Dialogue on a RES policy framework for 2030

towards2030

Climate change policy outside the EU: the role of carbon pricing

An Issue Paper for the Towards2030 Project

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About the project

The aim of **towards2030-*dialogue*** is to facilitate and guide the RES policy dialogue for the period towards 2030. This strategic initiative aims for an intense stakeholder dialogue that establishes a European vision of a joint future RES policy framework.

The dialogue process will be coupled with in-depth and continuous analysis of relevant topics that include RES in all energy sectors but with more detailed analyses for renewable electricity. The work will be based on results from the IEE project beyond 2020 (www.res-policy-beyond2020.eu), where policy pathways with different degrees of harmonisation have been analysed for the post 2020 period. **towards2030-*dialogue*** will directly build on these outcomes: complement, adapt and extend the assessment to the evolving policy process in Europe. The added value of **towards2030-*dialogue*** includes the analysis of alternative policy pathways for 2030, such as the (partial) opening of national support schemes, the clustering of regional support schemes as well as options to coordinate and align national schemes. Additionally, this project offers also an impact assessment of different target setting options for 2030, discussing advanced concepts for related effort sharing.

Who we are?

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Energy Research Centre of the Netherlands (ECN), Netherlands
Center for European Policy Studies (CEPS), Belgium
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1. Introduction

This issue paper is an output from Work Package 6 (WP6) of the Towards2030-dialogue project, which seeks to stimulate and enable an informed and useful dialogue among key stakeholders about the 2030 renewables policy framework for the EU. The focus of WP6 is on the impact of selected major external influences on the evolution of that renewables policy framework, including: trends in global fossil fuel markets; cost reduction in renewable energy technologies; and climate policy developments in non-EU countries.

This issue paper considers the last of those - climate policy development outside the EU. Due to the potential breadth and complexity of the subject, and limitations on the time available, it focusses solely on the introduction and potential evolution of carbon pricing schemes, and assesses how their development could have implications for the achievement of EU renewables policy goals. Its aim is to identify the principal ways in which the evolution of carbon pricing in other countries is relevant to EU renewables policy; to gather evidence on how schemes are likely to develop, taking into account key uncertainties; to use scenarios to explore some plausible outcomes; and to consider their implications. To make the research and analysis manageable with the constraints of the project, only China and the US are considered in any depth.

The other potentially important external factors are considered in other WP6 issue papers[1]. Due to the intertwined nature of these factors and their relationship with EU renewables policy, there are potential overlaps; this paper attempts to note these and identify where related issues are addressed in other WP6 papers.

The following sections of this paper are arranged as follows: Section 2 considers how non-EU carbon pricing affects renewables policy in the EU; Section 3 briefly considers the central importance of China and the US; Section 4 assesses the current status of carbon pricing in China and the US, and their relative position with carbon pricing in the EU; Section 5 explores potential evolution pathways for carbon pricing in the three regions; Section 6 considers the implications of those pathways on the overall 2030 energy and climate policy objectives; and Section 7 outlines some additional questions that stakeholders in the EU may wish to devote further attention to as the dialogue progresses.

[1] The other issue papers can be accessed at http://towards2030.eu/the-project/results

2. Non-EU climate policy as an external influence

As countries begin to develop and implement climate policies – and they are now doing so in great numbers, and with increasing scope and ambition – there is a wide range of measures they may consider that offer the potential to reduce their emissions. Different types of action can be taken, across different sectors, with national circumstances and other objectives and factors taken into account. In some cases these actions may have consequences that are felt far from the country implementing them. The central concern of Work Package 6 is how the actions of non-EU countries, considering not only their implementation of climate policies, but also other actions stemming from their broader energy and economic policies, could impact upon the achievement of the EU's renewables policy goals.

The vision of the EU's 2030 climate package, and broadly of its renewables policy framework too, is to build "a low carbon economy which ensures competitive and affordable energy for all consumers, creates new opportunities for growth and jobs and provides greater security of energy supplies" (EC, 2014). How easy or not it will be to achieve this vision depends not only upon the actions of the EU and its member states, but of other countries too. For example, whether or not the EU's energy remains competitively priced depends in part on what actions other countries take that determine the cost of the energy they consume; and whether or not the security of the EU's energy supplies is improved is likely to depend greatly on developments in global energy markets, which are the net result of supply and demand actions taken by a large pool of countries. Understanding the potential evolution of these influences, and their implications for the EU should therefore be of considerable relevance to the challenge of successfully implementing renewables policy, 'success' being defined here as meeting all the three key objectives articulated above (low carbon; competitive & affordable; secure).

Other issue papers being produced by WP6 of this project are tackling important aspects of this question, for example separate papers are being produced on how the following can influence EU renewables policy: global developments in fossil fuel use; the development of nuclear policy in the EU and beyond; and developments in the cost of renewable energy technologies following global innovation and deployment efforts.

Much of the debate about the EU's transition to a low carbon economy, and especially about the pace, scope and ambition of that transition, has had at its heart concerns about the cost of the transition, and fears that the EU may be putting itself at a disadvantage by moving faster and further than other nations. Such concerns have informed the positions of important constituencies (such as energy-intensive industry), and led to concerted lobbying efforts, on key issues such as the evolution of the EU ETS and the imposition of other explicit carbon pricing mechanisms (principally taxes), and on the introduction of policies and fiscal mechanisms to subsidise and deploy renewable energy technologies. Mainstream politicians are in general now wary of actions that may be seen to reduce competitiveness. This poses a particular challenge to the effective implementation of renewables policy in a bloc as economically diverse as the EU.

With topics such as the cost of renewable energy technologies covered in other issue papers, one of the remaining topics touching on the competitiveness issue that warrants an issue paper of its own is that of carbon pricing, and specifically the evolution of carbon pricing in non-EU countries where such schemes have a strong potential influence on the relative competitiveness of the EU and its industries. There is a very clear and direct link between the imposition of explicit carbon pricing schemes, and the cost of energy, and thus the relative competitiveness of important industries – and as such there is a clear potential influence on at least one of the pillars of EU climate and energy policy (competitive energy prices).

The remainder of this paper thus focusses solely on the evolution of carbon pricing outside the EU, and the question of how this could influence EU renewables policy. Limiting the paper's focus to this particular mechanism is also practical given the resources available, and the additional breadth and complexity of issues that could be in scope if broader non-EU climate policy was the focus. It is worth noting that carbon pricing, in addition to being a specific policy tool in its own right, is also intended to stimulate and support the uptake of other low carbon measures that have their own families of specific policies, such as renewable energy and energy efficiency. Thus it influences and links to a number of other 'categories' of low carbon development. It is also very much a policy measure *du jour* at present, and is being implemented or considered in a range of countries that might have seemed unlikely just a few years ago (see the World Bank's recent 'State and Trends of Carbon Pricing 2015' report for a summary of recent and planned developments around the world). With wider uptake expected in the coming decade it is only likely to become more important as an external factor. Finally, given its current popularity among policymakers, it could be argued that the state of carbon pricing in a given country can be viewed as a bellwether of its broader climate ambition, and thus as an indicator of the likely direction and speed of travel in other policy areas relevant to the broader question addressed by WP6.

