

Climate action in Asian and Pacific countries

Implications of NDCs and the role of carbon pricing for the energy sector

Case study carried out with EVALUATE

NREL Webinar: June 2018



Agenda

- **Part 1: Major contribution of Asian countries in global energy demand & CO2 emissions**
 - Global and Asian energy system projections (Enerfutur Scenarios)
 - Asian country & region emissions and pledges
- **Part 2: Study Framework**
 - Proposed approach based on MACCs with EVALUATE
 - Study cases' objectives
- **Part 3: Results and key findings**
 - No sectoral & No international cooperation (« Regulation » scenario)
 - Sectoral flexibility (« Domestic ETS » scenario)
 - Sectoral & international cooperation (« International Cooperation » scenario)

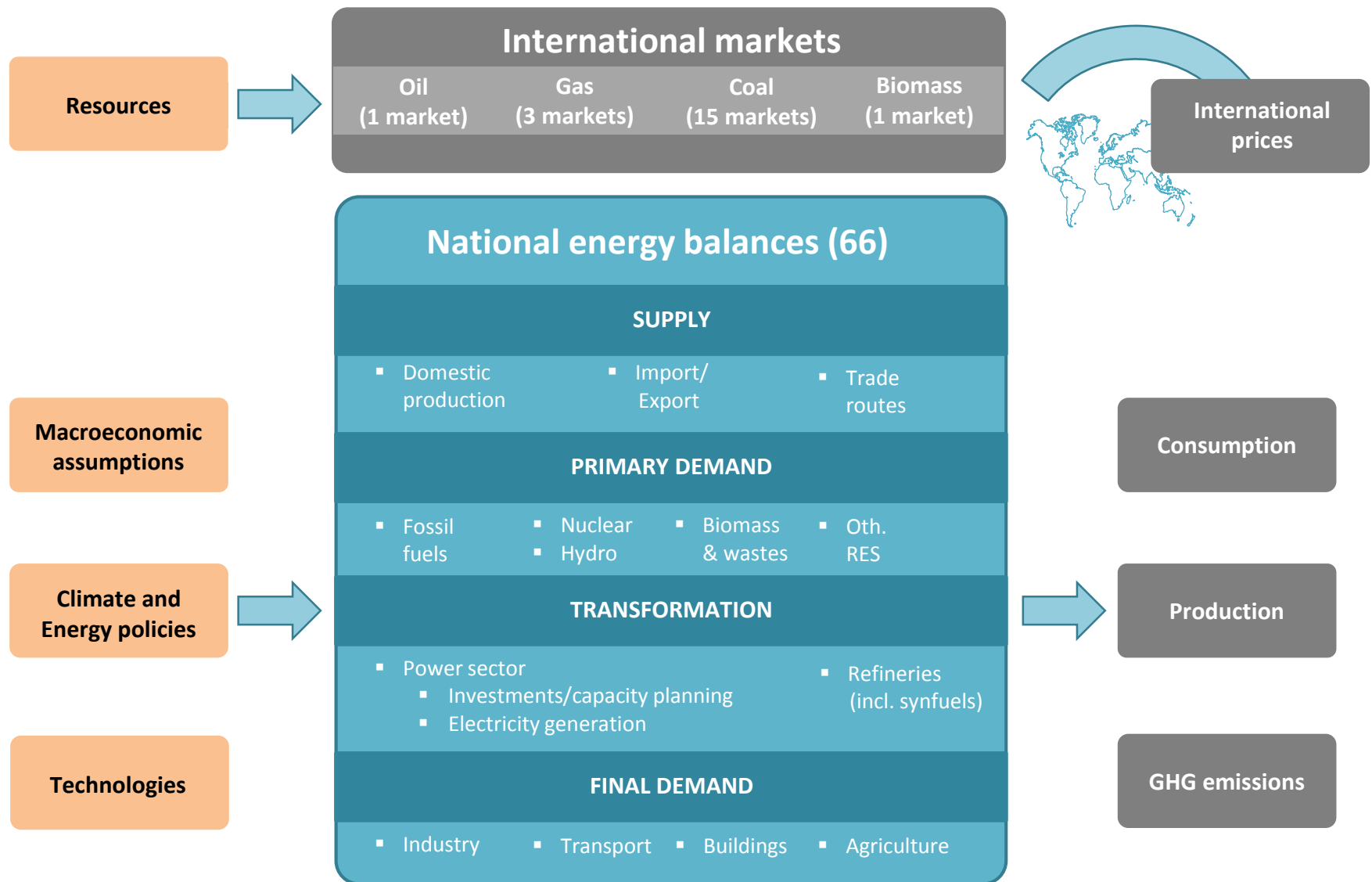
PART I

Major contribution of Asian countries in global energy demand & CO2 emissions

Global and Asian energy system projections

EnerFuture Scenarios

POLES: A multi-issue energy model



For more details: <https://www.enerdata.net/solutions/poles-model.html>

Scenario building with POLES

Alternative assumptions for key drivers : resources, climate and energy policies, available technological options ...

macro-economic hypothesis: population, GDP growth...

Today

2030 / 2040 / 2050

Demand

Global & regional dynamics, fuel mix, efficiency...

Supply & Prices

Availability, self-sufficiency, trade, bills ...

Sustainability

CO₂ emissions...

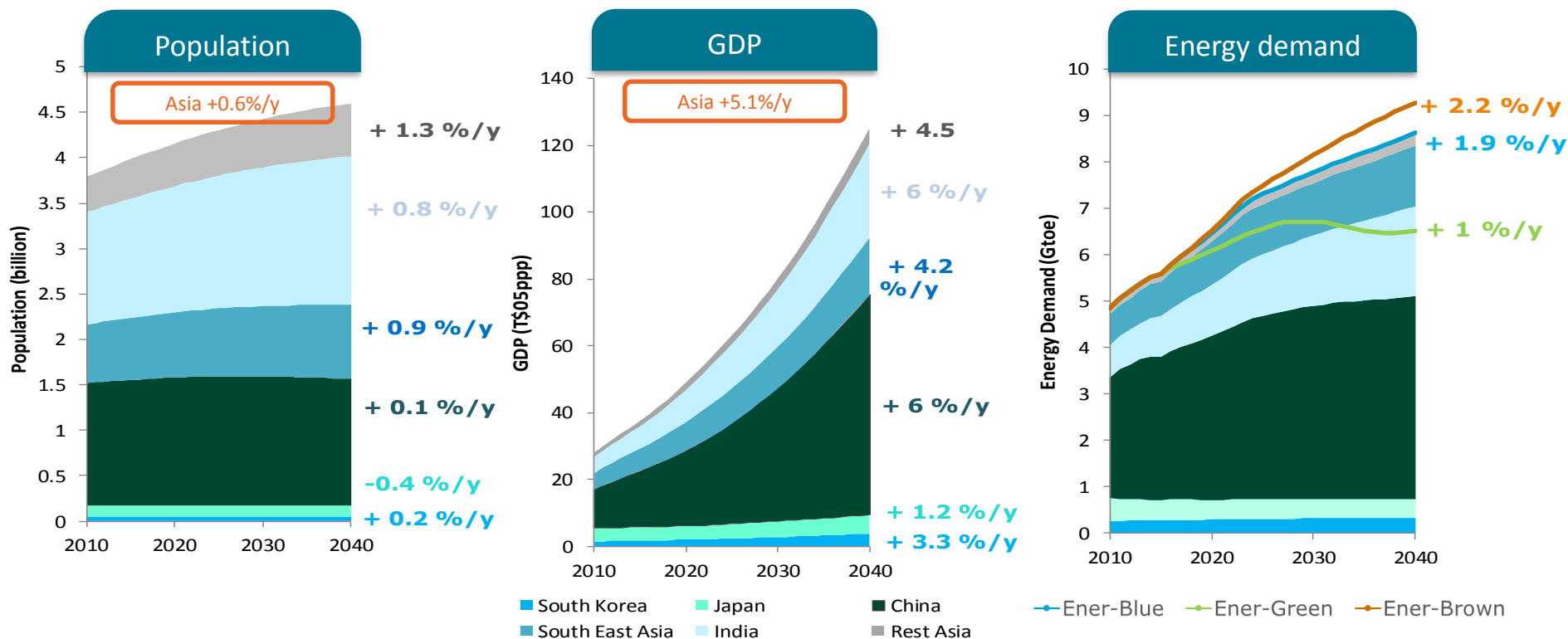
... allows us to explore different pathways for energy markets

Strong economic growth leads to a doubling of Asian energy consumption...

Enerdata EnerFuture scenarios:

EnerFuture sc.	Ener-Brown	Ener-Blue	Ener-Green
Global context	No climate constrain	NDCs implemented	2°C compatible

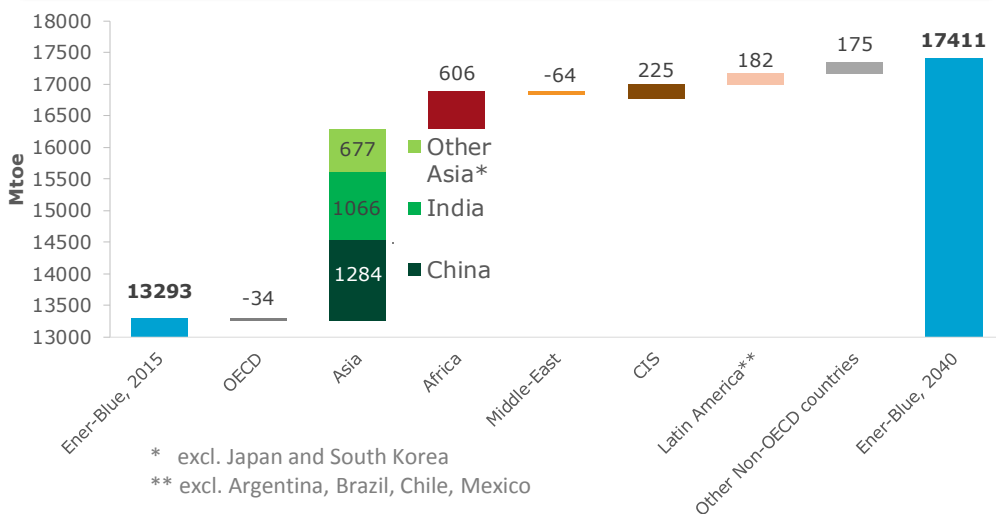
For more details: <https://www.enerdata.net/research/forecast-enerfuture.html>



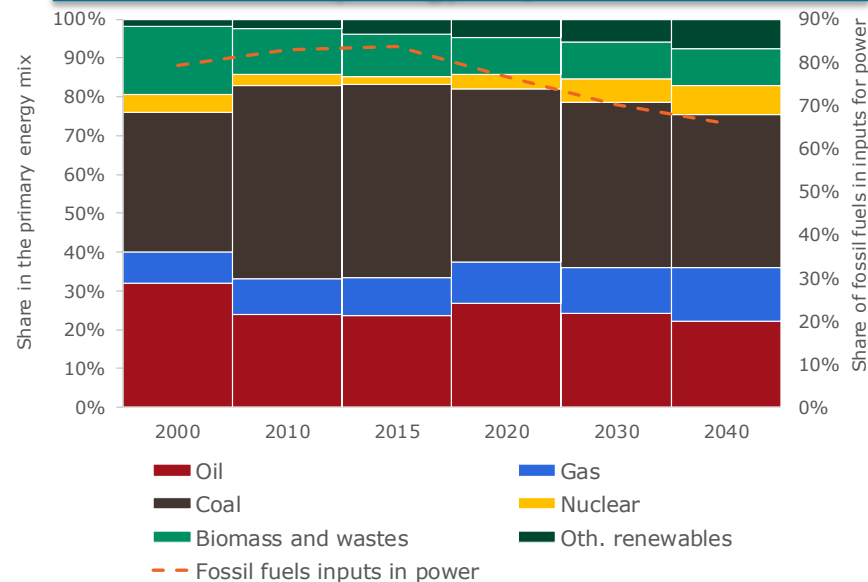
... which drives the global demand (~50% of the worldwide demand in all EnerFuture scenarios).

