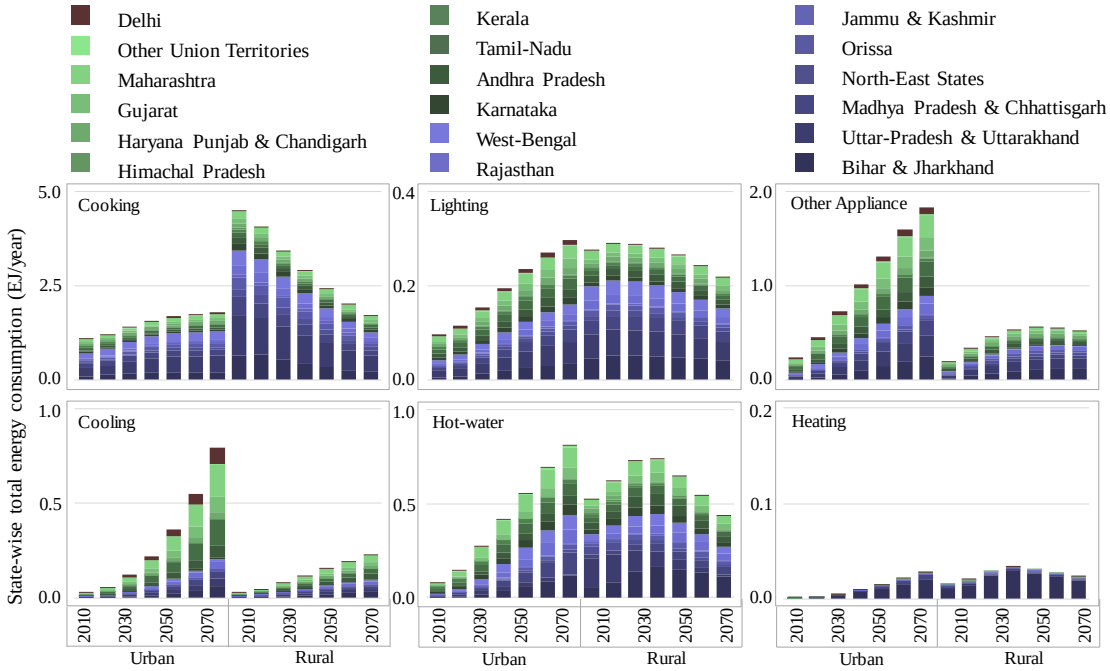
National Urban & Rural Air Pollutant Emissions

Source: (Xing, R., Hanaoka, T., Masui, T., paper to be submitted)

Energy Demand Projections in State-wise Residential in India
- Dynamic Transitions in Rural & Urban by States -



Energy-wise per capita energy consumption and GDP per capita in 2011



State-wise Urban&Rural Energy Demand Projections up to 2070

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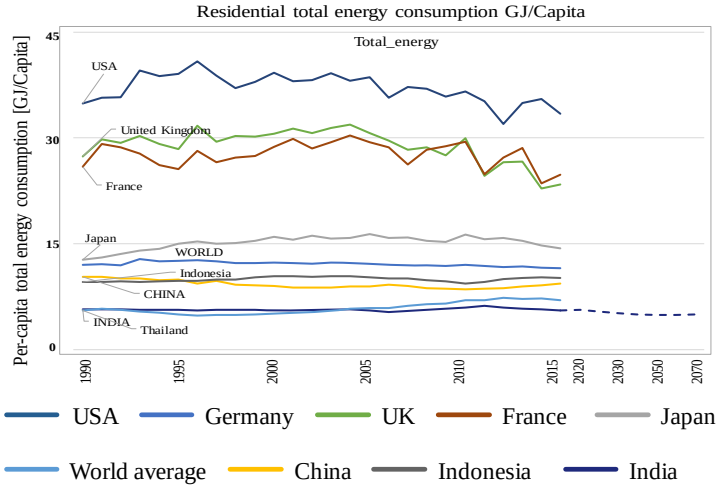
In details, please visit Dr. Yawale's poster