How carbon pricing outside the EU can affect RES policy inside the EU

Before assessing the current status and potential evolution of carbon pricing schemes in key countries, and considering the implications for EU renewable policy, it will be useful to explore and articulate the various dynamics through which the existence and evolution of carbon pricing schemes outside the EU could (or should) influence renewables policy within the EU.

A carbon pricing scheme aims to provide a price signal that will shift investment from higher carbon activities towards lower carbon ones. Ultimately it aims to internalize the costs of climate change and link them to the source of the emissions (the 'polluter pays principle'), though prices in most schemes are currently a long way from the level required to do that in full (not least because of the current political difficulty of introducing pricing at such a level).

In the case of an emissions trading scheme covering power generation and other entities consuming very large quantities of fossil fuels (e.g. the EU ETS), the carbon price (which is determined by the scarcity (or lack thereof) of emissions allowances) flows through the economy, raising energy and production costs and disadvantaging high carbon activities in favour of lower carbon alternatives. The implementation of a similar scheme in a non-EU country (or regional bloc) with material trade flows with the EU might have a number of potential effects that could be relevant to EU renewables policy (both first and second order effects, or a combination of both), including:

- The competitive disadvantage of the EU versus regions without carbon pricing is reduced (as energy and production costs are increased in those regions by the new carbon price)
- Concerns about carbon leakage (i.e. migration of higher carbon industries out from the EU towards jurisdictions without carbon pricing) are lessened
- Lobbying by trade exposed energy-intensive industry sectors against unilateral EU-led environmental policies that increase energy or production costs is reduced

- Renewable energy technology (and other GHG reducing technology e.g. CCS) costs reduce (due to greater overall investment in innovation and deployment, supported by more widespread carbon pricing)
- Low carbon technology and service sectors (e.g. renewable energy technology providers) benefit from increased demand (supported by more widespread carbon pricing)
- Fossil fuel demand evolves (as investment moves from higher carbon fuels (e.g. coal) to ‘transitional’ fossil fuels (e.g. gas) and ultimately away from fossil fuels)

The occurrence and extent of these effects depends on the level of the carbon price (and other aspects, discussed below) and its impact on energy demand and investment patterns. Other factors such as the price of fossil fuels, and the existence and strength of other policies influencing energy production and consumption behaviour may also play an important role. It seems clear though that the existence of carbon pricing in other countries could impact on the achievement of EU renewables or broader climate goals due to some combination of the above outcomes (none of which it must be noted could be attributed solely to developments in carbon pricing). Before the recent acceleration in the implementation of climate policy in China and the US, the lack of climate action in one or both countries was frequently cited by constituencies within the EU keen to slow climate legislation as a reason not to put ambitious policies in place. Claims that new climate legislation (and especially carbon pricing) would create costs for business and industry not felt by their Chinese competitors and would thus be ‘anti-jobs’ or ‘anti-growth’ resonate powerfully with segments of the voting population. This causes genuine political challenges for the introduction of ambitious climate policies.

As already mentioned in this paper, several of these potential dynamics are the subject of other WP6 tasks and issue papers: the evolution of the cost of renewables (Task 6.3.3); trends in fossil fuel demand and supply (6.2.1); and the evolution of the carbon price within the EU (6.3.2)). Discussion of the first two will be limited in this paper to avoid duplication with those tasks. Because however some of the influences of carbon pricing are due to the *relative* level of carbon pricing between third-party countries and the EU, the evolution of carbon pricing within the EU must be covered at least in part in this paper.

Before turning to the non-EU carbon pricing schemes that are the principal focus of this paper, it is also important to consider which dimensions of those schemes really matter. It is information on these key dimensions, and their potential evolution, that will help assess whether the overall influence of other schemes on EU renewables goals will be positive or negative, and how it may evolve over time.

The most important aspect of a scheme is its price (usually expressed per tonne or ton of CO_2). This is the principal determinant of the impact of the scheme both against its own domestic objectives, and its international impact through the dynamics discussed above. Estimates of how pricing could evolve in the future are thus of great relevance and interest. A number of other aspects also affect the relative position of EU and non-EU schemes and therefore could alter the strength of the effects described above:

- **Scheme coverage**: the proportion of a nation's emissions that are covered by a scheme, both in terms of the range of sectors and fuels covered, and the number of entities affected, affects the international relevance of a scheme. A scheme covering a small fraction of national emissions (even with a high price), or excluding important (and trade-exposed) sectors, will be less relevant to the EU.
- **Compliance and enforcement**: EU firms exposed to carbon pricing need to be assured that they will not be disadvantaged by EU carbon pricing. As such they need to believe that their international competitors are indeed fully exposed to the carbon prices imposed by their local schemes and that compliance requirements in those schemes are comparable to those that firms face in the EU.
- **Longevity & certainty**: carbon pricing schemes are more effective at driving behaviour, especially investment, if participants and investors are certain that the scheme will exist for long enough to justify and reward low carbon investment. Likewise competitiveness concerns will reappear rapidly if there is doubt over the longevity of non-EU schemes.
- **Political support**: the strength of political support behind a scheme (and the level of support among other important stakeholder groups) will have a strong influence on all these dimensions; a scheme with weak support is unlikely to be able to maintain a high price or wide coverage of emissions, and its relevance is likely to diminish over time.

The following two sections look at the relevance of China and the US to the EU, and the current status of carbon pricing in China and the US.

3. China and the US in the global context

2015 has been a busy year with regard to carbon pricing. Around the world, more and more countries are planning or implementing carbon pricing schemes of one form or another. According to a recent World Bank report summarizing the state of carbon pricing around the world, "about 40 national jurisdictions and over 20 cities, states, and regions—representing almost a quarter of global greenhouse gas (GHG) emissions—are putting a price on carbon" (World Bank, 2015). Figure 1, from the same World Bank report, shows the geographic spread and type of the instruments currently either being implemented or under consideration.

The introduction of these schemes, and all those that will surely follow in the next few years, is relevant to the EU. They are further evidence of a world taking climate change more and more seriously, and putting in place the measures necessary to mitigate it. And in the ways explored in the previous section, their existence and evolution will have an impact on the EU's ability to achieve some of its own climate and renewables objectives. For several reasons though, this paper will focus only on the current state and evolution of carbon pricing in the US and China.

The US and China are, using most metrics relevant to this topic, the most important two countries as far as the EU is concerned. Figure 2 shows the relative size of China, the US, and a selection of other major countries, in three key areas: share of global emissions; share of trade with the EU; and share of the global low carbon goods & services market. Together, China and the US account for 38% of global emissions; receive 25% of EU exports; provide 28% of EU imports; and have a 33% share of the low carbon market. So for the key objectives of EU climate policy (low carbon; jobs & growth; energy security (share of energy consumption is not shown separately as the shares are very similar to emissions), these are the two countries that matter most.