Global demand is driven by Asia with an energy mix still dominated by fossil fuels, especially coal

Regional contribution in primary consumption, 2015 vs 2040, EnerBlue



Primary energy mix, Ener-Blue

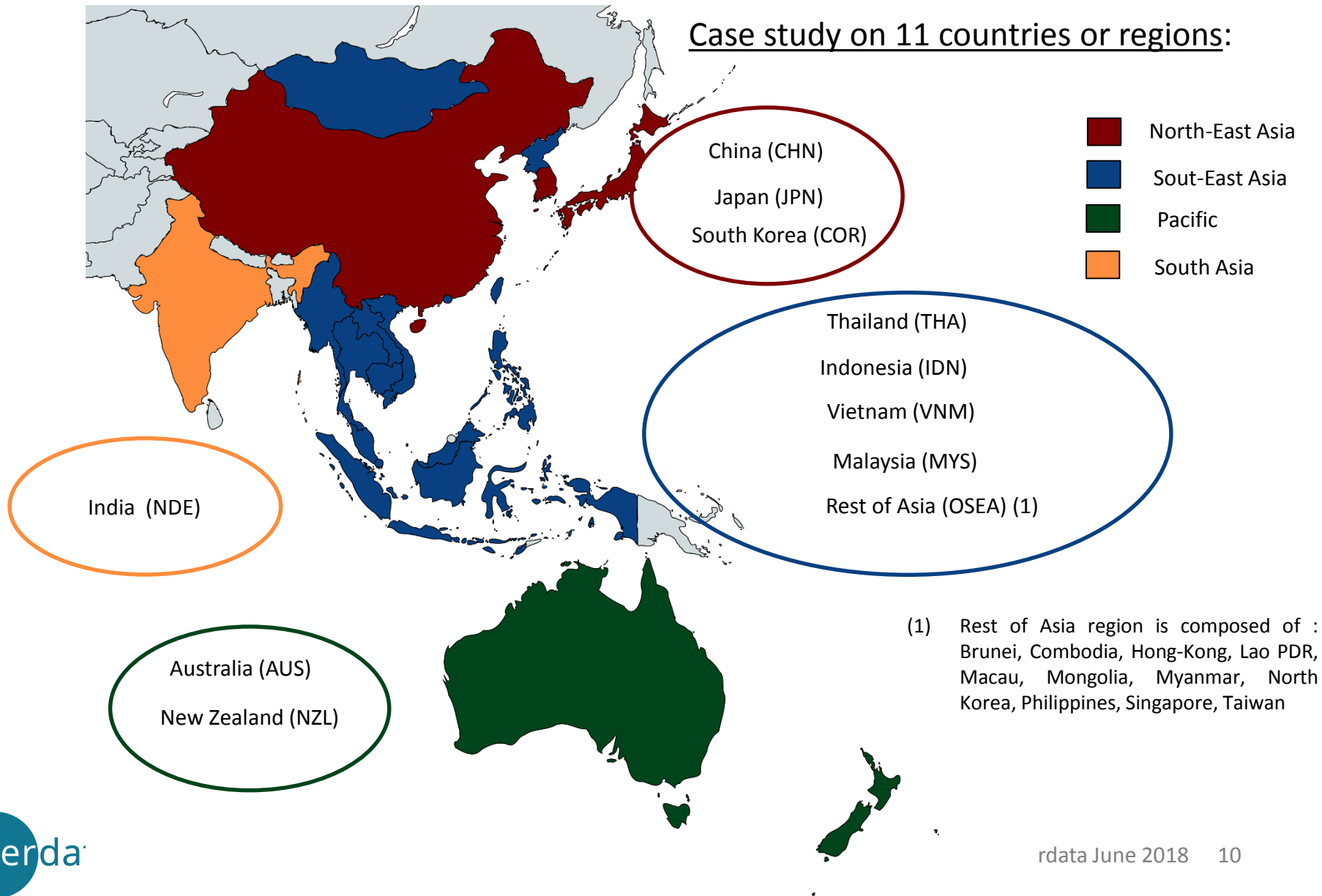


74% of the demand growth over 2015-2040 will come from Asia, and 15% from Africa.

In the power sector, the share of fossil fuels inputs decreases from 84% to 66% between 2015 and 2040.

Asian country & region emissions and pledges

POLES country and region description in Asia



What contribution to global warming?

Countries	2010 (bunk. excluded) *		2030 POLES Baseline (bunk. excluded) *			
	MtCO2e	% world	MtCO2e	Var. / 2010 (MtCO2)	% world	Var./ 2010 (% world)
China	8408	22,8%	13042	+4728	28,3%	+5,1%
South Korea	737	2,0%	822	+129	1,8%	-0,2%
Japan	1239	3,4%	1051	-158	2,3%	-1,1%
Australia	462	1,3%	462	+12	1,0%	-0,3%
New Zealand	45	0,1%	49	+8	0,1%	-0,0%
Indonesia	520	1,4%	872	+354	1,9%	+0,4%
Malaysia	251	0,7%	372	+128	0,8%	+0,1%
Thailand	314	0,9%	421	+120	0,9%	+0,1%
Vietnam	158	0,4%	467	+312	1,0%	+0,6%
Rest of Asia	907	2,5%	1238	+500	2,7%	+0,6%
India	2206	6,0%	5166	+2976	11,2%	+5,1%
Total studied countries	14852	41,5%	23961	9109 (+61,3%)	52,0%	+10,5%
World	35789	100,00%	46093	10303 (+28,8%)	100,00%	

- Energy-related emissions from Asian countries are planned **to increase twice faster** than global emissions.
- Asian energy-related emissions will account for **more than half** of global emissions (+10.5 percentage points compared to 2010 global share)

* Energy related GHG emissions. international aviation and maritime bunkers are excluded.

NDCs of countries included in the study

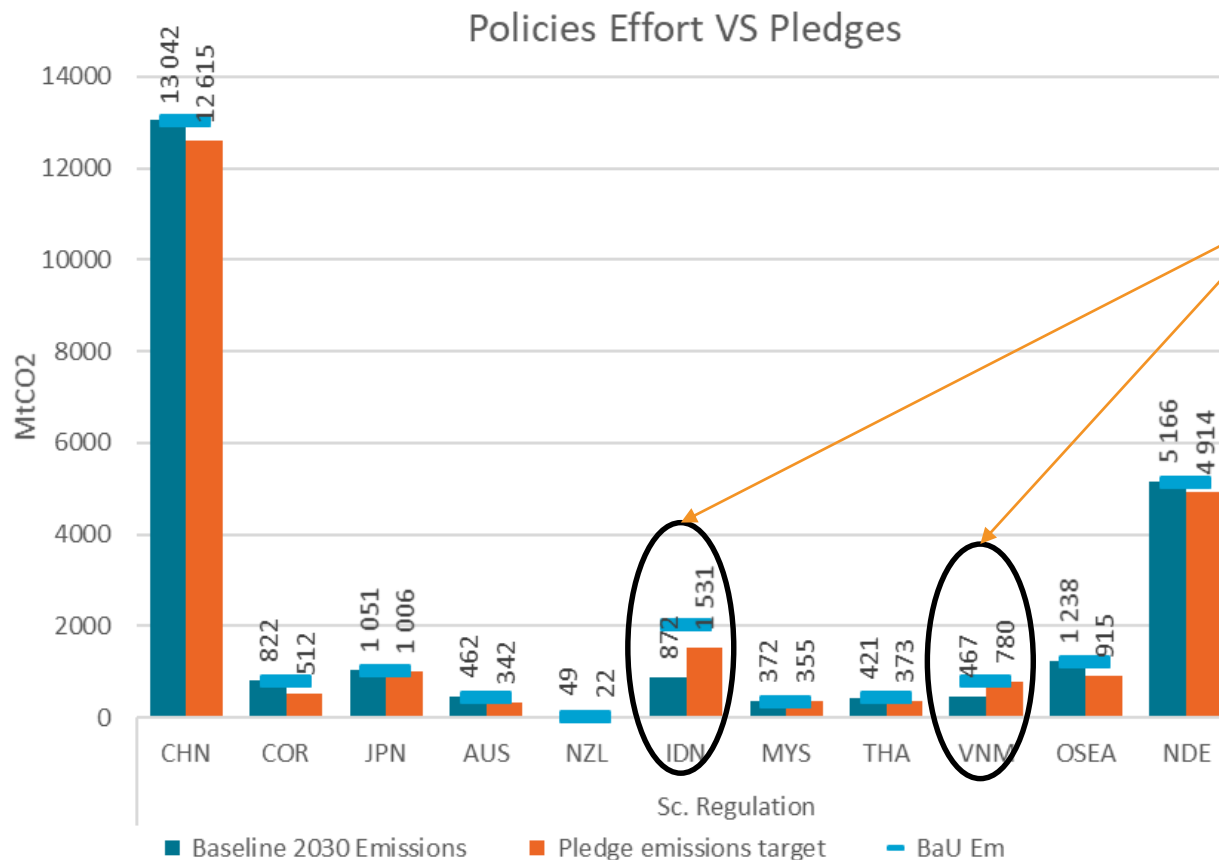
Country	Type of Target	Energy related Mitigation Effort	Base Year	Scope of pledge	POLES Baseline energy related emissions. (MtCO2e)	Country's BaU total emissions (MtCO2e)	POLES GDP projections in 2030 (US\$2010ppp)
China	% Intensity/GDP	60,0%	2005	Economy-wide	13 042		39 869
South Korea	%	37,8%	Pledge BaU	Economy-wide	822	851	2 700
Japan	%	22,8%	2005	Economy-wide	1 051		4 807
Australia	%	19,6%	2005	Economy-wide	462		1 379
New Zealand	%	48,9%	2005	Economy-wide	49		184
Indonesia	%	24,8%	Pledge BaU	Economy-wide	872	2869	4 389
Malaysia	% Intensity/GDP	35,0%	2005	Economy-wide	372		1 275
Thailand	%	20,0%	Pledge BaU	Economy-wide	421	555	1 335
Vietnam	%	4,3%	Pledge BaU	Economy-wide	467	880	999
Rest of Asia	%	26,1%	Baseline*	Energy related	1 238		4 453
India	% Intensity/GDP	33,0%	2005	Economy-wide	5 166		17 213

