CLEAN ENERGY SOLUTIONS CENTER
ASSISTING COUNTRIES WITH CLEAN ENERGY POLICY

Climate Action in Asian and Pacific Countries: The Implications of NDCs and the Role of Carbon Pricing for the Energy Sector

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Webinar Presenters

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Katie

Hello, everyone. I'm Katie Contos, and welcome to today's webinar, which is hosted by the Clean Energy Solutions Center in partnership with Enerdata. Today's webinar is focused on the climate action in Asian and Pacific countries, the implications of NDCs and the role of carbon pricing for the energy sector. Before we begin, I'll quickly go over some of the webinar features. For audio, you have two options.

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Today's webinar agenda is centered around the presentation from our guest speaker, Cyril Cassisa, who has joined us to discuss climate action in Asian Pacific countries, the implications of NDCs and the roles of carbon pricing for energy sector.

Before we jump into the presentation, I'll provide a quick overview of the Clean Energy Solutions Center, then, following the Cyril's presentation, we'll have a question and answer session where he will address questions submitted by the audience. At the end of the webinar, you will be automatically prompted to fill out a brief survey as well, so thank you in advance for taking a moment to respond. The Solutions Center was launched in 2011 under the Clean Energy Ministerial. The Clean Energy Ministerial is a high level global forum to promote policies and programs that advance clean energy technologies, to share lessons learned and best practices, and to encourage the transition to a global clean energy economy. 24 countries in the European Commission are members, covering 90 per cent of clean energy investment and 75 per cent of global greenhouse gas emissions.

This webinar is provided by the Clean Energy Solutions Center, which focuses on helping government policy makers design and adopt policies and programs that support the deployment of clean energy technologies. This is accomplished through support in crafting and implementing policies relating to clean energy access, no-cost expert policy assistance, and peer to peer learning and training tools, such as this webinar. The Clean Energy Solutions Center is co-sponsored by the governments of Australia, Sweden, and the United States, with in-kind support from the governments of Chile. The Solutions Center provides several clean energy policy programs and services, including a team of over 60 global experts that provide remote and in-person technical assistance to governments and government supported institutions; no-cost virtual webinar trainings on a variety of clean energy policy topics; partnership building with development agencies, and regional and global organizations to deliver support; and an online library containing over 5500 clean energy policy related publications, tools, videos, and other resources. Our primary audience is made up of energy policy makers, and analysts from governments and technical organizations in all countries, but we also strive to engage with the private sectors, NGOs, and civil society.

The Solutions Center is an international initiative that works with more than 35 international partners across its suite of different programs. Several of the partners are listed above, and include organizations like IRENA and IEA, and programs like SEforALL, and regional focused entities such as ECOWAS Center for Renewable Energy and Energy Efficiency. A marquee feature of the Solutions Center provides is the no-cost expert policy assistance known as Ask an Expert. The Ask an Expert service matches policy makers with more than 60 global experts selected as authoritative leaders on specific clean energy finance and policy topics. For example, in the area of renewable energy, we are very pleased to have our guest speaker, Cyril Cassisa, serving as one of our experts.

If you have a need for policy assistance and renewable energy or any other clean energy sector, we do encourage you to use this valuable service. Again, this assistance is provided to you free of charge. If you have a question for our experts, please submit it through our simple online simple form at cleanenergysolutions.org/expert. We also invite you to spread the word about this service to those in your networks and organizations. Now, I'd like to provide a brief introduction for today's speaker.

Our expert today is Doctor Cyril Cassisa, who is a senior expert on energy and climate policy analysis. He works as a project manager in global energy forecasting team using the POLES model and future in-house models for scenario building and analysis. And with that brief introduction, I'm very pleased to welcome our expert today, doctor Cyril to the webinar. Cyril?

Cyril

Good morning, good afternoon, and good evening, everyone. Thanks, NREL, for the invitation to present you today our recent results on the implication of Nationally Determined Contributions—that after, I will call NDCs—and the role of carbon pricing for the energy sectors in Asia and Pacific countries. Today's presentation is organized in three parts. First, I will introduce technical background and key figures explaining why we chose to focus _____ on the Asian countries.

Second, I will describe this particular study framework. Then, in the last part, I will present to you to the results for the different study cases. The technical background on with us today has been realized—realized on the use of energy scenario projections. The country _____ predictions have been produced with the prospective outlook of long-term energy system models called POLES. It is peer-reviewed global energy models that calculate food energy balances year by year for the energy supply and demand.

It covers 66 countries and regions around the world with detailed sectoral and technological descriptions. Some model inputs are shown by zero end boxes on the left, and the model description is in the blue box. The model outputs are the international energy prices, energy consumptions predictions, as well as greenhouse gas emissions that is shown in the gray box on the right. To build scenario with POLES, we make alternative assumptions for key drivers—like, the resources, climate and energy policies, or available technological options. We also make micro-economic assumptions on population and GDP growth.