They also represent very different political systems and states of development, and as a result, carbon pricing in these two countries will evolve in very different ways, and will need to overcome very different challenges. As such they provide interesting and complementary case studies, and between them are likely to provide examples of the main issues that EU policymakers will need to be aware of when considering the implications for EU climate and renewables policy of the evolution of carbon pricing around the world.

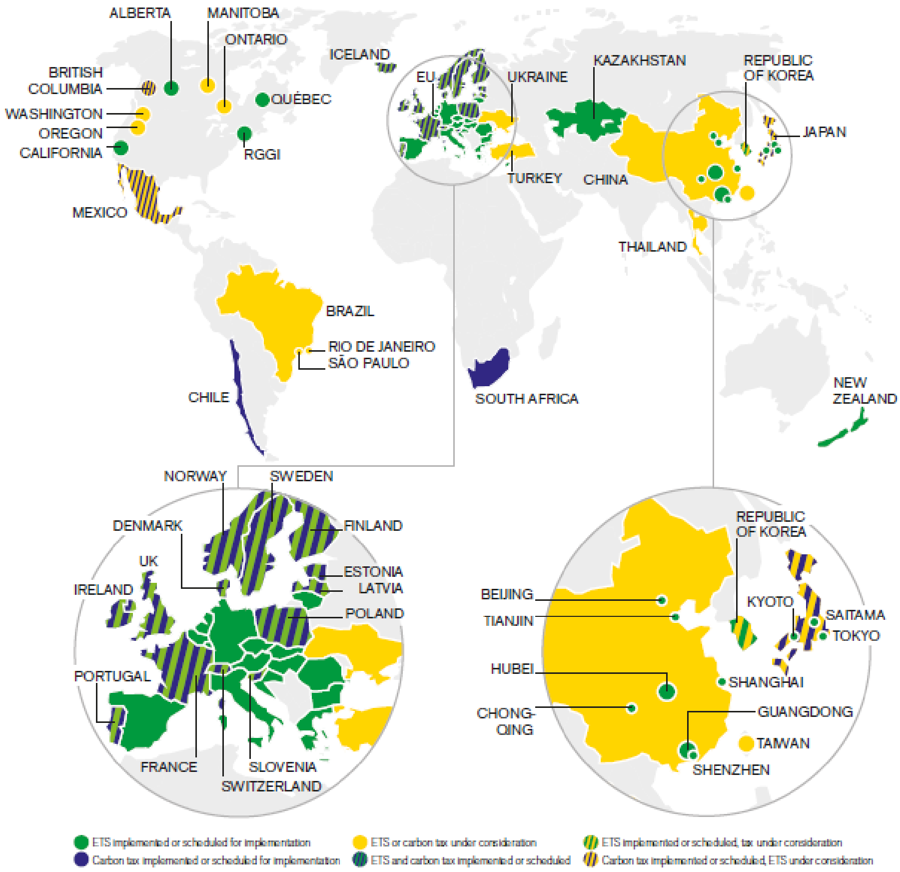


Figure 1: Current and potential national and sub-national carbon pricing schemes (World Bank, 2015)

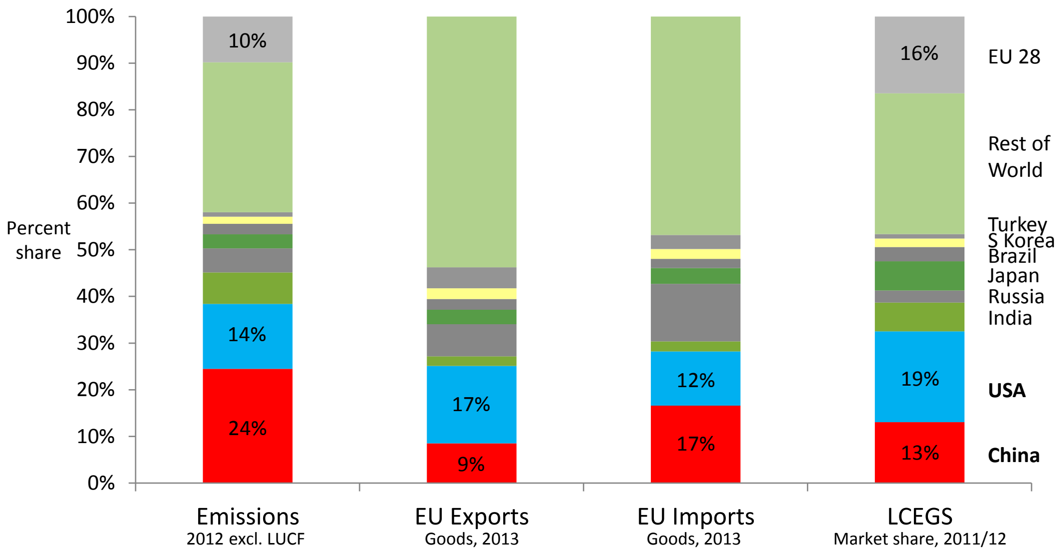


Figure 2: Share of China, the US, and other major countries, of global emissions, EU trade, and low carbon goods & services market (LCEGS)

Sources: Emissions data from Climate Analysis Indicators Tool 2.0; EU Exports & Imports data from Eurostat; LCEGS share data from UK Government Low Carbon Goods and Services Report 2013

4. Current status of carbon pricing in China, US and the EU

This section provides an overview of the current status and recent history of carbon pricing in China and the US, and for the purposes of comparison, the EU. Its aim is to show where these countries are today with regard to carbon pricing and to set the scene for the exploration of potential evolution pathways in Section 5.

China

From a standing start just a few years ago, China is now moving fast on the introduction of carbon pricing. There are 7 carbon trading pilot schemes in operation across the country (covering the cities of Beijing, Tianjin, Shanghai, Shenzhen and Chongqing, and the provinces of Guangdong and Hubei), which were approved in 2011 and commenced trading between June 2013 and June 2014. It is currently planning the introduction of a nationwide emissions trading scheme, now scheduled for 2017, following early indications that it would be introduced in 2016. The 2017 launch date was recently confirmed in the US-China Joint Presidential Statement on Climate Change released in late September 2015 (The White House, 2015).

China's Intended Nationally Determined Contribution (INDC), submitted to the UNFCCC in June 2015, is clear that carbon trading will play an important role in achieving China's low carbon development plans. It says it will "build on carbon emission trading pilots, steadily implementing a nationwide carbon emission trading system and gradually establishing the carbon emission trading mechanism so as to make the market play the decisive role in resource allocation". The INDC also articulates China's overall mitigation aims: to peak GHG emissions around 2030 with best efforts to peak before then; and to lower GHG emissions per unit of GDP by 60-65% by 2030 from 2005 levels (PRC, 2015).