- **Wide heterogeneity** of NDC definitions
- Most of the Asian countries have an **economy-wide NDC mitigation target**
- China, Malaysia and India targets are **GDP intensity-based**
- South Korea, Indonesia, Thailand and Vietnam have a **pledge compared to a BaU**

* For Rest of Asia region, we quantified the energy related mitigation efforts of each country and aggregated it in a regional NDC mitigation target

Countries ambitions

Asian region	MtCO ₂ e
Total Baseline Emissions covered in 2030	23961
Total Emissions Reduced by 2030	1567

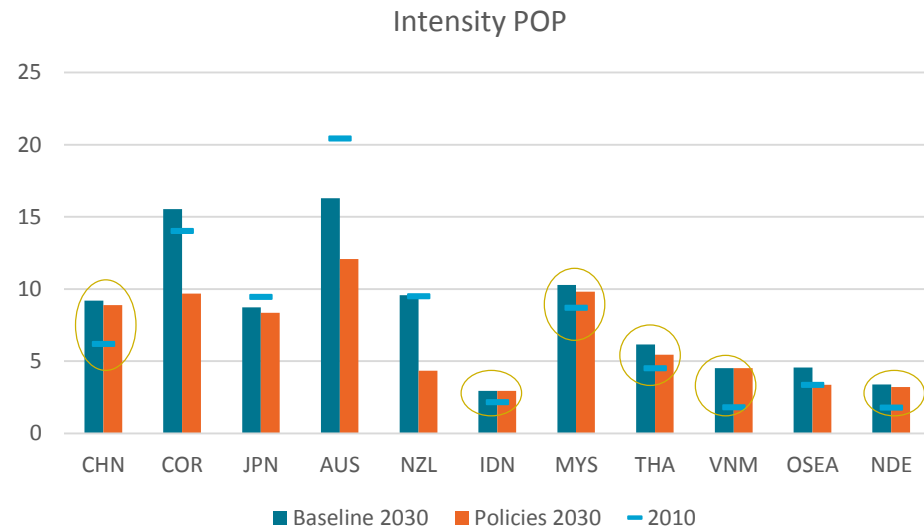
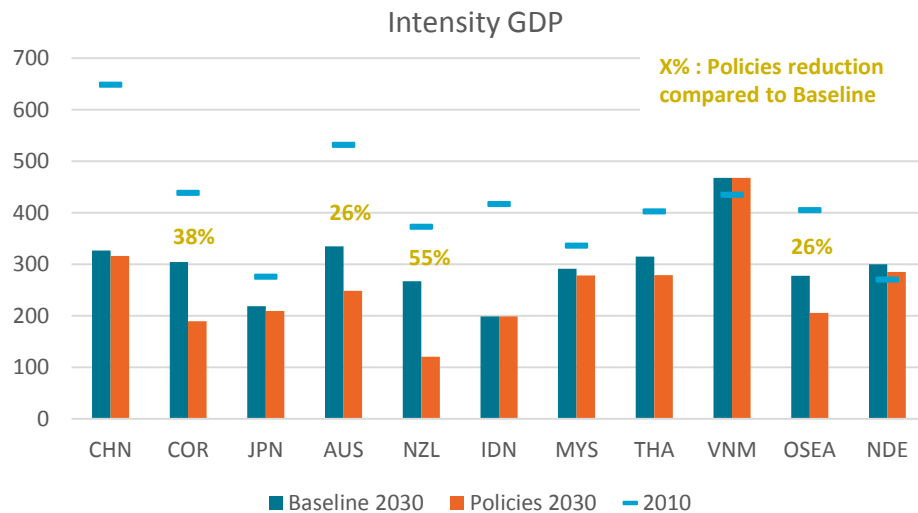


- Gap between BaU & POLES Baseline emissions
- No additional effort to reach pledges targets.

Assumptions made in our POLES baseline scenario result in not stringent NDC mitigation targets for Indonesia and Vietnam. These countries might not need addition mitigation efforts to achieve the targets *

* Indonesia and Vietnam are then excluded from the analysis of Sc. Regulation and Sc. Domestic ETS scenarios

Countries ambitions: other indicators



- **Intensity GDP :**
 - **Most countries reduce their intensity GDP / 2010** except Vietnam and India
 - Countries reducing the most / 2030 are New Zealand, South Korea, Australia & Rest of South Asia.
- **Intensity Pop :**
 - Between 2010 and 2030, China, Indonesia, Malaysia, Thailand, Vietnam, and India **emissions have grown faster than population.**
- **3 countries both reduced emissions and intensity GDP compared to 2010 :** South Korea, Japan, Australia, and New Zealand.

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PART II

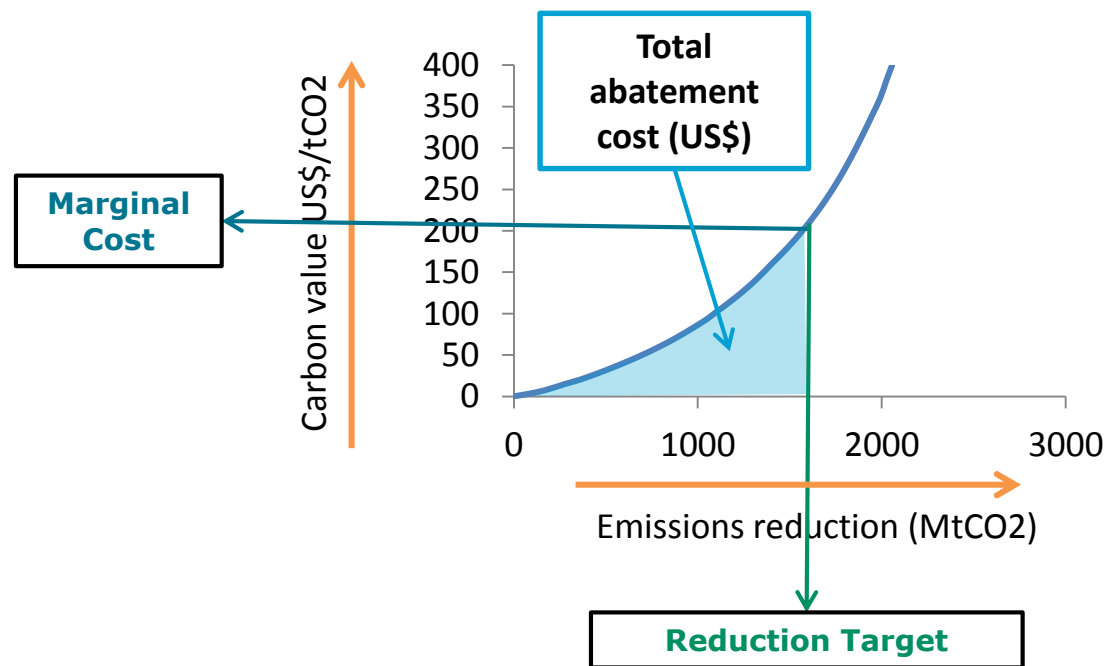
Case study framework

Proposed approach based on Marginal Abatement Cost Curves (MACCs)

Using EVALUATE tool

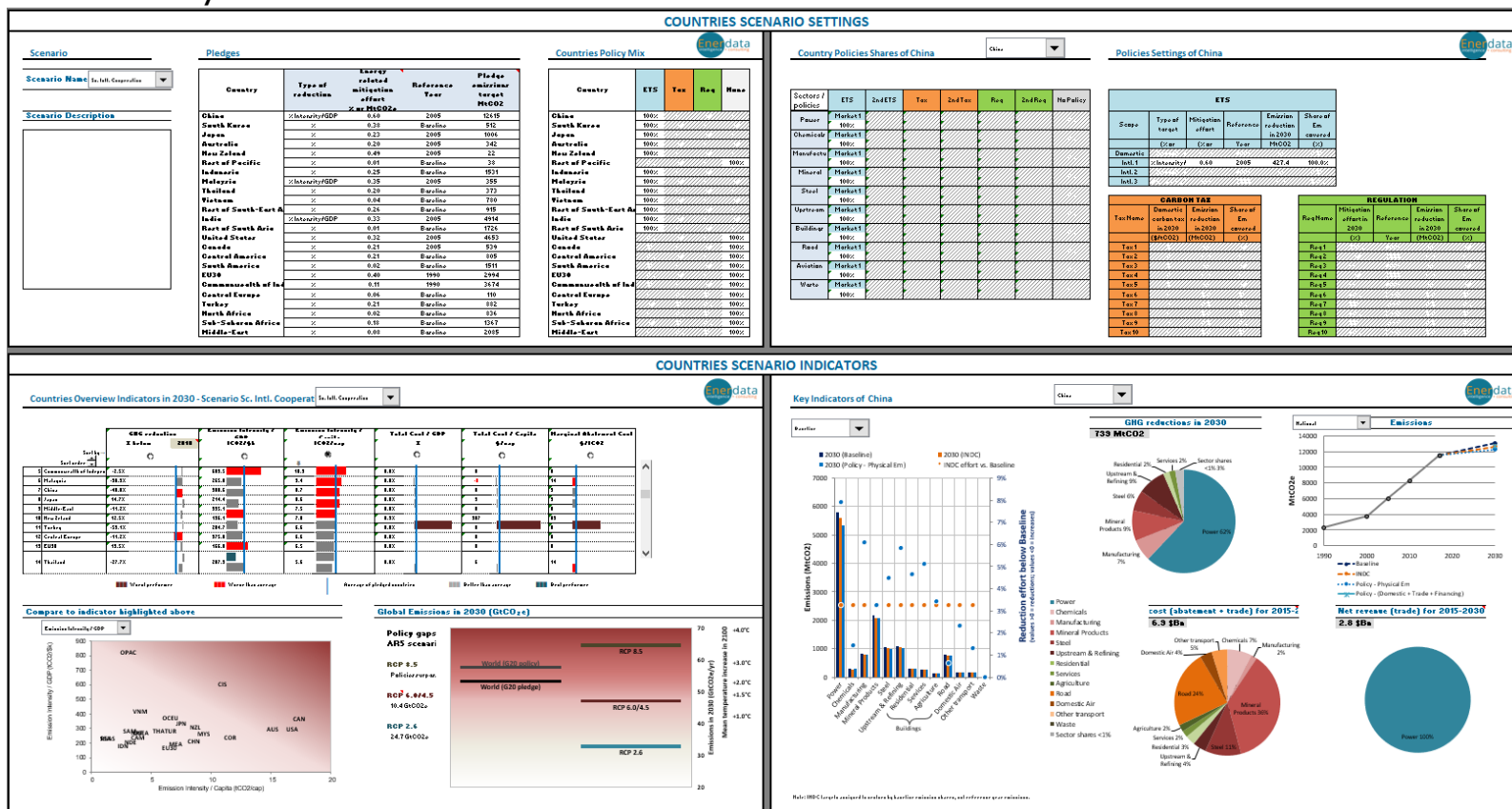
Marginal Abatement Cost Curves (MACCs)

- Top-down MACCs produced by the POLES model as the result of sensitivities on **carbon value**
- Curves are produced by POLES for:
 - 66 countries/regions
 - 20 emitting sectors
 - All years from 2020 to 2050



MACCs are an essential input for the present work

- A set of coherent and interdependent MACCs for all sectors and countries considered
- Covers all GHG and emitting sectors, with the exception of LULUCF and non-CO₂ agriculture
- MACCs for the year 2030 constitute the main input data to the EVALUATE model, used for this study.