The scenario simulation allows us to explore different pathways for the energy markets. We usually ran POLES to 2030 or 2040 or even 2050. As said in the previous slide, for each year, the model return us detailed information on the energy supply and demand by country, sector, and fuels, as well as greenhouse gas emissions. From our annual scenarios exercise—called EnerFuture scenarios—we _____ scenarios representing different potential future energy developments. EnerBrown scenario—has no climate constraints. EnerBlue scenarios is a scenario where countries NDCs are cheap, and EnerGreen scenario is a two-degree compatible scenario satisfying the IPCC recommendations where the NDC are paralytically reviewed and the ambitions are increased.

These three figures shows the population and GDP growth for the Asian countries, and on the right, the resulting energy demand for the region. Color _____ correspond to the EnerBlue scenarios, which is the NDC scenario. Strong economic growth leads to a doubling of the energy consumptions which drive the global energy demand. Asian countries which drive the global energy demand in the following decades. About 74 per cent of the domain growth between 2015 and 2040 will come from Asia.

However, the Asian primary energy mix will still be dominated by fossil fuels, and especially coal. In the power sector, the share of fossil fuel inputs show a decrease from 84 per cent to 66 per cent between 2015 to 2040. Considering these key figures, NDCs ambition of Asian countries would be essential to achieve Paris Agreement Education goal. For this study, we look at the Asian countries in the days considering POLES geographical coverage. We gather these countries into four regions—China, Japan, South Korea representing the Northeast Asia; Thailand, Indonesia, Vietnam, Malaysia and the rest of Asia representing the Southeast Asia; Australia and New Zealand for the Pacific; India for the South Asia.

We did not consider entering the study to the rest of South Asia region. For all Asian countries, greenhouse gas emission are expected to increase in the baseline scenario by 2030 compared to 2010 levels, except for Japan. Asian countries emission are planned to increase twice faster in Asia than global emissions, with about 60 per cent increase in 2030 compared to 2010 levels. Emissions of the region will reach about 24 gigaton of CO2 equivalent for the energy related sectors and will account for half of the world energy related emissions, gaining 10 per cent point compared to 2010 global share. We thus first realized quantitative and qualitative analysis of the study country and regions NDCs.

As NDCs are very heterogeneous, we had to uniform the information collected from the different official documents like NDCs, UNFCCC documents, or national plans. The table shows different NDCs' categories. China, Malaysia, and India having a GDP intensity-based target; South Korea, Indonesia, Thailand, and Vietnam have a target compared to a business as usual scenario. As most of the NDC target are economic wide, we have to extract from official sources, or to estimate the contribution of the energy related sectors into the national NDC mitigation target. The mitigation efforts of energy sectors varied significantly between countries, however, it is difficult at this stage to evaluate the NDC level of ambitions since we need to understand what this mitigation target mean considering the energy system development on one side and taking into account their national circumstances.

Reaching countries' ambition mitigation target for energy related sectors by 2030 will represent for the Asian aggregate region—a reduction of 1 and 5 gigaton of CO2 equivalent compared to the baseline projection, which is equivalent to 6.5 per cent of the baseline emissions by 2030 or 10 per cent of 2000 emissions for region. This graph shows the greenhouse gas energy related emission for different countries. 2010 have been represented by the light blue line, and 2030 levels are shown with bars in blue for the baseline in 2030 and in orange for the NDC mitigation target in 2030. For some NDCs defined compared to business as usual scenarios, the assumption we made in a post-model scenario result in an important gap between the national business as usual and POLES baseline emissions for only two countries, which are Indonesia and Vietnam. For these countries, the NDC mitigation target on the energy related sectors must _____ be constraining.

From the top graph—this graph—the difference between the light blue line and the blue bar allow us to observe the emission intensity, evolution per GDP on the left and per capita on the right between 2010 and 2030. We see that most of the country reduce the emission intensity for GDP compared to 2010 levels, except for Vietnam and for India. Between 2010 and 2030, emissions of China, Indonesia, Malaysia, Thailand, Vietnam, and India have grown faster than the population. The difference between the blue and the red bars provides an information about the NDC mitigation effort. New Zealand, South Korea, and Australia have the most ambitious emission intensity reduction per GDP and per capita in _____ by 2030 compared to the baseline.

This first analysis of Asian countries and this mitigation target for the energy related sector provides already interesting information. However, we only look at the difference between the baseline and the NDC target in 2030. The policy framework that the country will implement to achieve the target will have considerable impact on the sectorial contribution in the national mitigation effort and, of course, on the resulting cost at sectorial and national levels. This is what we intended to do with these case studies using our Evaluate tool. In these few slides, I will briefly describe the methodology used for this case study.