China's seemingly sudden appetite for market based measures such as carbon trading is thought at least partly to be a reaction to the high cost of the actions taken to try to achieve the energy intensity goal in the 11th 5 Year Plan (a 20% reduction by 2010 vs 2005 levels) which used traditionally top-down, planned economy style measures such as firm-level savings targets, forced closure of old plants, and even electricity rationing (Lo, 2015). Senior officials declared their interest in a national trading scheme as early as 2010.

The scheme covers roughly 1,900 enterprises and total emissions of around 1.2bn tonnes (Zhang, 2015). Thus the pilot schemes in China together form the largest national carbon trading scheme in the world, though the multi-country EU ETS is larger, covering c. 2 billion tonnes from 11,000 installations. The number of sectors covered varies from pilot to pilot, as does the proportion of emissions covered: 36% of Hubei's emissions are covered by its pilot compared to 57% in Shanghai (Zhang, 2015). In the absence of strong drivers for carbon reduction during the timeframe of the pilots, at the national, provincial or enterprise level, trading volumes have been relatively light. Between June 2013 and end August 2015, 42 million tons were traded on the secondary markets of the 7 pilots (only the Guangdong pilot auctions allowances and is thus the only pilot with a primary market), worth USD 200m, and with an average price over the period of 4.76 USD/ton (Sino Carbon, 2015). Pricing levels have thus generally been slightly lower than in the EU ETS, in which prices averaged around 6 USD/ton in 2014. Throughout the second half of 2015 prices fell in most of the pilots due to over allocation of allowances by local governments, and continuing uncertainty over the future of the pilots (and whether allowances would be eligible in the national scheme) (Sino Carbon, 2015; Carbon Pulse, 2015). The price of Shanghai 2014 vintage allowances fell as low as 1.53 USD/ton at the end of July 2015, the lowest price seen across all pilots at that point.

The pilots themselves have shown interest in evolving their schemes, with Shanghai and Guangdong for example both stating a desire to include additional sectors, and a number of other provinces and cities have stated their interest in setting up pilots. Several of the pilot schemes have engaged in capacity building activities with other jurisdictions in China. The National Development and Reform Commission (NDRC), the macro-economic planning ministry with overall responsibility for climate policies and measures, however has not authorized any further pilots. With a national commitment now made on the creation of a nationwide scheme, the focus of efforts in the short term is likely to be restricted to launching that scheme. Unless carbon pricing policy takes an unexpected turn in China (e.g. the national plan is abandoned in favour of continued sub-national schemes), it is the evolution of the national scheme that will be most relevant to the EU, and so it is the national scheme that is the focus of the rest of this paper.

USA

The situation in the US is quite different to that in China. Where China is new to market mechanisms such as carbon trading, the US can look back to the sulphur dioxide allowance trading scheme, introduced in 1990, which was the world's first large-scale cap-and-trade scheme, and is widely regarded as being both highly successful and cost-effective. The US also has in place many of the fundamental attributes necessary for a successful carbon trading scheme. An example is the availability and transparency of emissions data at the facility/enterprise level, which is almost non-existent in China, but well advanced in the USA in the form of the GHG Reporting Programme, through which around 8,000 large emitting facilities report their emissions, totaling around 3 billion tonnes, or half of total US emissions.

Yet the prospects for a national carbon trading scheme are highly uncertain, and China will launch its nationwide scheme long before the US finds itself able to do the same. The political economy in China now appears to be reasonably aligned behind the role of carbon trading, but this is far from the case in the US. Climate change has become a highly partisan issue between Democrats and Republicans and there is currently very strong opposition to such schemes in the Republican-controlled Congress.

The failure – so far – of any cap-and-trade legislation to progress at the national level in the US has not however deterred all action at the state level. There are currently two schemes active in the US, one in California, and one comprising nine north eastern states in the Regional Greenhouse Gas Initiative (RGGI).

California paved the way for its scheme with its 'Global Warming Solutions Act' of 2006, often referred to as AB32, which authorised the use of measures such as cap-and-trade. AB32 was the first comprehensive, long-term climate change law in the US, and requires California to reduce its emissions to 1990 levels by 2020 and to 80% below those levels by 2050. There were attempts to suspend AB32 in 2010, led and funded by fossil-fuel interests active in the state. However, Californians voted to reject the attempted suspension, and in 2011 the cap-and-trade element of the Bill received final approval. The first auction was held in 2012, and the first compliance period covered 2013-14.

California's scheme covers about 450 entities, and now applies to 85% of the state's GHG emissions. From 2013 only electricity generators and large industrial facilities were covered, and from 2015, distributors of transport fuels and natural gas were included. The cap declined at around 2% per annum for the first two years of the scheme and from 2015 to 2020 declines at 3% per annum. Allowances were allocated initially with a transition to more auctioning as the program matured. 100% compliance was achieved at the first compliance event in November 2014. (ARB, 2015)

In January 2014, California's scheme and the Quebec cap-and-trade system in Canada officially linked, allowing joint auctions and mutual acceptance of allowances. This linkage was a major milestone for an initiative to create a linked cap-and-trade scheme covering a number of US states and Canadian provinces that began in 2007 under the name of the Western Climate Initiative (WCI). The WCI grew to comprise seven states and four provinces working together to develop and harmonise carbon trading schemes. However, it was never able to implement a full regional scheme, and a number of member jurisdictions left the WCI, which is now made up of California, Quebec and British Columbia. At the Paris climate conference in December 2015 the provinces of Ontario, Manitoba and Quebec signed a Memorandum of Understanding to develop a regional trading scheme and to bring Ontario and Manitoba into the linked system with California and Quebec.

The other cap-and-trade scheme currently active in the US is the Regional Greenhouse Gas Initiative (RGGI), which comprises nine north-eastern states including Massachusetts, New York and Vermont. Development of the RGGI started in 2005, and auctions commenced in 2008, making the scheme the first cap-and-trade scheme for GHGs in North America. The first compliance period for the RGGI ran from 2009 to 2011.

The RGGI covers around 160 power plants (with capacity above 25MW) across the nine states, and nearly all allowances are auctioned. The proceeds are invested in renewable energy and energy efficiency programmes. Following a programme review in 2012, the RGGI cap was tightened by 45% in 2014 and set at 91m short tons. This declines at 2.5% per annum between 2015 and 2020. Up to the end of 2014, the RGGI had auctioned 729m CO_2 allowances for a total of USD 1.9bn, with an average auction clearing price during 2014 of USD 4.72 per short ton (RGGI, 2015).

Although they have not yet passed carbon trading legislation, the states of Oregon and Washington are actively considering the introduction of cap-and-trade in their states. Oregon is debating several bills on the subject, and the Washington Governor announced a cap on GHG emissions which may include provisions for trading, following the failure of the state legislature to pass a cap-and-trade bill in June 2015 (World Bank, 2015).