EVALUATE
tool
screenshot
illustration

→ EVALUATE recent developments since 2015 have been supported by the World Bank

Why EVALUATE?

- **Enable to assess NDCs and adoption of Carbon Pricing instruments in terms of economic efforts**
 - What are the estimated **national cost associated to the NDCs**?
 - What are the estimated **sectoral and national costs of climate change policies**:
 - **ETS, tax, regulation and finance** policy instruments at sectoral resolution
 - **Economy-wide** but also for **13 individual sectors**

→ Most Innovative Feature: **Economic Indicators**

- + **Carbon intensity of GDP** (baseline and with NDC pledge)
- + Corresponding **Marginal Abatement Cost** of pledge (\$/tCO₂e)
(MAC: cost of last tCO₂ abated to achieve target)
- + Estimate of effort: **Total Abatement Cost**
 - in million of USD or Euros
 - in % of GDP
 - in \$/capita

→ Impact of Introducing Carbon Tax and Trading:

→ **National, Regional, Global**

→ But also: **Physical Indicators**

- + **Emissions per capita** (baseline and with pledge) (tCO₂/cap)
- + **Consolidate total global efforts & gaps**

Gap to IPCC scenarios RCP 2.6, 4.5/6.0 and 8.5



EVALUATE Sectoral Coverage

Study cases' objectives

Study Objective

- Analyzing the impacts of NDC pledge achievement for Asian countries under three different policy scenarios:
 - **Regulation** : All the countries are under a regulation policy. All sectors contribute to meet emissions reduction and reduce to the target level regardless of the marginal cost. To meet NDC's target, every sector reduces its emissions proportionally to its weight in 2030 baseline emissions.
 - **Domestic ETS** : All the countries are covered by a national emission trading system (ETS) allowing participating sectors to trade emission allowance permits to achieve the lowest overall abatement cost to meet NDC's mitigation target.
 - **International ETS** : Countries are covered by an international ETS. Sectors of countries belonging to the same market can trade emissions allowance permits to achieve the lowest overall abatement cost to meet NDC's mitigation target.

Scenarios design

Country	Scenario 1: Regulation		Scenario 2: Domestic ETS		Scenario 3: International Cooperation	
	Policy	% of National Emissions covered	Policy	% of National Emissions covered	Policy	% of National Emissions covered
China	Regulation	100%	Domestic ETS	100%	Intl. ETS 1	100%
South Korea	Regulation	100%	Domestic ETS	100%	Intl. ETS 1	100%
Japan	Regulation	100%	Domestic ETS	100%	Intl. ETS 1	100%
Australia	Regulation	100%	Domestic ETS	100%	Intl. ETS 3	100%
New Zealand	Regulation	100%	Domestic ETS	100%	Intl. ETS 3	100%
Indonesia					Intl. ETS 2	100%
Malaysia	Regulation	100%	Domestic ETS	100%	Intl. ETS 2	100%
Thailand	Regulation	100%	Domestic ETS	100%	Intl. ETS 2	100%
Vietnam					Intl. ETS 2	100%
Rest of Asia	Regulation	100%	Domestic ETS	100%	Intl. ETS 2	100%
India	Regulation	100%	Domestic ETS	100%		

- ➡ **Regulation** : NDC mitigation targets for energy-related sectors aim to be achieved with an equal distribution of emission reduction effort by sector
- ➡ **Domestic ETS** : Sectors are allowed to trade national emission allowance permits to achieve the lowest overall abatement cost to meet NDC's mitigation target.
- ➡ **Intl. ETS** : Sectors of countries belonging to the same market can trade emissions allowance permits to achieve the lowest overall abatement cost to meet NDC's mitigation target.

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PART III

Results and key findings

- Scenario 1 : « Regulation »
- Scenario 2 : « Domestic ETS »
- Scenario 3 : « International Cooperation »

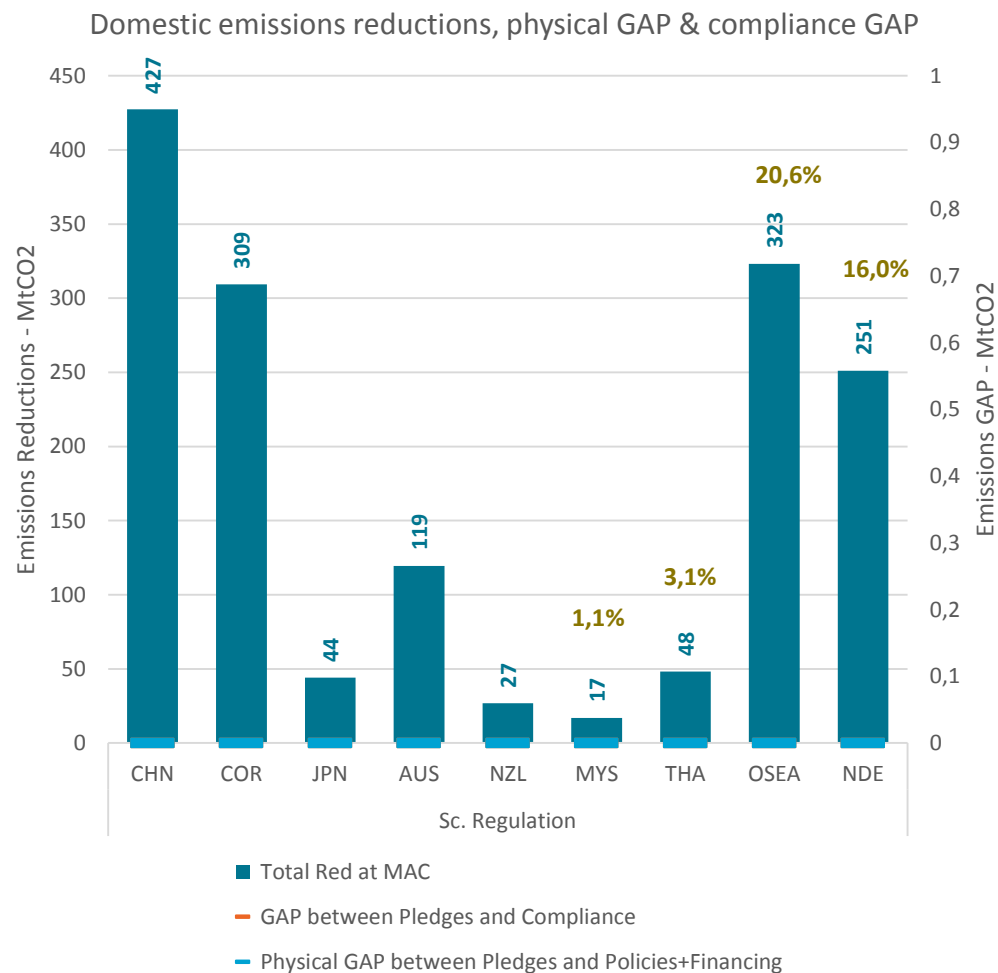
Scenario 1 : « Regulation »

No sectoral & No international cooperation

-

Countries achieve NDCs through an economy-wide regulation policy.

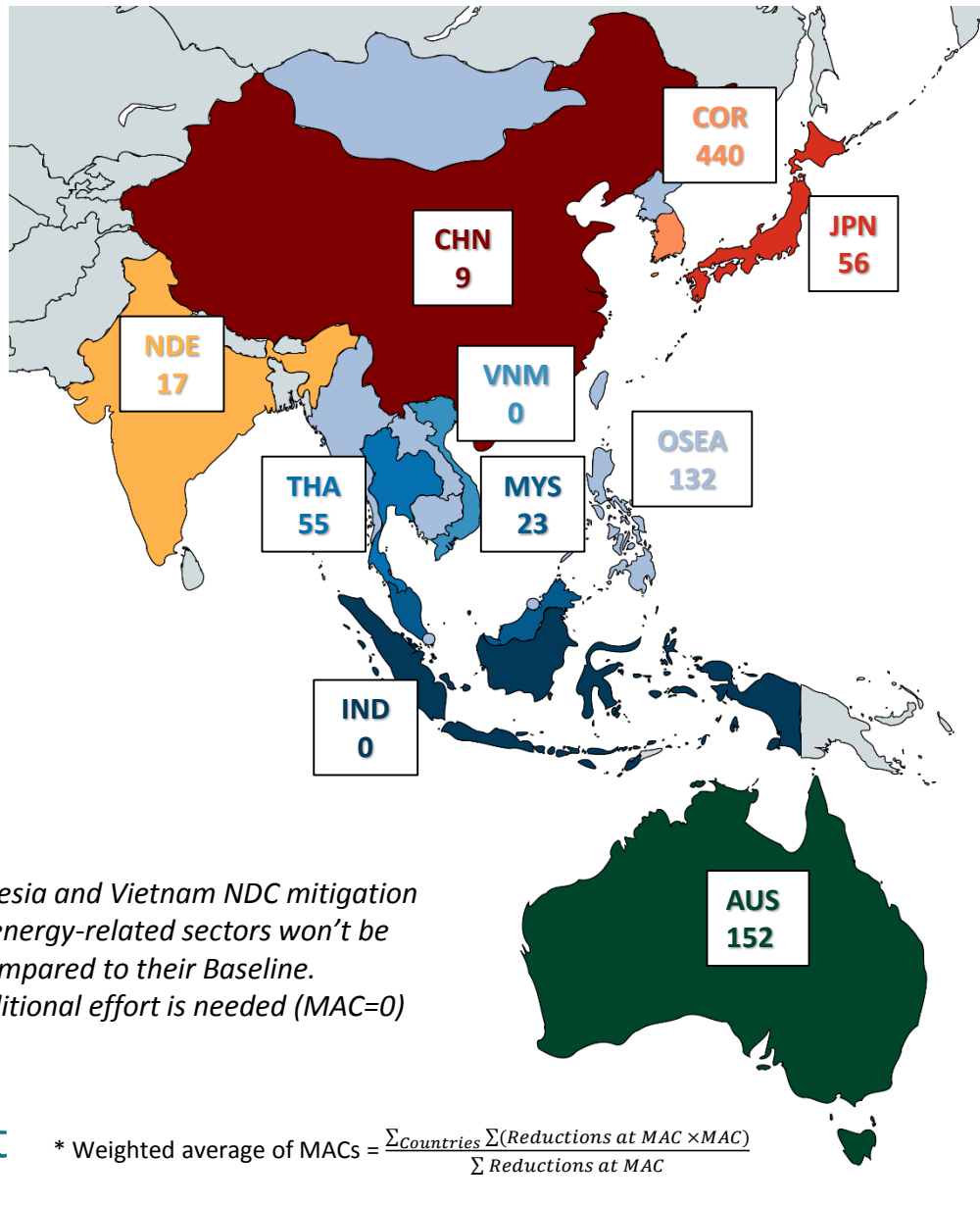
84% of total Asian emissions reduction is done by 4 countries



- All emissions targets achieved through domestic reductions. (Physical GAP = 0)
- 4 countries* represent **84% of total emissions reduced in Asian region**:
 - China,
 - South Korea
 - Rest of Asia
 - India.