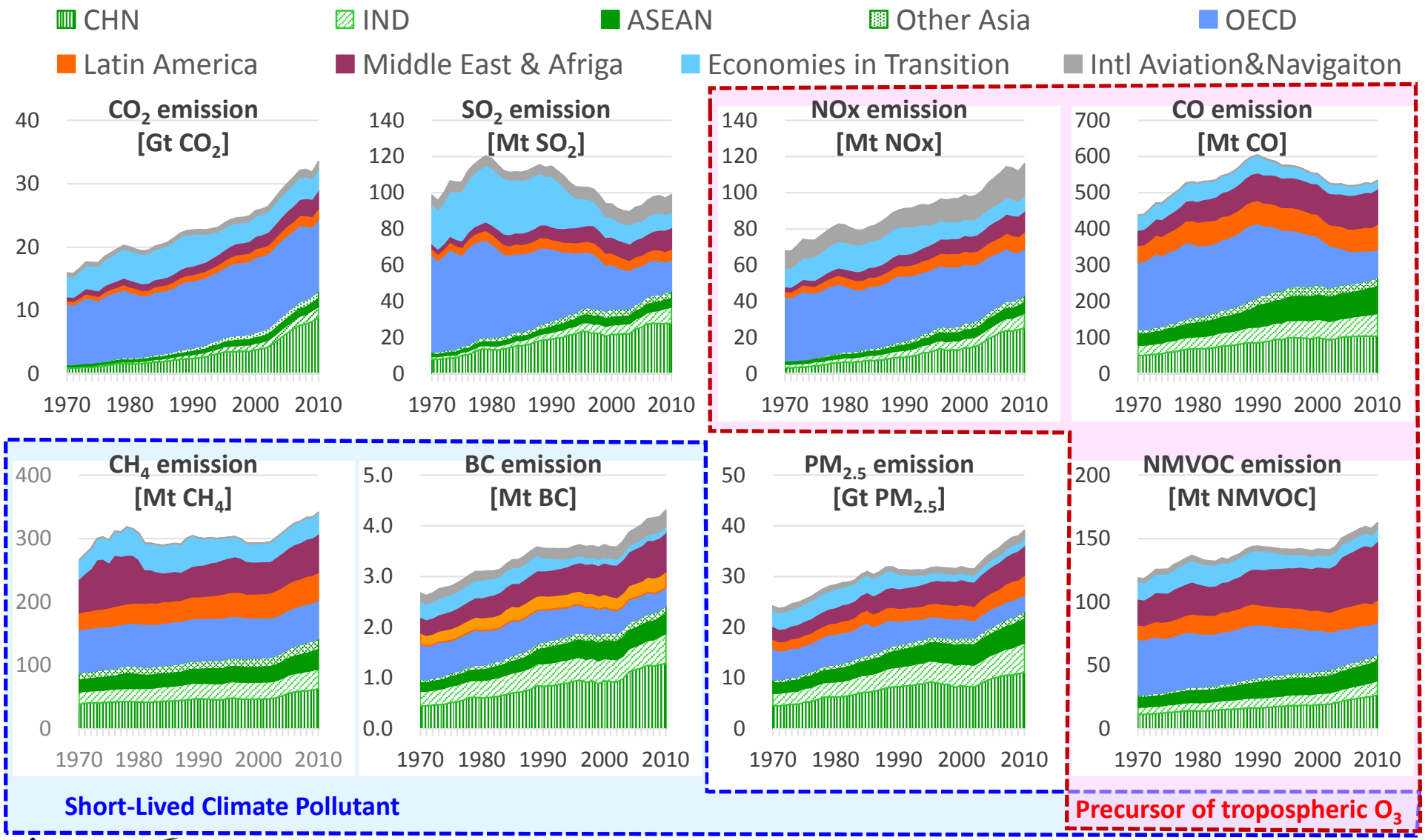
- To project future province-wise rural & urban energy demands, it is necessary to develop province-wise Energy Balances Table.
- The more urbanized and more economic developed, the less traditional energy and the less per-capita energy.
- Energy demands sharply increase in cooling, cooking, and electric appliances in urban, but national average per capita energy level is still low in the future compared to the current developed country levels.



Source: (Yawale, S., Hanaoka, T., Kapshe, M., Renew Sust Energ Rev, under review), (Yawale, S., Hanaoka, T., paper in preparation)

Global Anthropogenic Historical Emissions
- Importance of ASEAN -

SLCPs and air pollutants emissions from South-east and South Asia has been on the increase