One further initiative is relevant to the current status of carbon pricing in the US and could have a significant impact on its future development. President Obama has made climate change a priority in his final years in office and is working with the Environmental Protection Agency (EPA) to put in place climate legislation that will help unlock more ambitious international action on climate change, and which does not require Congressional support. In August 2015 the President and the EPA announced the Clean Power Plan (CPP), which requires US power plants to reduce their emissions, leading to a 32% reduction vs 2005 levels by 2030. An important feature of the plan is its explicit reference to the role of emissions trading as a way for states to more cost-effectively reach their targets. The EPA has committed to supporting states in developing the systems necessary to implement multi-state emissions trading, and has issued model trading rules for states to adopt to increase the flexibility with which they can achieve their targets (EPA, 2015; EPA, 2015 B; IETA, 2015). These model trading rules in effect form a 'trading-ready' package of rules, standards and methodologies that states can adopt, which will be immediately identical to the rules, standards and methodologies of other states that have adopted the model rules. This could pave the way for a bottom-up approach to a trading system with wide participation from states, as it will be in the economic interest of many states to engage in trading (IETA, 2015). The inclusion of emissions trading provisions in the CPP was welcomed by organisations such as the International Emissions Trading Association, who stated they hoped to see further carbon market development throughout the US following the introduction of the Plan (IETA, 2015 B).

As this paper was being finalized in February 2016, the CPP suffered a setback in the form of a ruling from the Supreme Court halting its implementation[2]. The implications of this are unclear at present, and while the White House and EPA have stated they fully expect implementation of the CPP to continue (and indeed many supporting states continue to prepare for its implementation), it does indicate the challenges facing the passage of meaningful climate legislation in the US.

[2] In February 2016 the Supreme Court ruled to 'stay' the CPP, halting its implementation until a judicial review. The EPA website says "*On February 9, 2016, the Supreme Court stayed implementation of the Clean Power Plan pending judicial review. The Court's decision was not on the merits of the rule. EPA firmly believes the Clean Power Plan will be upheld when the merits are considered because the rule rests on strong scientific and legal foundations*". https://www.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants

The European Union

The EU Emissions Trading System (EU ETS) is the world's largest cap-and-trade scheme, and was the first to launch, in 2005. It is now in its third phase (phase 1 was a three year 'pilot' phase from 2005 to 2007; phase 2 ran from 2008 to 2012), and covers more than 11,000 power stations and industrial plants across 31 countries, and also now includes airlines. In total it covers around 45% of the EU's emissions. The cap for 2013 was set at 2.1 bn tonnes, and during phase 3 (2013-20) this declines at 1.8-2.1% per annum, leading to a total reduction of 21% vs 2005 levels by 2020. The annual reductions will increase beyond 2020 in order to hit the target to reduce emissions by 43% below 2005 levels by 2030 (EC, 2015).

In the first two phases nearly all allowances were allocated rather than auctioned. In Phase 3 there has been a move towards greater auctioning, with around 40% of allowances auctioned in 2013 and an increasing proportion being auctioned in each successive year. Different allocation approaches are used for different sectors, for example in the electricity sector there is near 100% auctioning while in aviation 85% are allocated for free based on benchmarks.

The EU ETS has seen very volatile prices. At times prices have fallen to extremely low levels, driven primarily by surplus allowances caused by the recession and by over generous approaches to allocation by some member states. High volumes of imported international credits (from e.g. the CDM) have also depressed prices. Prices reached a high point of over 30 €/tonne in the first years of the scheme but then fell to around zero around the end of phase 1 in 2007. In phase 2 prices held firm between 20 and 30 €/tonne during most of 2008, but as the global recession took hold, prices fell steadily into 2009 and then declined again during 2012, reaching a record low point for phase 2 at under €3 per tonne in January 2013 following the failure of the European Parliament to agree to delay the release of additional permits into the scheme, a move which would have limited supply and supported the price. (EEA, 2011; Guardian, 2013)

Recent developments in the EU ETS have been more positive, especially with regard to future price stability. In 2014 the proposal to delay the release of allowances was agreed on; this 'backloading' measure postpones the auctioning of 900m allowances planned for 2014-16 until 2019-20 (EC, 2015 B). Following this, prices in the EU ETS have recovered: the average price for 2014 was €6 per tonne, and by August 2015 had climbed up to just below €8 per tonne (World Bank, 2015). Prices however decreased in the first months of 2016, falling to just below €5 per tonne in March 2016. A longer term measure has also been introduced to improve price stability in the EU ETS, in the form of the Market Stability Reserve (MSR). The MSR, approved in October 2015, will commence in 2019, and will address the surplus of allowances and reduce price volatility by increasing or reducing the supply of allowances as appropriate (EC, 2015 B).

Comparison of schemes

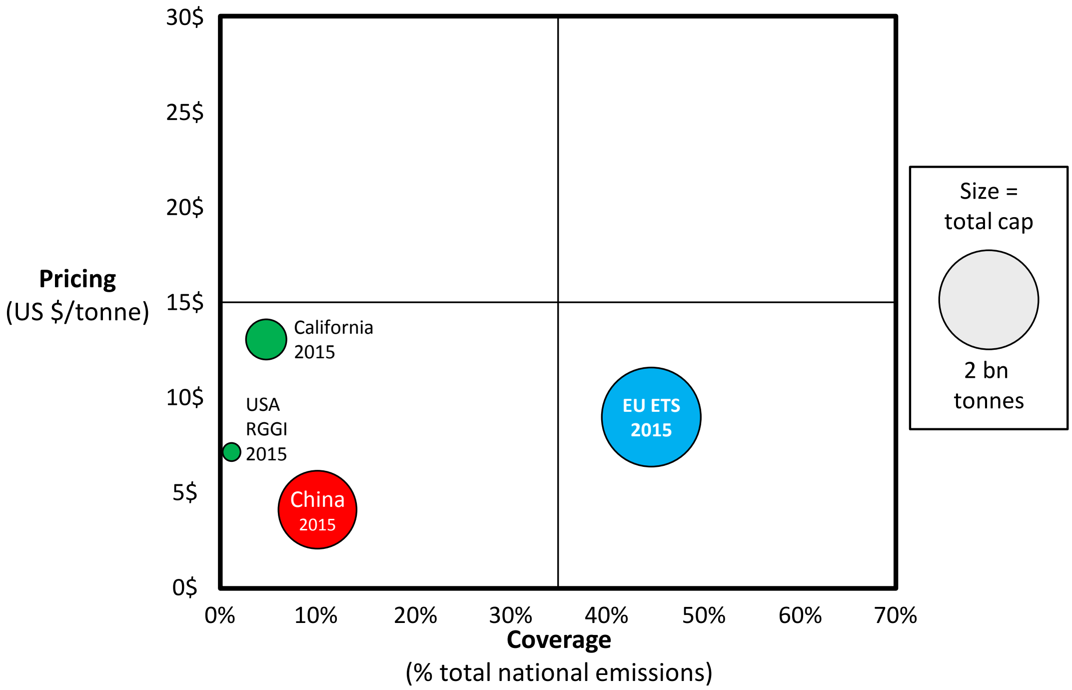
To aid comparison of the schemes described in the previous sub-sections, Table 1 below contains summary information about the schemes. The 7 city / province-level pilots in China are treated as one scheme, while the California and RGGI schemes are shown separately.