To quantify the marginal cost and the total abatement cost of emission reductions, we used marginal abatement cost curves produced by the POLES models as a result of a sensitivity analysis on carbon value. The carbon value—what we call "carbon value" in our model, is _____ than a _____ of carbon price applied to countries and sectors. POLES produces marginal abatement cost curves for any target year—so for projected year—covering safe greenhouse gas emissions, 20 emitting sectors, and 66 countries and regions. The illustration on the right represents marginal abatement cost curve with the emission reduction on the horizontal axis and the carbon value on the vertical one. When the carbon value is increasing, the emission reduction increase.

A defined reduction target is achieved at a certain marginal abatement cost and the total abatement cost is calculated from the area under the curve. To extract information and analysis from the last set of marginal abatement cost curve generated by POLES, we have developed a tool called Evaluate. Since 2015, the World Bank has also been commercially supported the recent development of the tool and they used it for international internal project. The tool contains marginal abatement cost curves for all sectors and countries covering all energy related greenhouse gas emissions, and for this study, the marginal abatement cost curve target here has been defined to be 2030, in line with the countries' NDC target year. The figures in the middle give you some screen shot illustration of the Evaluate tool.

Evaluate enable to assess mitigation efforts like the NDC in this case study, and also, the impact of carbon pricing instruments in term of economic efforts. We can now raise the question of what are the estimated national costs associated to the NDC and what are the sectorial or national costs of climate change policies? We can simulate emission through these themes—carbon taxes, regulations, and finance policies' instrument at a national level, which is at national aggregated level, and also, for each 13 individual sectors that are represented in Evaluate. You have the list of the sectors on the table on the right of this slide. Evaluate tool puts economic indicators like carbon intensity of GDP, marginal and total abatement cost, impact of introducing carbon tax, and trading at national, regional, and global levels, and also, physical indicators like emissions or emission per capita or consolidate total global effort and gaps analysis.

So, for this case on Asian countries, we explored three different policy scenarios for countries to achieve their NDCs. So, first scenario—called "Regulation"—considers that each country will achieve the NDCs mitigation target alone. There is no international cooperation; moreover, country plan to use only sectoral regulation policies like standouts, and we make the exception that every sectors reduce its emissions proportionally to its weight in the 2030 baseline emission regardless of the marginal cost curve. So, let's say if the target at the national rate 20 per cent reduction, then each sector aim to reduce 20 per cent of their emission. The second scenario is called "Domestic ETS.

Still considers that there will be no internal cooperation, however, a country will use sectorial flexibilities to achieve the national target at least cost. This is represented in all scenarios by introducing an emission trading scheme at domestic level, covering all energy related sectors, to trade national emission permit together. And the third scenario—called "International ETS"—is going further by opening the countries' climate actions to international cooperation, linking domestic ETS schemes over predefined regions. Sectors and those original ETS would then be able to trade emission permit. This table _____ three scenario's definitions for the different Asian countries.

Scenario one—where each country will achieve their NDC mitigation target along with sectorial regulations; Scenario two—where sectors allow to trade national emission allowance permits to achieve the lowest overall abatement cost to meet the NDC mitigation target; and Scenario three—exploring impact of international ETS. We chose to limit the international cooperation here into three regional ETS market—China, South Korea, Japan—in the Northeast Asia ETS; Australia and New Zealand in Pacific ETS; and Indonesia, Malaysia, Thailand, Vietnam, and rest of Asia in Southeast Asia ETS. For today's presentation, due to time constraints, I will only present you the result for the Northeast Asia ETS in the scenario three, highlighted in the blue in the table. So, in this results' section, I will present to you key results and findings, scenario by scenario, before concluding the presentation. In the Regulation scenario, each country achieves domestically its NDC mitigation target by 2030.

There is no gap between the countries' _____ and the achievement of its national policy framework. Compared to their respective baseline by 2030, China emissions would reduce by about 400 million tons of CO2 equivalent; South Korea and the rest of Asia—about 300 million ton of CO2 equivalent: India—by 250 million ton of CO2 equivalent. These four countries, which accounts for 65 per cent of the baseline emission in 2030, represent about 84 per cent of total emission reduction in the NDC for the Asian region. In this scenario, country sectors reduce its emission proportionally to its weight in the 2030 baseline emission, regardless to it marginal cost curves. The _____ of countries' mitigation efforts compared to their baseline emissions, as well as of cost of mitigation options between energy sectors, result in a wide range of average marginal abatement cost in 2030 between countries.

New Zealand average marginal abatement cost will be the highest of the region, reaching about $690.00 ton of CO2. South Korea will have the second average marginal abatement cost at $440.00 ton of CO2 in 2030. On the upper side, average marginal abatement cost will remain low for other Asian countries like China and India, with a cost of $9.00 a ton of CO2 and $17.00 a ton of CO2 respectively. This is due to the large country emission scale and an import on cheap mitigation options in these country sectors. In this map, we show Vietnam and Indonesia, just to recall that in the scarcity of baseline assumption result in non-constraining NDCs mitigation target for these two countries for their energy related sectors, which has been why the average marginal abatement cost is new for these two countries.