* Accounting for 65% of baseline emissions in 2030

New Zealand and South Korea will have the highest average marginal cost in 2030 reaching 693 and 440 \$/tCO₂ respectively



Wide range of average MAC* in 2030 :
From 9 \$/tCO₂ for China to 693 \$/tCO₂ for New Zealand

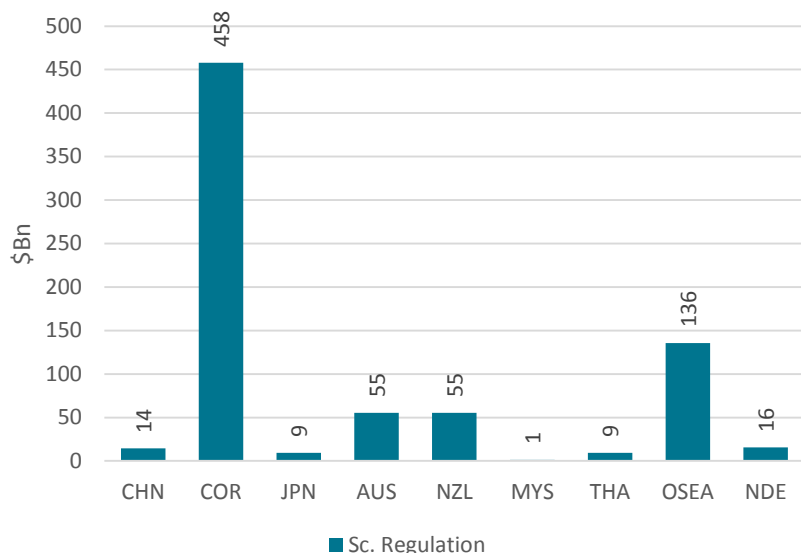
Country code
Average MAC (\$/tCO₂)

Note: Indonesia and Vietnam NDC mitigation targets for energy-related sectors won't be stringent compared to their Baseline. Thus no additional effort is needed (MAC=0)

* Weighted average of MACs = $\frac{\sum_{\text{Countries}} \sum (\text{Reductions at MAC} \times \text{MAC})}{\sum \text{Reductions at MAC}}$

Cumulated total abatement cost by 2030 reaches 1% of the Asian region GDP

Cumulated total abatement cost* at national level by 2030



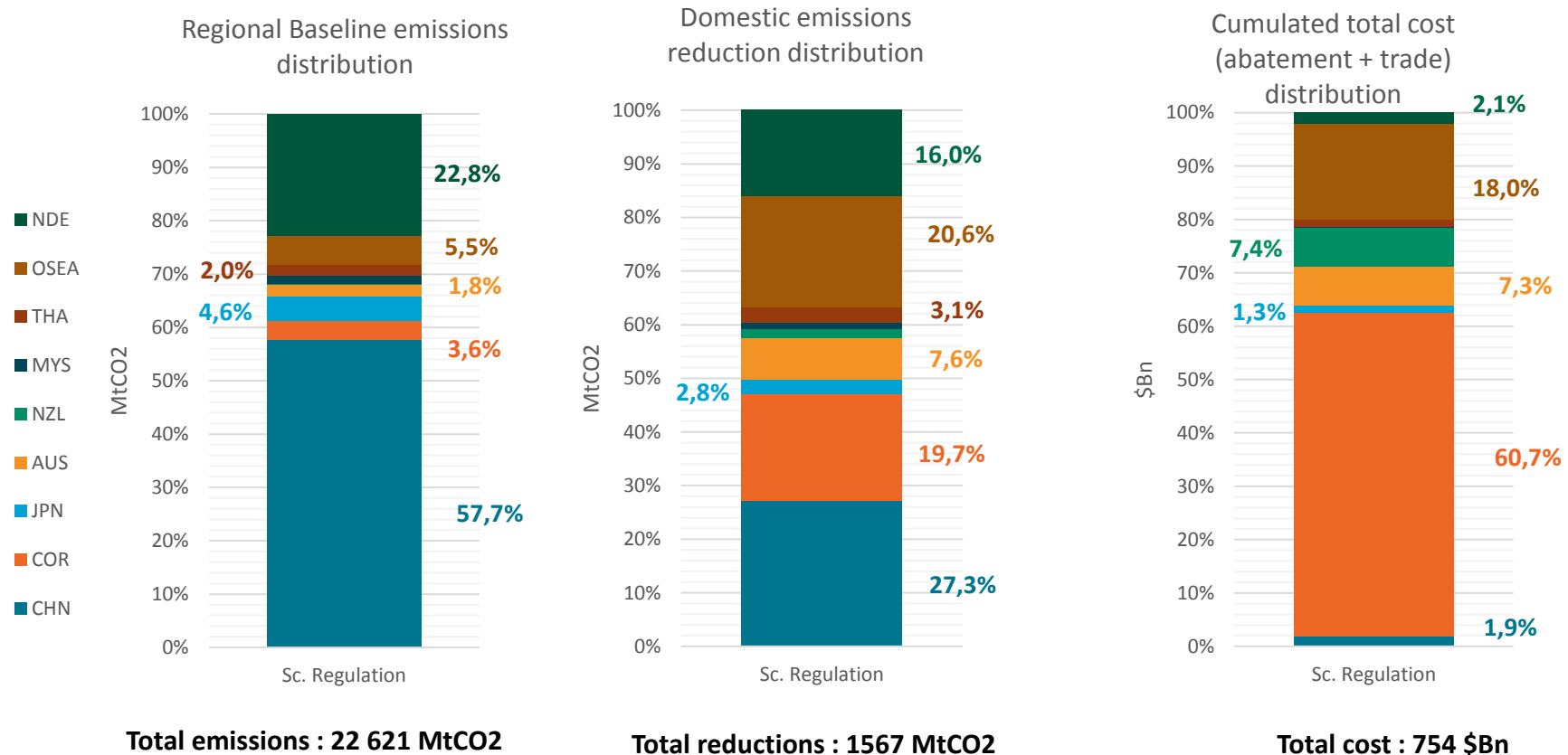
- **Wide range of abatement costs** due to high differences of MACs.

* Cumulated total abatement cost is the cumulated cost for abatement from 2015 to 2030

Country	Annual Total Cost/GDP in 2030 (%)	Annual Total Cost/capita in 2030 (\$/cap)
China	0,005%	1,4
South Korea	2,261%	1154,3
Japan	0,026%	10,5
Australia	0,534%	259,6
New Zealand	4,017%	1440,6
Malaysia	0,015%	5,2
Thailand	0,092%	18,0
Rest of Asia	0,406%	66,6
India	0,012%	1,4

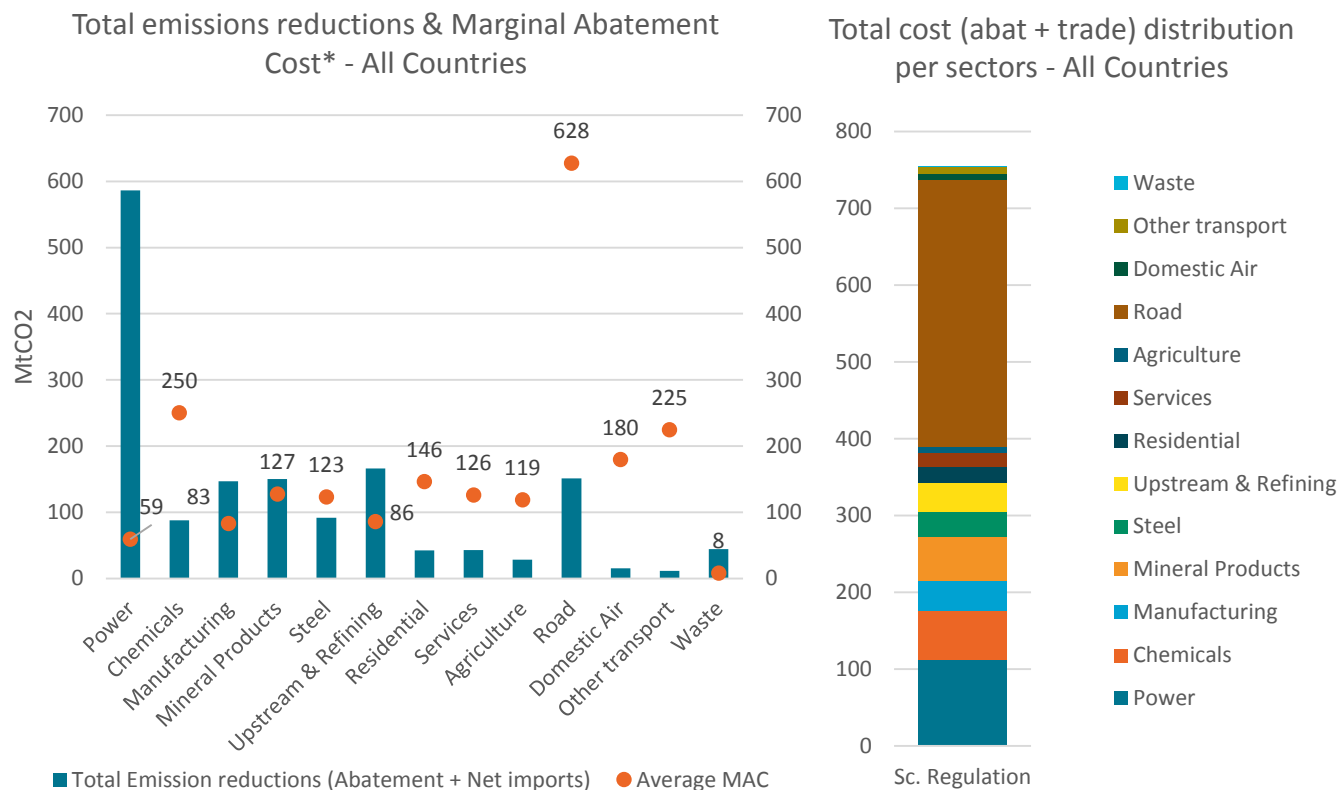
- **South Korea and New Zealand emissions targets are ambitious compared to their baseline.** It is thus very expensive to reach them compared to their GDP and population on the opposite of China, India, and Malaysia.
- India or China cost per capita is 1,000 times lower than for New Zealand and 820 times lower than for South Korea.

Heterogeneous distribution between emissions reduction and total cost distributions



- **Heterogeneous distribution between emissions reduction and total cost distributions.**
- Ex : South Korea accounts for 3,6% of 2030 Baseline emissions but has targeted to reduce about 20% of regional emission reductions, when the cost of these reductions account for 61% of regional total cost.