Source) made by author from EDGER 4.3.2

2℃ Targets and Mitigation Potentials by Sector in ASEAN

- Deep-Cutting beyond NDCs and Cobenfits for Air Pollutants and SLCFs -

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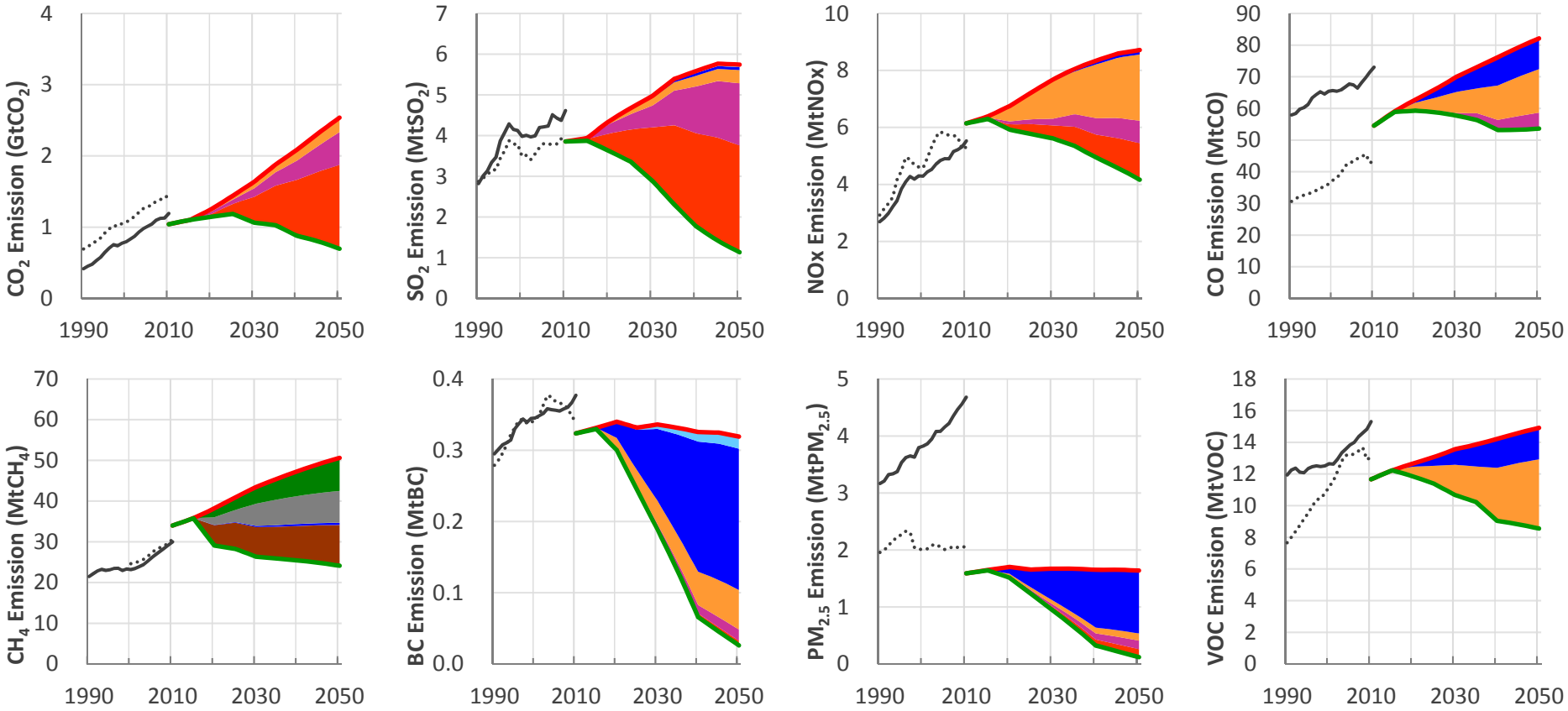
- Major sectors of effective mitigation options are different by gas
- Important to carefully consider constraints like inertia, energy transition, technological feasibility
- Important to pay attention to CH_4, N_2O and NH_3 related to non-energy sectors.



Source: (Hanaoka, T., International Regional Science Meeting 2019)

Regional Passenger Road Transport Demands and Emissions in Thailand
- Current Exhaust Emissions Regulatory Scenario -