	EU ETS	**China (7 pilots)**	**US - California**	**US – RGGI**
Start date	2005	2013	2012	2008
Number of entities	c. 11,000	c. 1,900	c. 450	c. 160
Eligibility	Sector based – electricity, energy-intensive industry, airlines	Varies per pilot. 4-26 sectors covered. Emissions and energy thresholds used	Electricity generators, heavy industry (>25 kt CO_2), transport fuel & gas distributors	Power plants >25 MW capacity
Total cap	c. 2.1bn tCO_2	c. 1.2bn tCO_2	c. 360m tCO_2	c. 80m tCO_2
Current price (USD / tCO_2)	9	4	13	7

Note: For China the price is the average across all 7 pilots for April to August 2015 based on data from Sino Carbon (Sino Carbon, 2015). For the other schemes the price is the nominal price at 1 August 2015 (World Bank, 2015). EU ETS prices have since declined to below 6 USD per tonne.

Table 1: Comparison of schemes in EU, China and US

Section 2 of this paper explored how carbon pricing in other countries could impact on EU renewables policy, and identified some of the attributes of international schemes that were most relevant to the relationship. Figure 3 takes two of these attributes that are especially relevant; namely price, and scheme coverage, and plots the four schemes discussed on a matrix to show their relative position with regard to these attributes in 2015. The price is as per the information in Table 1, while scheme coverage is defined here as the proportion of the total emissions of the country or region covered by the scheme. So the two US schemes are shown as a % of total US emissions (i.e. the California scheme, which covers 85% of state emissions, accounts for c. 6% of national emissions), the 7 Chinese pilots together as a % of total Chinese national emissions, and the EU ETS cap as a % of the total emissions of the 31 countries included. The size of the bubbles represents the size of the cap.



Note: Data for national emissions from Climate Analysis Indicators Tool (CAIT)

Figure 3: Price and coverage of carbon trading schemes in 2015

Of the four schemes, the EU ETS is the only one that is active in all its constituent sub-regions, and as a result its coverage of total national emissions is far greater than the other schemes, at c. 45% vs 1-10% for the Chinese and US schemes. The EU ETS is a 'cornerstone' of the EU's efforts to reduce emissions, and while it may become so in time, carbon pricing is not yet a centerpiece of the policy response to climate change in China or the US (the story is different at the state level, especially in California). Consideration of whether and how that may become the case is the focus of Section 5 of this paper.

Comparing price levels in the schemes is complicated by the volatility that has been seen in several of the schemes; a snapshot taken one year ago would have seen lower EU ETS prices and higher Chinese allowance prices. As with the coverage of the schemes, pricing is linked to scheme maturity: the approach taken is normally to introduce a scheme, and to use a pilot period to allow participants to become familiar with the processes and strategies required for successful, cost-effective compliance before increasing the scope and / or taking action to increase the price (e.g. through tighter caps and a move towards full auctioning).

5. Potential evolution of schemes

Having set the scene by describing the current status of carbon pricing in China and the US, this section explores how these schemes might evolve in the coming decade or so. Given the difficulty of predicting the future, especially with a policy instrument that is still relatively nascent, at least in the case of the US and China, several scenarios are sketched for each country to illustrate a plausible range of possible pathways. The following section then considers the implications of those ranges for EU policymaking.

Relative strength of key enabling factors in China and the US

Before considering the scenarios, it is worth reflecting on the main determinants of the evolution of a carbon pricing scheme in a given jurisdiction, and the relative strength of these in China and the US. The direction and balance of these enabling factors will shape how (and indeed if) a scheme develops in either country. A selection of the main factors are described in turn, and their status in each country is outlined. Note: Green = enabling factor is strong/well developed. Red = enabling factor is weak. Orange = medium / moderate

Table 2 below provides a summary of the position of each country with regard to each enabling factor.

As the principle objective of a carbon pricing scheme is, or at least should be, to reduce emissions in a cost-effective manner, there is a clear link between the strength of a country's overall climate policy ambition and its interest in implementing an effective carbon pricing scheme. As noted in Section 2, the introduction of a carbon pricing scheme in a country can be seen as an indication of a serious national effort to reduce emissions. Conversely, countries that are not committed to emissions reduction are unlikely to take on the substantial task of designing and implementing a carbon pricing mechanism, especially a carbon trading scheme. Climate ambition in China and the US has taken considerable strides forward in recent years, and both countries have committed to emissions reductions through the UNFCCC process. Assessment of the level of ambition of their INDCs by Climate Action Tracker (an independent scientific analysis of country pledges) rates both countries as 'Medium' (stronger than its 'Inadequate' rating but weaker than 'Sufficient or 'Role Model'). While this level of ambition is evidently consistent with the establishment of carbon pricing schemes, it may have implications for the rate of decline of the cap, which has important ramifications for the price and overall environmental impact of the scheme. It is worth noting that the EU also receives a 'Medium' rating (CAT, 2015). In summary both China and the US have sufficient ambition at the highest level to support an effective carbon pricing scheme.

As noted in Section 2, climate policy and in particular carbon pricing are strongly political issues in many countries. A debate has emerged around carbon pricing and climate ambition that is fueled by entrenched interests and lobbying as much as it is by economic and environmental realities. The linkage to jobs and growth, which are important political issues in all countries, means that there must be strong political commitment for the implementation of a carbon pricing or trading scheme to go ahead at the national level. On this factor, China and the US are in very different places, as noted in Section 4. China has made public statements at the very highest level about its plans to introduce a national emissions trading scheme, for example in the US-China Joint Presidential Statement on Climate Change, released in September 2015 which stated that "China also plans to start in 2017 its national emission trading system, covering key industry sectors such as iron and steel, power generation, chemicals, building materials, paper-making, and nonferrous metals" (The White House, 2015). Given the high degree of state control, the balance of political economy, and the way in which major policy decisions are arrived at and communicated in China, this high level commitment towards emissions trading means that there is likely to be limited stakeholder opposition to, or deviation from, that plan. That is not to say by any means that the resulting emissions trading scheme will necessarily be a total success, as that will be determined more by a combination of other enabling factors (discussed next) than by political will and commitment.

Unlike his Chinese counterpart, President Obama is not in a position to make announcements about plans for a national-level carbon pricing mechanism in his country. Previous attempts to pass federal cap-and-trade legislation have met with stiff resistance (and been abandoned) and with a Republican controlled Congress at this time the prospects for top-down imposition of a cap-and-trade scheme seem fairly remote. As noted in Section 4, the Clean Power Plan makes specific reference to emissions trading as an option for states to meet their targets, and the states that look to develop trading mechanisms of their own will be supported by the EPA. In addition there are the 10 states already active in cap-and-trade (California and the RGGI) who may well be joined by further states in the near term, whether prompted or not by the CPP. From the EU perspective, a national scheme in the US or China would be considerably more relevant than a patchwork of sub-national schemes. In this respect, China is far better positioned politically to take the steps necessary to put one in place.