Road transport emission reductions are the most expensive



Sectors	Share of emission reductions	Share of total cost
Road	9,7%	46%
Steel	5,9%	4,3%
Power	37,4%	14,8%

- **Wide range of average marginal abatement costs over sectors:** from 8 to 628 \$ /tCO2
- Highest MACs : Road, Chemicals, Other transports, Domestic air
- Lowest MACs : Waste, Power, Manufacturing, Upstream & Refining
- **Emission reduction in Road transport are the most expensive in any country**

* Weighted average of MACs =
$$\frac{\sum_{Sectors} \sum (Reductions at MAC \times MAC)}{\sum Reductions at MAC}$$

Scenario 2 : « Domestic ETS »

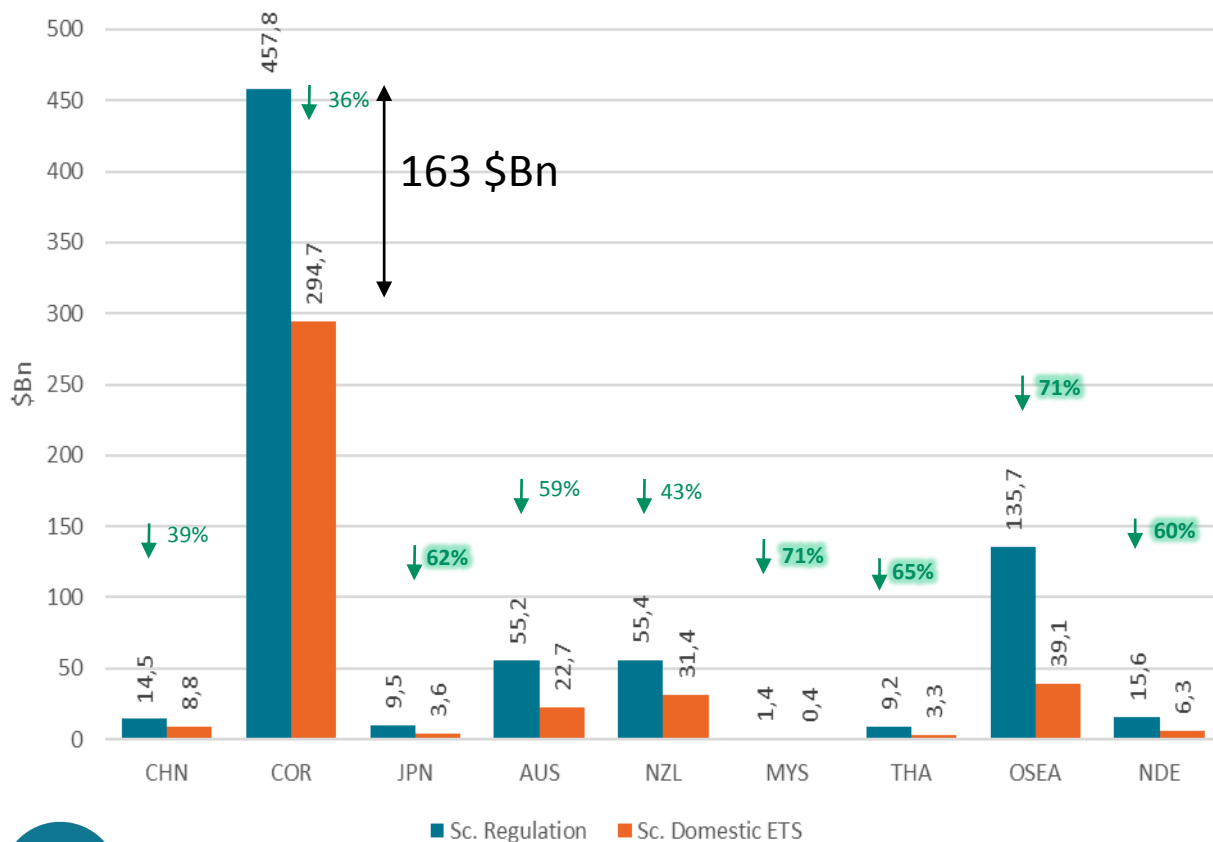
Sectoral flexibility: Achieving NDC domestically at least costs

Focus on : South Korea, China

Domestic ETS would help to reduce total abatement cost by 45% over the Asian region

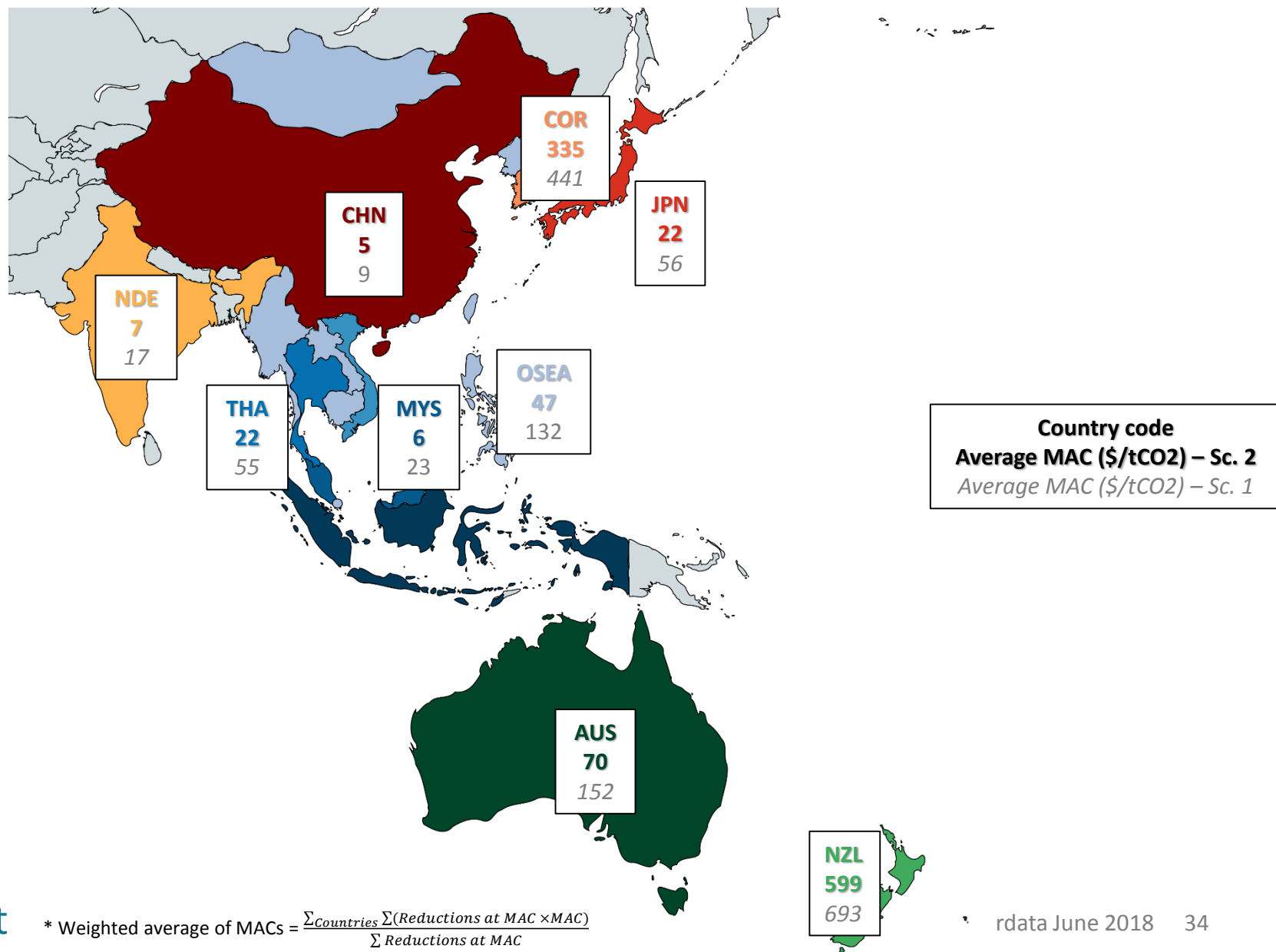
	Scenario 1 : Regulation	Scenario 2 : Domestic ETS
Cumulative total cost by 2030 (\$ Bn)	754	410

Total cost (abatement + trade)



- Total costs of Rest of Asia, Malaysia, India, Thailand, and Japan **decrease by more than 60%.**
- South Korea's total cost decreases proportionally less than other countries (36%). But **absolute cost reduction is huge** : 163\$Bn= **47%** of total cost reductions of all countries of the region.

Scenario 2 optimized country's marginal abatement cost

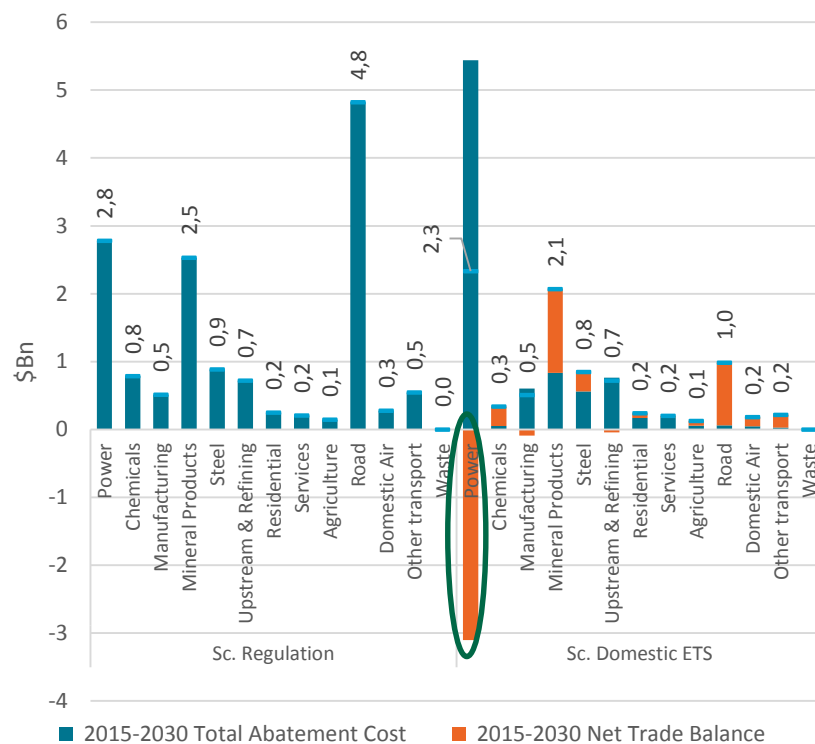


* Weighted average of MACs = $\frac{\sum_{\text{Countries}} \sum (\text{Reductions at MAC} \times \text{MAC})}{\sum \text{Reductions at MAC}}$