The cumulative total abatement cost by 2030—which is accumulated cost of abatement from today—2015; it was 2015 in our scenario—to 2030—would reach about 1 per cent of the Asian region GDP over the period. South Korea will have the highest cumulated total abatement cost so far, with about $450 billion of US dollar, followed by the rest of Asia, Australia, and New Zealand, due to the high differences of marginal abatement cost over the countries. If we look closer at the annual relative total cost in 2030—at the year 2030—per GDP or per capita, this is what it shown in the table—we find that in scenario one, New Zealand and South Korea NDC mitigation target will be very costly. The annual total cost in 2030 could reach four and two per cent of their GDP respectively. And if we look at per capita for the population to handle the cost of a climate action to achieve the NDC, it could be higher than $1,000.00 per capita.

These results mean that New Zealand and South Korea NDC mitigation target by 2030 is very ambitious. Moreover, it will be achievable at a very high cost if this country aim to achieve the target only domestically, without international cooperation, asking sectors to reduce their emission respectively to the weighted contribution in country's emission. On the upper side, cumulative total abatement cost by 2030 stay low for Malaysia, Japan, Thailand, China, and India. In 2030, annual total cost per GDP would even remain under or around 0.01 per cent of the GDP for China, Malaysia, and India, with a cost per capita of $1.00 for China and India and $5.00 for Malaysia. Whenever taking into consideration the challenge of scale, the energy security or stability of the economic growth, scenario one show that

NDC mitigation target for this energy sectors would be far less costly for this country than for South Korea and New Zealand.

This slide allow to quickly compare the distributions of the different indicators between the Asian countries. For example, China and India represent the major part of Asian emission by 2030 in the baseline—57 per cent and 22 per cent respectively. The NDC mitigation contribution in the Asian emission reduction by 2030 are also significant, but lose dominance compared to the other Asian countries. However, in the regulation scenario, the cumulative total abatement cost to achieve the NDC would be one of the lowest compared to the other Asian country, with only 1.9 per cent and 2.1 per cent of the cumulative total abatement cost for the entire region. On the upper side—South Korea accounts for 3.6 per cent of the 2030 baseline emissions but has target to reach just about 20 per cent of the regional emission reduction target.

But the cost of this reduction for South Korea accounts for 61 per cent of the regional total cost. In addition to the ambition of countries in this mitigation efforts compared to their baseline emission, the policy framework by regulation, asking each sectors to reduce their emission proportionately to their weighted contribution in national emissions—we penalize some sectors due to their high cost for reducing emissions. This slide shows the sectoral emission reduction for the Asian region—blue bar on the left graph. The respective sectorial average marginal abatement cost in the orange dot on the same graph. And on the _____, the graph is showing the cumulative total sectorial abatement cost by share—not by share, but by billions of US dollars, which is the total cost cumulative from 2015 to 2030. The table on the right highlight the shares of emission reduction of total cost, and for the road transport, steel, and power sectors.

In this scenario, we see that despite the fact that the power sectors would reduce the biggest amount of emission with 37 per cent of total emission reductions, it would only support 15 per cent of the cumulative total development cost. However, for transport sectors—the transport sectors would represent 9.7 per cent of emission reductions, but it will handle the highest cost, reaching almost half of the regional community development cost. This result show that countries who care for a distribute, it's a national mitigation effort to its sectors. It could be done by a sectorial policies or to find what could be the contribution of each sectors at the least cost. We could simulate the impact of a national ETS covering all energy related sectors.

It's what we have decided to do in _____ scenario to implement an ETS for the oil sector that will simulate and reach the equilibrium of the least cost for the country to reach the NDC. This scenario two result in the lease cost distribution for country's sectoral contribution to achieve the national NDC mitigation target for those energy sectors. Each country reach the NDC target by 2030, with other years of international cooperation. This result in the same emission reduction achieved as in the regulation scenarios for each country. Implementing domestic ETS in each country would help to reduce cumulative total abatement cost for the whole region by 45 per cent from $750 billion US in scenario 1 to $420 billion US in scenario 2 accumulated over the period 2015 to 2030.

Accumulated total cost for the rest of Asia, Malaysia, India, Thailand, and Japan decrease by more than 60 per cent. South Korea total cost decreases proportionately less than the other countries, but the absolute cost reduction between scenario 1 and 2 is huge, saving about $163 billion US, which represent almost half of the region total cost reduction. Domestic ETS will minimize countries total abatement cost to reach the anticipated mitigation target. This result in a unique national marginal abatement cost that is lower than the average marginal abatement cost obtained in scenario one. Reductions are different between countries depending to the absolute amount of emission to reduce and also, mitigation production of the energy sectors.