Being able to commit to, and to start implementing, a national carbon pricing mechanism is one thing, however, making it effective is another matter. Once again, China and the US are positioned very differently with regard to this. When considering the enabling factors that contribute to the effective and efficient operation of a carbon pricing scheme, it is the US that is in the far stronger position. China faces considerable challenges in making its planned national scheme work, not all of which have been addressed or overcome during the current sub-national pilot phase. These challenges include: its lack of experience with complex market mechanisms operating at this scale; lack of capacity in its financial sector along with relatively weak legal and regulatory standards; low levels of transparency over emissions data at the enterprise and corporate level and inconsistent quality and reliability of national and sub-national emissions data; and serious misalignment with other policies especially central price setting in regulated industries such as the power sector (Lo, 2015; Zhang, 2015; EUCCC, 2015). 63% of respondents in the 2015 China Carbon Pricing Survey said their organization was not adequately prepared for participation in an emissions trading scheme (China Carbon Forum, 2015). These are significant challenges. Because of these and other challenges, in its September 2015 Position Paper, the Carbon Markets Working Group of the EU Chamber of Commerce in China stated that "it is by no means a given that the national scheme will deliver what it is intended to deliver: a contribution to cost-effective emission reductions that will help China to reach its GHG emissions reduction goals" (EUCCC, 2015).

Most of these enabling factors are well developed in the US. It is a mature market economy with successful and valuable experience in emissions trading mechanisms from the sulphur dioxide trading scheme introduced in the 1990s and from the cap-and-trade schemes in California and the RGGI (which at least in the case of California is operating far closer to the best-practice ideal of an emissions trading scheme than are the pilots in China). The US has world-leading financial centres with all the capacity and legal and regulatory strength that that entails. Major emitting facilities already collect and report verified emissions information through the GHG Reporting Programme, and national emissions are reported through the annual GHG inventory process that conforms to international best practice. Finally the state does not play a role in setting energy prices in the US, allowing the carbon price signal to influence behavior and investment. Thus it has all the key ingredients of a successful carbon trading scheme in place except for the political space to make it happen.

These factors are summarized in Note: Green = enabling factor is strong/well developed. Red = enabling factor is weak. Orange = medium / moderate

Table 2, using colour coding to indicate the strength of these enabling factors. The contrast between the positions of the two countries is clear. Because of this, carbon pricing can be expected to follow very different pathways in China and the US in the short to medium term.

Enabling Factor	China	USA
Overall climate ambition	Orange	Orange
Political support for trading at national level	Green	Red/Orange
Experience with market mechanisms and capacity of financial institutions	Red/Orange	Green
Transparency & data reliability	Orange	Green
Alignment with other policies (inc. economic)	Red/Orange	Green

Note: Green = enabling factor is strong/well developed. Red = enabling factor is weak. Orange = medium / moderate

Table 2: Summary of the status of the main enabling factors for carbon pricing in China and the US (author's assessment)

Developing scenarios for China and the US

To develop scenarios for the evolution for the schemes it is necessary to identify which dimensions or characteristics of carbon pricing to vary between the scenarios. Section 2 identified some of the dimensions of a carbon pricing scheme that vary between schemes and which together determine its relevance to, and influence, on the EU: price; scheme coverage; compliance and enforcement; and longevity and certainty. Given the shortage of published information about how these and other aspects of schemes are being considered or are expected to evolve in China and the US, and to keep the task manageable, only the dimensions of price and coverage will be explored in the scenarios. These are the two most relevant dimensions when considering the relative positioning of carbon pricing between the EU and non-EU schemes, because they relate to the key questions of how high the carbon price is in other countries, and how widely it is applied. Because the current direction in both China and the US is towards carbon trading schemes rather than carbon taxes (and because by far the most significant carbon pricing policy in the EU is a trading scheme not a tax), the scenarios cover only the evolution of carbon trading schemes in China and the US. These may be complemented or even replaced by carbon taxation in the future but the rest of this paper considers only carbon trading.

A range of factors determine the price in a carbon trading scheme. Some are the result of institutional decisions on the design of a scheme, and principally affect the supply of allowances. These include initial allocation levels, rules around banking and borrowing of allowances, linkage with other schemes (e.g. the CDM), and the inclusion or not of mechanisms to limit price volatility such as price floors or ceilings (Ellerman & Joskow, 2008). External factors also affect the price, including the price of fossil fuels (especially gas in the EU), changes in the level of GDP, and weather. The level of abatement stimulated by the scheme, whether expected or unexpected, also affects the demand for allowances and thus the price (Ellerman & Buchner, 2007; Ellerman & Joskow, 2008; Maydybura & Andrew, 2011). It is beyond the scope and resources of this paper to separately consider these influences; instead the scenarios draw upon a few published forecasts of prices, where available, and also surveys of practitioners as to their expectations regarding future prices.

The coverage of schemes is less complicated, and is ultimately the result of institutional decisions over what sectors to include, and what thresholds to use for inclusion of specific enterprises or installations. These are of course highly political decisions and subject to fierce lobbying. As has been seen with the introduction of the cap-and-trade scheme in California, and with the extension of the EU ETS to cover the aviation sector, the road towards greater coverage can be somewhat rocky. For the purposes of the scenarios, the metric used will be the percentage of national emissions covered by the carbon pricing scheme (where for example the EU ETS currently covers c. 45% of total emissions from the EU). How schemes evolve against this metric could vary dramatically depending on which way the political wind is blowing (especially so in the US).

China

For China the main question is around the effectiveness of the scheme, given the challenges presented by the relative weakness of the key enabling factors for a robust and effective carbon trading scheme. With such firm and public high-level commitment to the implementation of a national trading scheme, the bandwidth of possibilities around the size and scope of the scheme is likely to be relatively narrow. There is much greater uncertainty around the prices that are likely to be seen in a national Chinese scheme.

Two scenarios are presented for China. In both scenarios a national scheme is implemented in 2017, as per the commitments made recently. Whether or not there is a pilot phase for the first 2-3 years before full scale is reached is not likely to be hugely material for the overall question of influence over the EU in the medium and is not considered in the scenarios. The latest indication from the Chinese government is that the scheme will commence at full scale at c. 4 bn tonnes rather than ramping up to that level only by 2020 (Carbon Pulse, 2015 B). The number of sectors and enterprises covered also does not vary between the scenarios, so coverage of total national emissions will be around 30% in 2025 in both scenarios, up from around 10% under the pilot schemes (based on total emissions in 2025 of around 13 $GtCO_2e$ (CAT 2015)). 'External' factors such as GDP growth, and energy prices are also not assumed to vary between the scenarios.