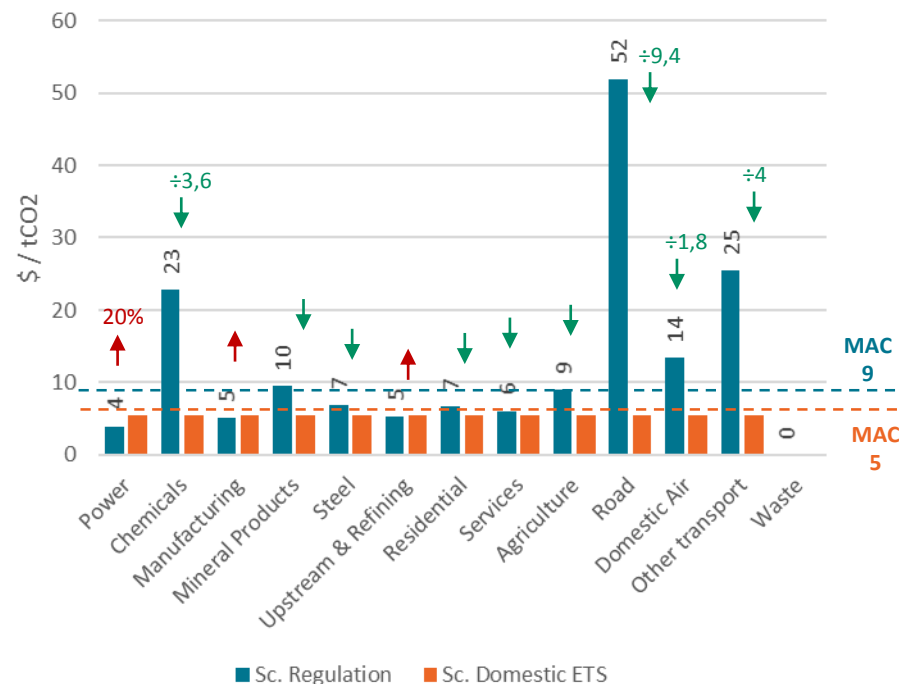
Power sector drives China's emission reductions

Amount of emission reduction : 427 MtCO₂

Abatement & trade costs at sector level - CHN



MAC per sector- CHN

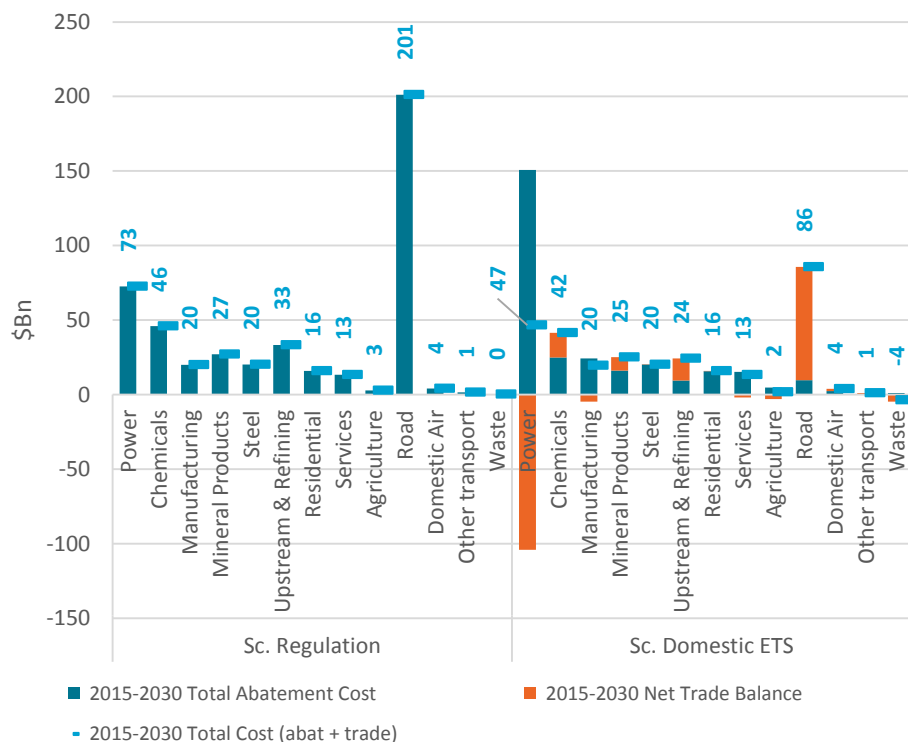


- Total cost (abatement + trade): 14,5 \$Bn
- Total benefit compared to regulation : 5,7\$Bn – **Domestic ETS reduces cost by 39%.**
- Average MAC is almost divided by 2, from 9 to 5 \$/tCO₂.
- Reduction of cost driven **power sector : 96% of traded emissions.**
- Average MAC and costs are very low in China compared to the region:

→ China shows interesting potential for selling to other countries in international markets

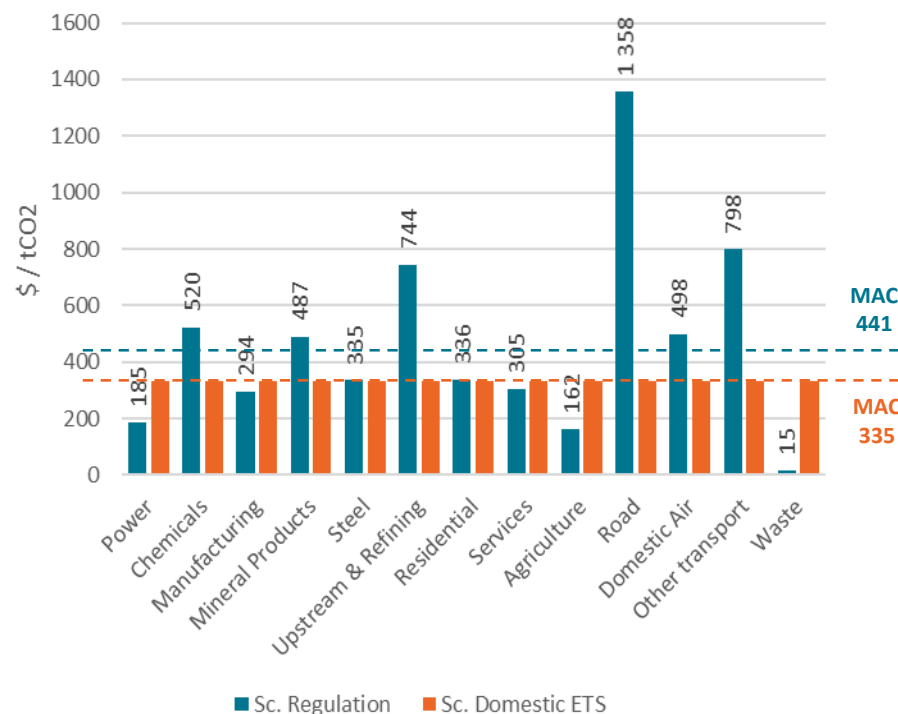
Even with an ETS, South Korea MAC remains very high

Abatement & trade costs at sector level - COR



Emission reduction target : 309 MtCO₂

MAC per sector- COR



- Total cost (abatement + trade): 295 \$Bn (-36% / **Sc. Regulation** = 163\$Bn saved).
- **Cost reduction is mainly done by Power sector** and benefits to Road, Upstream & Refining, and Chemicals
- South Korea benefits from domestic ETS proportionally less than other countries :
 - Sc. Regulation : 61% of regional costs. Sc. Domestic ETS : 72% of regional costs.
 - MAC remain very high, 335\$/tCO₂.

→ South Korea shows interesting potential for linking with other countries to reduce costs

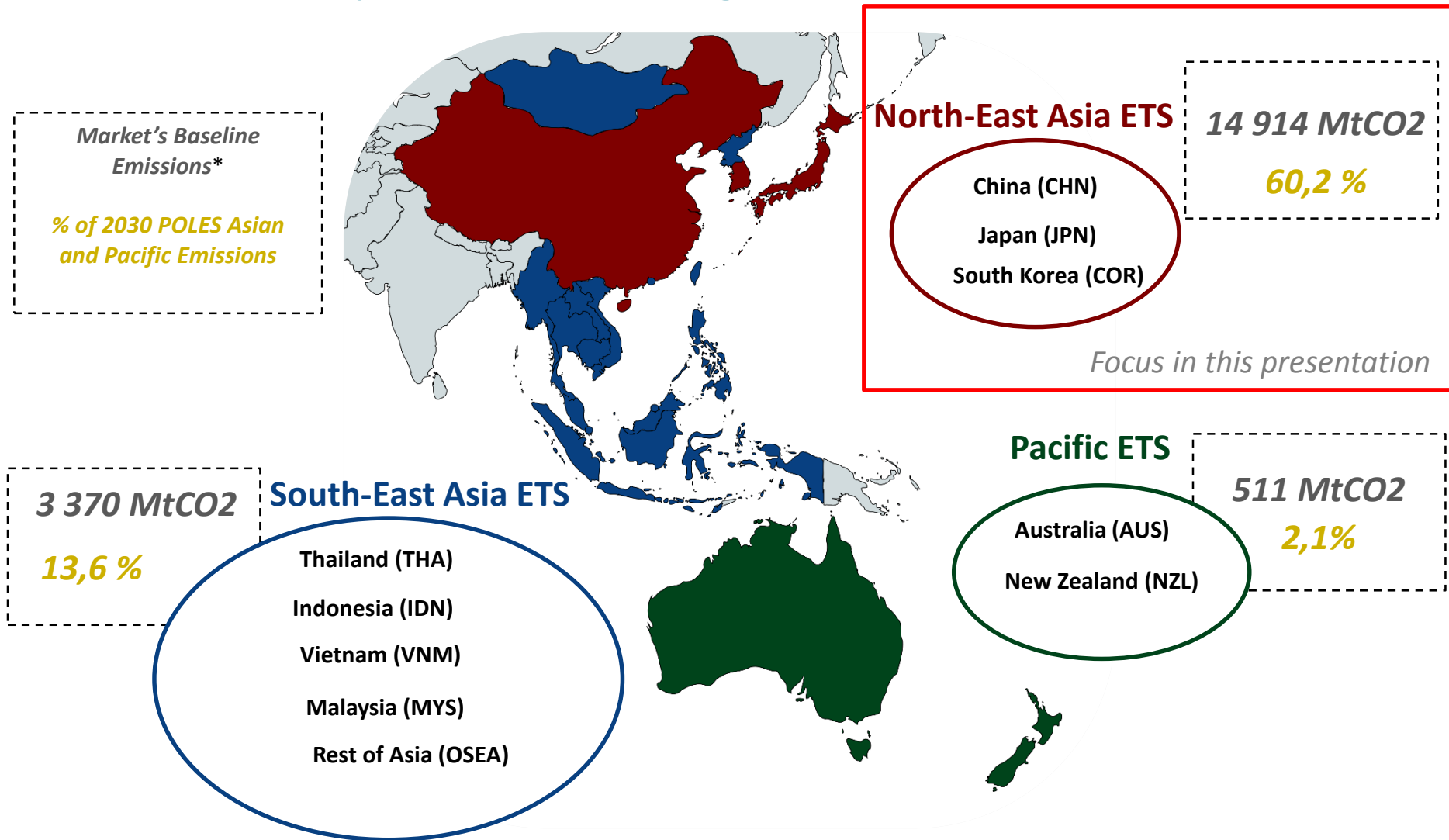
Scenario 3 : « International Cooperation »

Sectoral & international cooperation

Study of three international markets:

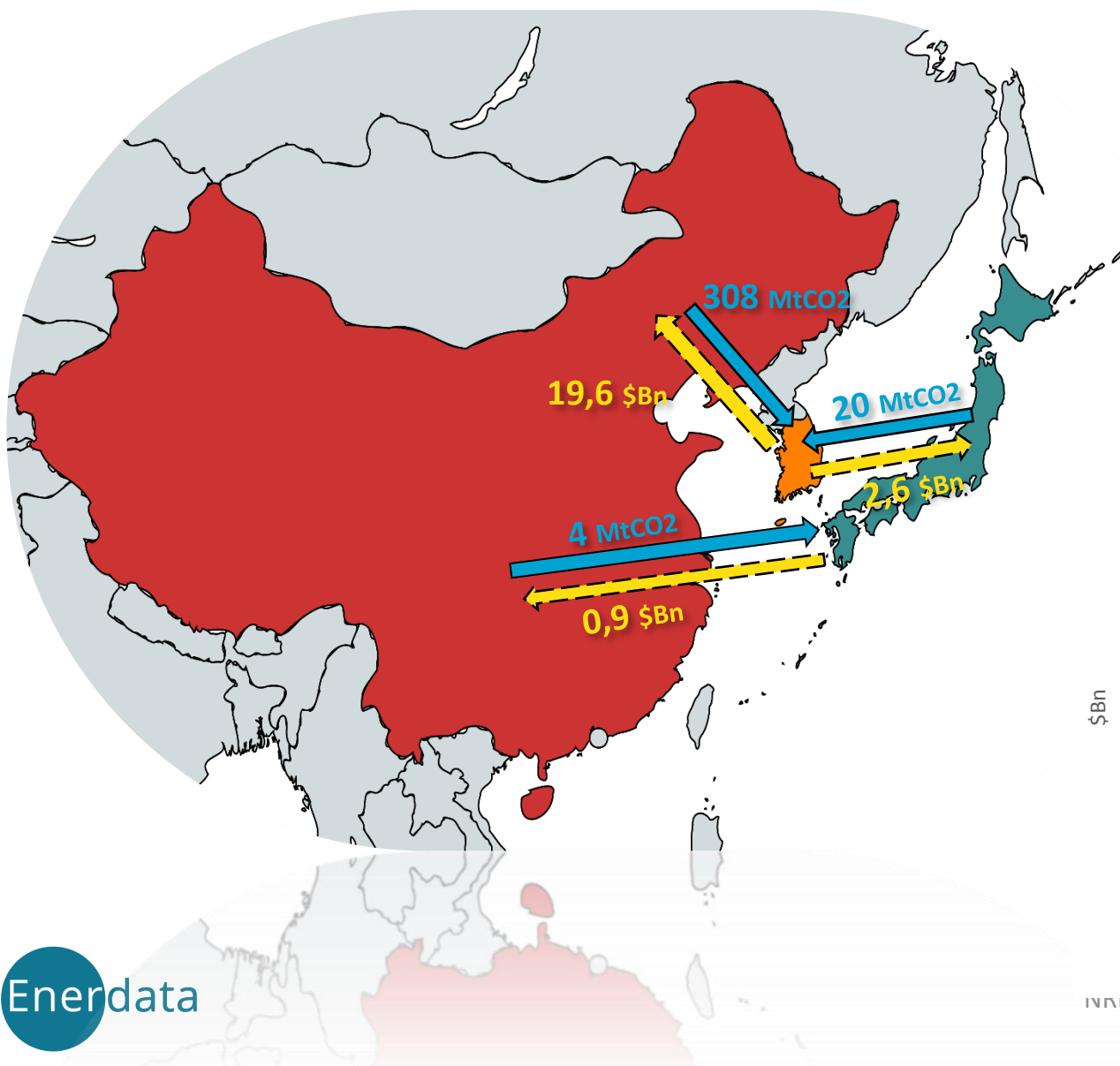
- Market 1: China, South Korea, and Japan
- Market 2: Thailand, Indonesia, Vietnam, Malaysia, and rest of Asia
- Market 3: Australia and New Zealand

Sc.3 : Composition of regional ETS



* Energy-related emissions. international aviation and maritime bunkers are excluded.

Regional cooperation will drastically reduce costs



Baseline emissions :

14 914 MtCO₂

Total emissions reductions:

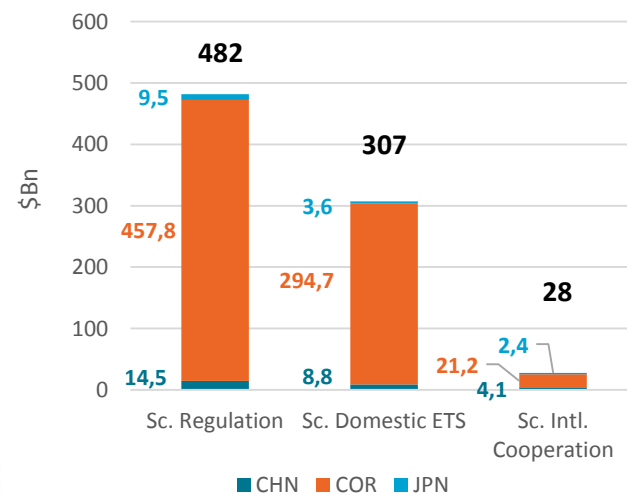
781 MtCO₂

Reduction of total cost :

-94% / Sc.Regulation

-91% / Sc. Domestic

Total emission reduction cost
(abatement + trade) by 2030



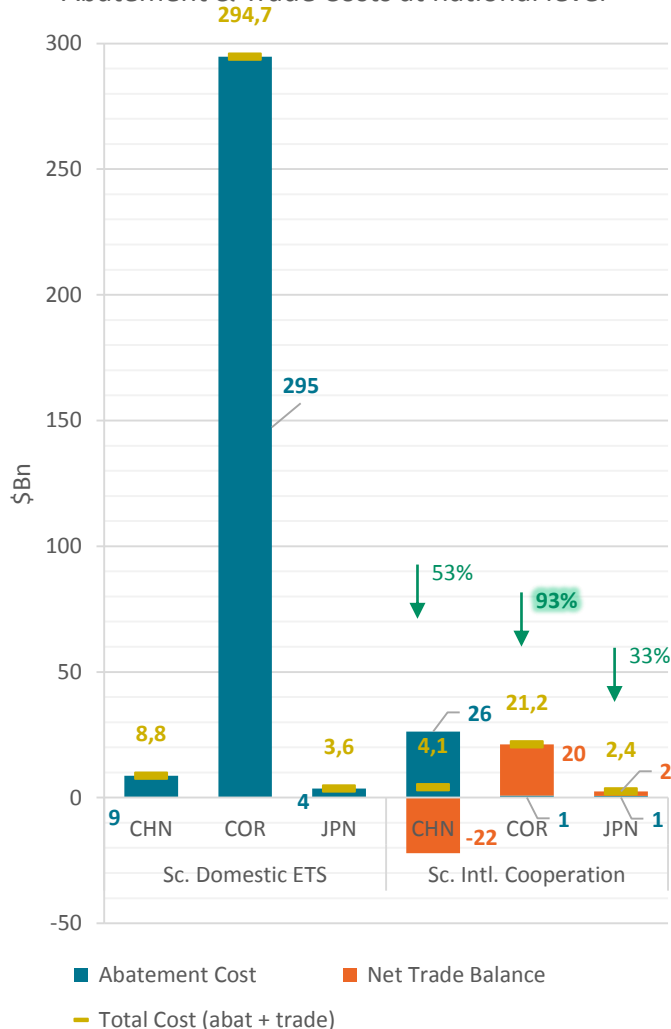
China reduces 95% of the regional emission reduction target in 2030



- Pledges are achieved for all countries
- South Korea is mainly relying on imports to achieve its mitigation target:
 - 287 MtCO2 imported accounting for 93% of its compliance in 2030
 - Only 22 MtCO2 reduced domestically (7% of its compliance)
- Japan would rely about half on imports (24 MtCO2) and domestic emission reductions (19 MtCO2)
- China reduces 312 MtCO2 more than its pledge emissions for international trades (about 73% more than its compliance)
- China reduces domestically 739 MtCO2, i.e. **95% of market's emission reduction.**

Regional cooperation benefits to all by reducing their costs to achieve their NDC

Abatement & Trade Costs at national level



	Annual total cost / GDP (%)		Annual total cost / cap	
	Domestic ETS	Intl. Cooperation	Domestic ETS	Intl. Cooperation
China	0,003%	0,001%	0,82	0,39
South Korea	1,455%	0,105%	743,14	53,37
Japan	0,010%	0,007%	3,96	2,69

National Marginal Abatement Cost			
	Scenario 1 : Regulation	Scenario 2 : Domestic ETS	Scenario 3 : Intl. Cooperation
China	9	5	9
South Korea	441	335	9
Japan	56	22	9

- South Korea total cost is divided by almost 14 compared to Sc. Domestic ETS. **96% of its total cost comes from trade.**
- **China total cost is divided by 2** compared to Domestic ETS .

Study Key Messages

Key learnings: Scenario Regulation

If NDC mitigation targets for energy-related sectors aim to be achieved with an equal distribution of emission reduction effort by sector, it would result in:

- **High emissions reduction costs** – an average 1% of countries GDP.
- Considerable **disparities of cost between countries** due to :
 - Diverse mitigation efforts ambitions
 - Substantial disparities of cost distribution between sectors and countries
- **Big disparities of burden sharing between sectors** due to the fact that under a regulation policy, sectors contribute to reduction in proportion of their emissions and independently of their MACs.
- Sectoral flexibility could reduce total cost and disparities between abatement costs of sectors.

Key learnings: Scenario Domestic ETS

- Compared to Sc. Regulation, **total cost decreased by 45% for the same amount of reduced emissions.**
- With 163 \$Bn saved compared to Sc. 1, South Korea cost reduction account for 47% of Asian region total cost reduction in scenario 2.
- ETS equalizes MAC between sectors and then decrease total cost discrepancies between sectors. **Resulting mitigation efforts by sector are cost-effective.**
- But :
 - MACs of New Zealand (599 \$/tCO₂) and South Korea (335 \$/tCO₂) remain high even with an economic-wide ETS...
 - ... when China, Malaysia, and India have extremely low marginal abatement costs.

→ It would thus encourage countries for ETS linking.

Key Learnings: Scenario International Cooperation

- **Intl. Cooperation allows to reduce total cost** of China, Japan, & South Korea by **91% compared to domestic ETS only**.
 - 2 factors explain this drastic cost reduction:
 - **MACs of China ,and particularly those of its Power, are very low**. 59 % of market's emissions reductions are done by the Chinese Power sector.
 - **Very high MAC of South Korea incents the country to import almost all of its emissions reductions**, and thus to reduce radically its total cost. South Korea accounts for 96% of total cost reduction of the North-East Asia region.
 - Nevertheless, trade leads low domestic emissions reductions for Japan and South Korea. This situation could have negative effects :
 - A dependency toward international carbon prices
 - Both countries can be stuck into a technological lock-in if there are no incentive to reduce emissions domestically
 - Furthermore, letting markets working with no constraints could incent countries to lower their environmental ambitions.
- Solutions to tackle these issues could be through market rules by setting trading cap (offset limits) or discount rates*

Contact:

Global Energy Forecasting

Cyril Cassisa & Alexandre Katsenis

Cyril.cassisa@enerdata.net

About Enerdata:

Enerdata is an energy intelligence and consulting company established in 1991.

Our experts will help you tackle key energy and climate issues and make sound strategic and business decisions. We provide research, solutions, consulting and training to key energy players worldwide.

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