New Zealand and South Korea have a marginal abatement cost reducing by about $100.00 ton CO2, but still remain high. China, Malaysia, and India still enjoy the lowest marginal abatement cost, reaching even a cost less than $10.00 a ton of CO2 in 2030. To better understand what is happening at the national level, we propose here to have a focus on China and South Korea in the next two slides. Similarly, same analysis have been done for the other countries of the study, but you can probably extend on that later in other presentations. China reduction target brings its emission to about 12,600 million ton of CO2 by 2030, representing a reduction of 3 per cent compared to the baseline, but representing an increase of 50 per cent compared to 2010 levels.

Total amount of reduction to achieve the NDC is about $427 million dollars CO2. The left side graph shows abatement cost in blue bar and trade cost in orange bar by sector for the regulation scenario on the left of the graph, and for the domestic ETS scenario on the right. Domestic ETS in China reduced its total cost by 39 per cent compared to the regulation scenario. And due to cheap with large potential of emission reduction in the power sector, almost all of the other sectors in China would be met by off-emission permits, many issued by the power sector. We clearly see the total abatement cost in blue bar of transport, chemical, and mineral product sectors strongly reducing.

Net import of permit in arranged bar are significant in these sectors, but due to a lower material development cost reduction on this national market, the net cost for the _____ strongly reduced compared to scenario one. Even for the power sector, which sees its abatement cost increasing due to the increasing of emission reduction in these sectors to sell on the national market, and the prize going to $5.00 a ton of CO2, the power sector see its total abatement cost decreasing. The right graph show how evolved the marginal abatement cost by sectors between scenario one and scenario two. So, in scenario one, we have a regulation—sectoral regulation—to achieve the NDC, so different marginal abatement cost by sectors. We see here, the transport sectors, the chemical sectors, ending with a high marginal abatement cost due to fast increasing marginal abatement cost periods, making each additional emission reduction more expensive than other sectors.

And with the national ETS market, they all _____ to the optimal marginal abatement cost, which is here to $5.00 ton of CO_2. A domestic ETS in China will thus be beneficial for all sectors in term of total abatement cost. The power sectors will account for 96 per cent of traded emissions with a very low marginal abatement cost compared to the region, China, showing interesting potential for linking with other countries, and to be a net seller of emission permits at low prices. For South Korea, reduction target—this South Korea emissions will, by 2030, about 512 million ton of CO_2, which represent a reduction of 37 per cent compared to the country's baseline, and a reduction of 26 per cent compared to 2010 levels. Total amount of emission reduction to reduce in its NDC compared to its baseline is about 309 million ton of CO_2.

Domestic ETS in South Korea reduces the total cost by 36 per cent compared to the scenario 1. As for China, due to cheap and larger potential of emission reduction in the power sector, most also cause gains and emission reduction will be done by this sector. Similarly, we clearly see that total abatement cost—the blue bar for road transport—strongly reduce net import of permit, and orange bar becomes a major cost for the transport techs. This means that with a domestic ETS, the transport tech—they will have an economic incentive to purchase permits on the market instead of to invest for low carbon technology. Even with the domestic ETS, the marginal abatement cost in South Korea will remain very high compared to the other Asian countries.

South Korea show then, an interesting potential for linking with other countries to reduce its cost for chains' NDCs. For this last scenario, we explore the impact of international cooperation for achieving globally all countries NDC mitigation target. The scenario three is simulating three potential future regional ETS in Asia. So, it's potential because it's not certain at this point. The Northeast Asia ETS covers about 15 gigaton of CO_2 by 2030 and representing 60 per cent of Asian emissions.

The Southeast Asia ETS cover 3.3 gigaton of CO_2, and the Pacific ETS covers just 2 per cent of Asia rate emissions. We only present, in the following slide, the result for Northeast Asia ETS. But _____ analysis have been done for those original ETS. We represent, on this map, the annual traded emission permit in 2030 between the 3 countries. Blue arrow is showing the duration of the trade.

The yellow arrow show, in return, the annual financial flows between countries to purchase these permits. To achieve countries' NDC mitigation target, the Northeast Asia region showed reduce about 580 million ton of CO_2 globally, about 330 million ton of CO_2 has been traded, which represent 40 per cent of the emission reduction objective. This international flexibility allows us to drastically reduce accumulated total abatement cost by more than 90 per cent compared to scenario 1 and scenario 2. This is what is shown in the bottom right figures—comparing those three scenarios with accumulated total cost—which is abatement plus trade—from 2015 to 2030. And we see that the one who gains the most—South Korea.

The figure shows the domestic emission reduction and the net import by countries for domestic ETS scenario on the left, and for the international cooperation scenario on the right. In both scenario and this mitigation target are achieved for all countries. The countries' NDC's compliance is shown on the video by the light blue line. We see that both scenario is the same at the end. So, each country are compliant with their NDC's target in scenario two, and this is achieved only with domestic action.