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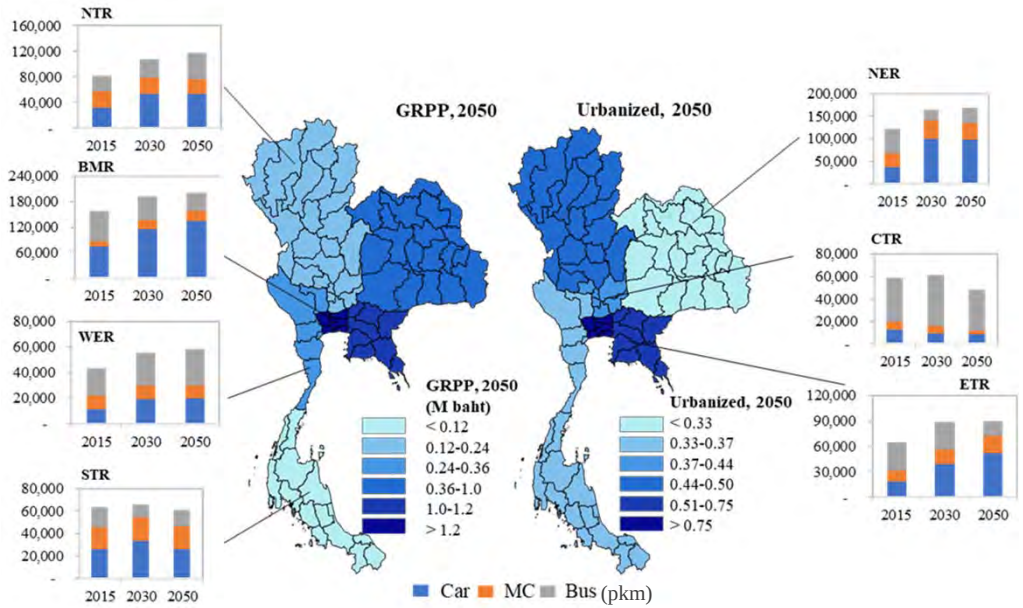
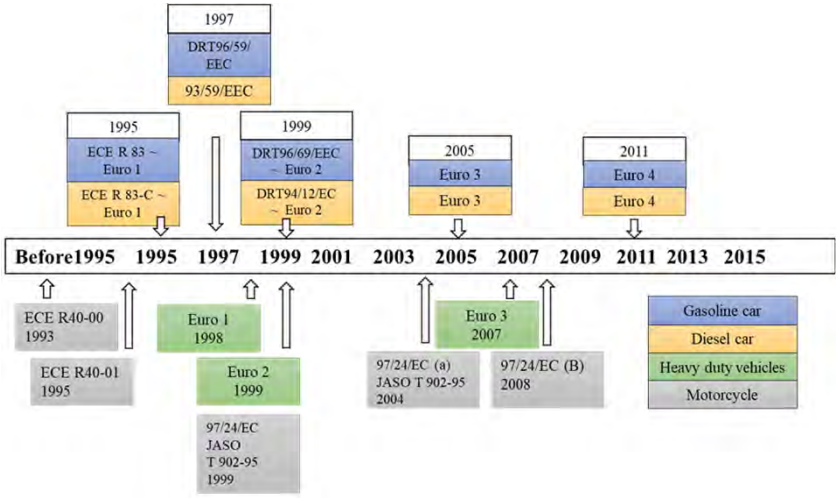
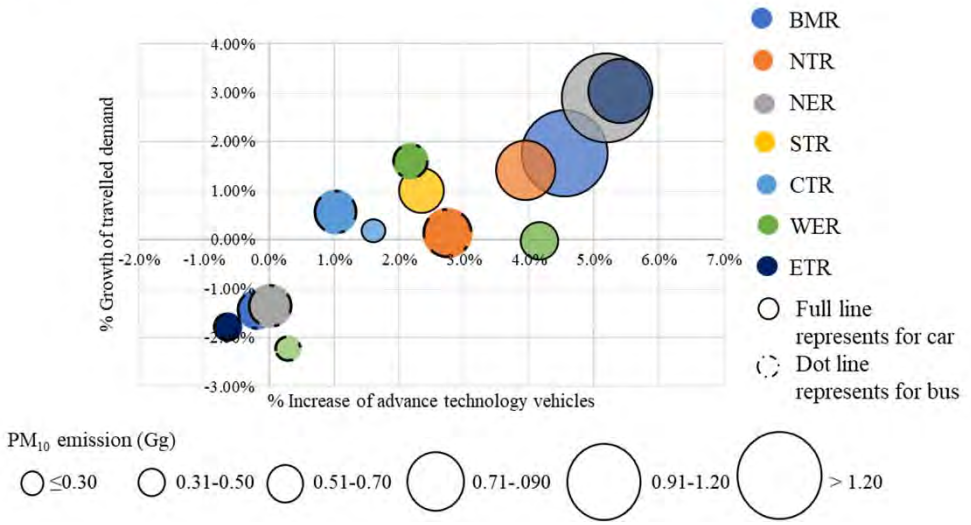


Diversities of socio-economics and transport demands

- It is important to consider regional socio-economic diversities and mode-wise characteristics carefully, for estimating future transport volumes.
- It is necessary to consider baseline scenario to understand inertia of current regulations and its characteristic among demand growth, efficient vehicle diffusion and CO_2 & air pollutants emissions.
- Effects on emissions by travel demand growth are larger than by inertia of efficient vehicle diffusion, especially in BMR, NER and ETR areas. Thus, it is important to consider mitigation policies such as EV and biofuel.



Current Exhaust Emissions Regulation



Relations among demand growth, vehicle diffusion and PM emission in 2050 under Baseline scenario

Source: (Cheewaphongphan, P., Hanaoka, T., Chatani, S. paper to be submitted)

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Thank you for your attention