But, in scenario three, countries are relying on international set of emission permits for their NDC compliance. Country sectors with high marginal abatement cost curves will have incentives to purchase emission permits from country sectors with lower marginal abatement cost curves. This process will result in an optimal marginal prize, minimizing the total abatement cost for the region ETS. At this optimal marginal abatement cost, South Korea will mainly rely on imports to achieve its NDC. 287 million ton of CO2 is imported in 230, which accounts about 93 per cent of its compliance in this year.

Only 22 million ton of CO2 reduce domestically in 2030. Japan would rely about half on its import and half on domestic emission reduction. China reduces 312 million ton of CO2 more than its NDC mitigation target for the international trade. The country domestic emission reduction reach a total of 739 million ton of CO2 in 2030, representing 95 per cent of the original ambition reduction target. We've shown that the regional ETS are also drastically reduced—cumulative total cost—by 2030 over the region.

The figure here shows a cumulative abatement cost and the cumulative total trade cost by countries comparing scenarios two with scenario three. South Korea has the biggest cost reduction with 93 per cent. China and Japan will also gain from the regional cooperation market, reducing their respective total cost by 53 per cent and 33 per cent. Scenario three will bring the annual total cost per unit of GDP for South Korea within the reasonable range. This was shown in the table—so, from 1.4 per cent to 0.1.

This low regional marginal abatement cost will find equilibrium at $9.00 a ton of CO2, which is shown in the middle table. This low price might increase the risk of jeopardizing the _____ integrity of the NDC mitigation goal. Moreover, South Korea will be strongly relying on permits import, requiring a high annual financial flows from its country to China. This dependency would also penalize South Korea to invest domestically, to engage towards low _____. To complete this presentation, I would "centertize" key learning from these three scenarios.

In the regulation scenario, if NDC mitigation target for energy related sectors aim to be achieved with an equal distribution of emission reduction efforts by sector, it would result in these two points—high emission reduction cost with an average of one per cent of countries' GDP from 2015 to 2030; and considerable disparities of cost between countries due to diverse mitigation efforts/ambitions, and substantial disparities of cost distribution between sectors and countries. Big disparities of burden sharing between sectors due to the fact that under regulation policy, sectors contribute to reduction in proportion of their emissions and that independently to their marginal abatement cost. So, sectoral flexibility, like a domestic ETS, for example, will help to reduce total cost and disparities between abatement cost of sectors. With Domestic ETS, that tends to bring flexibility between sectors' mitigation efforts. We found that cumulative total cost from 2015 to 2030 decreases by 45 per cent for the same amount of emission reductions compared to the regulation scenario.

With $163 billion US compared to scenario 1, South Korea cost reduction account for 47 per cent of Asian regional total cost reduction in scenario 2. ETS equalizes marginal abatement cost between sectors, and then, decreases total cost discrepancies between sectors. Resulting mitigation effort by sectors are thus cost-effective. But, we found that marginal abatement cost of New Zealand and South Korea remain very high, even with an economic-wide ETS on energy sectors, when China, Malaysia, and India have extremely low marginal abatement cost. So, this would encourage countries to use international cooperation for their compliance, and this could be done by regional ETS linking, for example. That's what we studied in scenario three.

The International Cooperation Scenario shows that international cooperation allowed us to drastically reduce total cost for the regions, but also, for each country. Cumulative total cost for China, Japan, and South Korea reduces by 91 per cent compared to domestic ETS scenario. Two factors explain this drastic cost reduction. First, the marginal abatement cost of China—and particularly, those of its power sector—are very low. 59 per cent of market's emission reduction are done by the Chinese power sector.

Second, very high marginal abatement cost of South Korea incent the country to import on us all of its emission reductions, and that reduce drastically and radically its total cost. South Korea accounts for 96 per cent of total cost reduction of the Northeast Asia region. Nevertheless, trade leads low domestic emission reduction for Japan and South Korea. This situation could have the following negative effect that are very serious and should be addressed. First—a dependency toward international carbon prices; second—both countries can be stuck into a technological lock-in and heavy carbon intensive locking if there are no incentive to reduced emission domestically; and furthermore, letting markets working with no constraint could incent countries to lower their environmental ambitions.

Solutions to tackle these issues could be through the definition of ETS market rules by setting trading caps—for example, like, offset limits in million ton of CO2 or in per cent of emission reduction, or by adding discount rate between the countries permit. In this context, we have used a value rate for the World Bank project to assess the impact of these market rules to link, in the study case, to link ETS in China, South Korea, and Mexico. So, I would like to thank you all for your attention. I hope I've not been too long, and I will be pleased to answer to your questions. Thanks.

Katie: Wonderful. Thank you so much to Doctor Cyril for that outstanding presentation. We're going to shift to the Q&A discussion. I just want to remind our attendees to please submit the questions using the "Questions" pane at any time. We also will keep up several links on the screen throughout for quick reference that point to where to find information about upcoming and previously held webinars and how to take advantage of our Ask an Expert program.

We'll use the remaining time to answer and discuss questions. The first question is—could you tell us—or, I'm sorry—for this case study, you compare NDC ambitions to a baseline. Could you tell us more about it?

Cyril Yes. So, to add the economic incentive of emission reductions, we have to define a baseline. And this baseline should represent the current state of the countries' policy within that information and _____ of the energy sectors development. So, for that, we use first, Enerdata EnerBlue Scenario—which is the NDC scenarios—and from these scenarios, we remove all the additional policies that is needed to achieve the NDCs to get this current and these baseline scenarios. So, we move from 2015 all additional _____ needed in EnerBlue Scenario to generate this baseline.

So, I would resume that the baseline is a current policy derived from the EnerBlue Scenario in our future.

Katie Wonderful. Thank you so much. Our next question is—the attendee would like to know; how can one compute the MAC for other countries or other periods not covered in this presentation?

Cyril So, MAC could be computed from energy models, and is something we've developed here with a POLES models running a lot of sensitivities regarding to a carbon value—what we call "carbon value"—which is a shadow of carbon price that is impacting the different sectors and different countries. So, with our model, we have developed that, so we could generate that for 66 countries and regions, which is the one that is covered by POLEs. If I'm correct, there is more than 40 to 50 individual countries around the world, and then, some regions. But what is important is the way the process—you generate this MAC—and the way you use it to extract information. So, it's a atter of having—

Katie Very good. Thank you.

Cyril [Inaudible] is a sensitivity analysis of the carbon value and the resulting emission reduction of the different energy sectors.

Katie Very good. Thank you so much. Our next question is—could you tell us more about why, in your study, Vietnam and Indonesia NDC targets are not ambitious?

Cyril Yes. _____ question. For this region, it is because, let's say, that the country have different target compared to business as usual—that is their own business as usual—and there is two reasons that I can explain why all estimation and all baseline doesn't fit and find that the baseline is more ambition that the NDC target. First reason is that first, we only cover energy related sectors, so we have to understand what will be the contribution of the energy related sectors into the national target. So, for some countries, we have officiant plans, and for some countries, we don't know what the distribution between the non-CO2 [Inaudible] and UCF land use sectors—what are their contribution and what the contribution would be for the energy sectors.

So, for us, estimation is different there for the contribution of energy sectors. Second point will be about—for the baseline, we had to input to use some macroeconomic assumptions. So, we use population growth projections from the United Nation and we use the GDP projections from an economic center called CEPI. That is an economic center that produces GDP project info to different countries around the world. So, on this point, the GDP forecast that is using, input in model is very important and would strongly impact the energy demand forecast, and then, the CO2 _____ emissions of the country.

So, we found that all GDP forecast for Vietnam and Indonesia are less ambitious than the one that the countries define in their business as usual. So, this also result in lower emission by 2030. So, what is interesting there—it could be to work with the countries to assess different macroeconomic assumption in our model for them to see how it fits with their own business as usual.

Katie Thank you so much. Our next question is—there appears to be a bit of a tradeoff between trading to reduce MAC and ability to individual countries to increase their NDC over time. How do you reconcile this with your policy recommendation for international ETS?

Cyril Yes. This a very interesting question. And on this, we try to develop these case studies and this tool to support the policy makers in the way that we define policies to implement the NDCs. So, the first _____ policy is that what is potential of emission reduction of my sectors and what are the costs associated to that? So, you can use different [Inaudible] and so you can test different configuration of energy policy power sectors to reach an acceptable cost for achieving the NDC.

And you can also find that what are the cheapest options to increase the ambition of my NDC. So, of course, here, we use domestic ETS, which is a simple way to find the least cost solution of the contribution of the different sectors to achieve the national target. And, of course from that, policy makers could decide to say, "Okay. I won't have a domestic ETS covering on sectors, because it's quite impossible to implement and to define the situational framework to do it, but it could be to use an ETS for power energy _____ sector, which is very [Inaudible] and carbon intensive." And to perhaps, consider what are the potential or reduction of the other sectors to stand out our regulations to bring them to contribute at a reasonable cost.

And so, these are some things that the MAC curve can provide you. So, to resume is that the way you MAC will help you to define the contribution you want to set up for the different sectors, and that contribution into the national NDCs. And from that, then, you can see which sectors and what are the additional potential of emission reduction you can have, and how also you

	can increase the ambition of your own NDC over time. I hope I have been clear.
Katie	Yes, yes. Thank you for answering that. Our next question—what did you mean by a low MAC for China in that case study? And is it good? Is it bad? Can you review, again, how do you calculate the MAC?
Cyril	Yeah. So, the MAC is calculated as a sensitivity of shadow carbon price in the energy models. So, MAC are top-down calculated from the different sectors using the model. So, the process is similar of what has been shown in the slide—is you're in a multitude of scenarios, and every time you change your carbon value you use, and you see how your energy system evolve and how your emission evolve, and this help you to drive your MACs. Can you recall me the beginning of the question, please?
Katie	Yes, of course. The attendee would like to know—what did you mean by low MAC for China in that case study? Is it good? Is it bad? And how do you calculate the MAC?
Cyril	Okay. So, I answered the second part of the question, and so, for the first part, is that in China—China has huge potential of emission reduction and with lower cost of what could be in South Korea, for example. And for the models, if you use a marginal abatement cost about $10.00 a ton of CO2, you applied it on the power sectors in Korea, and then you apply it on the power sectors in China, you will find that China would be able to reduce much more emissions with this marginal abatement cost than South Korea. So, this explain why the marginal abatement cost curve for the power sectors in China is lower on the rate of—it [Inaudible] more at the same marginal abatement cost than—more emission than South Korea. So, this don't mean it's bad or it's good. It just means that there is more potential of cheaper emission reduction in China than in other sectors. So, it depend on the sectors, of course. It's not country based; it's sectoral based approach. So, as you can see—for example, in China—over in China, the marginal abatement cost curve for transporters is much higher. So, reducing emission in transport sectors—one unit of emissions; one million ton of CO2—will be more costly to reduce one million ton of CO2 in the power sectors. So, this is what we have. So, it depend on the _____ share of emission reductions due to the energy structure of the countries in the sectors.
Katie	Thank you so much for following up with that. Our next question is—for monitoring countries' NDC implementation over time, it is important to be able to understand if defined policies would be sufficient to achieve the target by 2030. Would you be able to track this gap?
Cyril	This is a very interesting point that I will explain during the different questions—that here, in the studies, we only look at what the baseline is and what the NDC target is, and those three scenarios of policy framework that all achieve this target. But, let's say that policy makers, once they want to define the policies they want to put in place to achieve a certain amount of emission reductions—so, that mainly goes on sectorial approach with sectorial policies

and then, what they qualifying that they would like to use for implementing the NDC target sectorial level—may not be sufficient to achieve the national NDC mitigation target. So, for example, something that I play with the tool to try to understand with [Inaudible]—so, you have, in European union, NDC target and you have UTS [Inaudible] certain sectors and emission sharing regulations that cover all the sectors, and then, you can look at where you get and how you could increase the ambition and at what cost by playing with the different parameters of the policy line. And so, using this match, you can support the [Inaudible] to do that in a way that if they want to, say, for example, "In power sectors, I won't be able to do more than 10 per cent emission reduction in power sector"—so, you know what you can do in power sectors, but then, what you could do in the other sectors. Perhaps when you aggregate all that, you not achieve your NDC.

So, there's a way you can find space of improvement. So, as the answer for the first question, you can find space for implement of the NDC's ambition, but you can also find space for the improvement of your national sectorial policy framework to achieve your NDC. So, both ways. To get between the policy framework to achieve a certain amount of emission reduction by 2030 with the NDC mitigation target can also be studied within the MAC.

Katie — Great. Thank you so much. I think in the final minutes, we have time for one more question. Are the presented scenarios realistic in the international context, knowing difficulties of existing ETS?

Cyril — Yeah. Of course, the scenarios try to look with _____ approach—very simple one first with all regulation or all ETS is covering all energy sectors. And then you link—fully link the ETS _____ so it's _____ and economic and the best solution. But, let's say it won't be realistic in the future. But this give you the most costly approach scenario and the least cost scenario, so you see this big difference between the total cumulative abatement cost between the three scenarios that are very huge.

But then, say that having that in mind, you will be able to understand that there is limits. So, if you want to go to international cooperation, you need to limit the way countries could be compliant for the NDCs by purchasing international _____. So, then, you can improve, and we can make a lot of [Inaudible], so I think the best is to make this support with the policy makers for different government—that they want to understand what their opportunity is to improve their policy design, to reach the climate commitment, but also, to reach it at the certain cost, and also, to have domestically policy designs that have the country to engage to the energy transition and low carbon system development. So, this study case was here to share this extreme scenarios, but everything remain to be done with very [Break in audio] specific cases.

Katie — Wonderful. Thank you so much for that informative Q&A discussion and thank you to the audience for those great questions. On behalf of the Clean Energy Solutions Center, I'd like to extend a huge "Thank you" to our expert speaker and to our attendees for participating in today's webinar. We very much appreciate your time, and hope, in return, that you were able to take some valuable insights that you can take back to your ministries, departments, or organizations. We also invite you to inform your colleagues and those in your networks about the Solutions Center resources and services, including our no-cost support for our Ask an Expert service.

I invite you to check the Solutions Center website if you'd like to view the slides and listen to the recording of today's presentation, as well as previously held webinars. Additionally, you'll find information on upcoming webinars and other training events. We also are now posting webinar recordings to the Clean Energy Solutions Center YouTube channel. Please, allow about a week for the audio recording to be posted. Finally, I would like to kindly ask you to take a moment to complete a short survey that will appear when we conclude the webinar.

Please, enjoy the rest of your day and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.