The only difference between the scenarios is in the price levels seen between 2020 and 2030. In the 'Higher Price' scenario, effective scheme design decisions (including about the banking of surplus allowances from the pilot schemes), sensible approaches to allocation, and a sufficiently tight cap, together combine to result in prices of around 100 RMB / tonne (c. 16 USD) between 2025 and 2030. This is the price level that China now estimates will be required in order to meet its target to peak emissions by 2030, according to a government think tank involved in the ETS design (Carbon Pulse, 2015 C). If the view persists that pricing at this level (or higher) is necessary to meet China's stated mitigation targets, then it is likely that steps would be taken to increase prices to around that level, as long as the political will remains to meet those targets. The average price expectation from respondents to the China Carbon Pricing Survey 2015 was 70 RMB / tonne (11 USD) in 2025, with a 20-80th percentile range of 40-100 RMB per tonne (China Carbon Forum, 2015). Prices in this scenario are thus at the higher end of the range expected in the survey. Much higher prices than 100 RMB seem unlikely before 2030 if that is indeed the level consistent with peaking emissions around that time, and given the large volume of relatively cheap abatement available in China, and the challenges facing scheme effectiveness. Prices at this level would remain in the 'Introductory' band ($0-20) as defined in a new report from the CDP and We Mean Business Coalition exploring possible future carbon pricing pathways and would not reach the 'Operational' or 'Transformational' levels that they identify as being necessary to drive sustained carbon reductions ($20-50 and $50-80 respectively), and it is worth noting that in their 2° pathway, prices in China's scheme are over 130 RMB ($20) by 2020 (CDP, 2015 B).

The second China scenario is a ‘Lower Price’ scenario. In this scenario the performance of the national scheme more closely resembles the sub-national pilots, with an insufficiently tight cap, over generous allocations, carryover of surplus allowances from the pilots, ongoing problems with data availability and transparency, and inadequate or ineffective legal and regulatory measures. The scheme coverage (% of emissions) remains the same as in the higher price scenario, though it is possible that in reality, options to induce a slower ramp up or include a more limited range of sectors might be taken in the face of ongoing difficulties with scheme operation. In any case these are not explored in this scenario. In the ‘Lower Price’ scenario, prices between 2025 and 2030 remain at the lower end of the range expected in the China Carbon Pricing Survey at around 50 RMB per tonne ($8), half the level in the Higher Price scenario and comparable to EU ETS prices in late 2015.

USA

For the USA, the uncertainties are greater, as explored in earlier sections, and there is a correspondingly wider range of plausible outcomes. The US has all the necessary enabling factors, and the experience, to create a carbon trading scheme with impactful and stable prices. But given the political situation at present and going into the next Presidential election, the evolution of carbon trading in the US is highly uncertain and could follow one of a number of quite different pathways. To explore the implications of this for the EU, two scenarios are outlined: one in which the US moves steadily towards a federal cap-and-trade scheme covering all states (the ‘Federal’ scenario); and one in which only a handful more states adopt cap-and-trade and it remains a patchwork approach (the ‘Patchwork’ scenario). Whilst it cannot be ruled out, scenarios where overall cap-and-trade activity declines or is abandoned are not considered here.

In the ‘Federal’ scenario, a number of supporting factors combine to create the conditions for the adoption of cap-and-trade by a growing number of states. These include: the imposition of the Clean Power Plan; the resulting economic incentive for states to wish to engage in trading; the facilitating provisions it includes; and the successful experience of California and the RGGI. By the early to mid-2020s this is followed by the successful introduction of a federal cap-and-trade scheme across all states. As Synapse Energy Economics point out in their 2015 carbon price forecast report, such a pathway towards a federal approach has historical precedent: “Historically, there has been a pattern of states and regions leading with energy and environmental initiatives that have in time been superseded at the national level. It seems likely that this will be the dynamic going forward: a combination of state and regional actions, together with federal regulations, that are eventually eclipsed by a comprehensive federal carbon price" (Synapse, 2015). For this scenario, coverage of emissions is assumed to be comparable to the EU at 40-50% of total US emissions. This is considerably lower than the 85% of state emissions currently covered by California's scheme, but given the likely political challenge this pathway would face, would still represent a major victory for advocates of carbon pricing. As discussed earlier the US is already well positioned in terms of the key enabling factors for successful carbon trading, so in this scenario, robust and increasing prices are assumed, based on Synapse's Mid case forecast, reaching USD 27.5 per ton in 2025 and USD 35 in 2030 (2014 USD; $27.5/ton equates to $30/tonne[3]). Their forecast is for a scenario "in which federal policies are implemented with significant but reasonably achievable goals" (Synapse, 2015).

In the 'Patchwork' scenario, there is continued opposition to cap-and-trade, and the CPP, limiting additional uptake of carbon trading schemes to just a few more states. At present more than half of the US states have challenged the legality of the CPP (IETA, 2015), and in the Patchwork scenario, these states remain opposed to cap-and-trade, and a number of other states postpone plans to introduce GHG emissions trading due to continued uncertainty around the future of the CPP and the role of carbon pricing in the US. After all, even in California, the progress of AB32 and cap-and-trade was beset by uncertainty and substantial opposition from some business and political interests. A further 4-5 mid-sized states, with annual emissions of c. 75-100 $MtCO_2$ decide to implement trading schemes covering roughly 50% of their total state level emissions. Combined with California and the RGGI, the aggregated emissions cap across all these active states amounts to around 550 $MtCO_2$, or c. 10% of US total emissions in 2025 (EIA 2015; CAT 2015). Given an overall atmosphere that is less committed to cap-and-trade and GHG reductions than in the 'Federal' scenario, and amid competitiveness concerns between states, pricing levels are lower, reaching around 15 USD per tonne in 2020 and 20 USD per tonne in 2025. At this level they are similar to Synapse's Low case forecast, and to California Carbon's forecast for the California-Quebec linked scheme (USD 22 in 2025) (California Carbon, 2015).

[3] In this paper, 'ton' refers to the short ton (2,000 pounds or 907.2 kg) and 'tonne' to the metric tonne (1,000 kg)

EU ETS

Only one scenario is outlined for the evolution of the EU ETS. As it is a much more mature instrument, and set to play a central role in the EU's decarbonisation plans to 2030 and beyond, there is far less uncertainty around the future of the EU ETS than there is with carbon trading in China or the US. In this scenario the EU ETS retains its present form and level of decarbonisation ambition (i.e. a 43% reduction vs 2005 by 2030 (EC, 2015)), and will continue to cover around 45% of total EU emissions. As noted in the section describing the current status of the EU ETS, several amendments have been agreed to reduce the surplus of allowances and to give greater price stability in the future. Prices in this EU ETS scenario increase at the rate forecast by Thomson Reuters in their 2015 EU Carbon Price Forecast, reaching €15 per tonne by 2020 (USD 17) and €24 by 2025 (USD 26) (Thomson Reuters, 2015).

Summary comparison of scenarios

Figure 4 summarises the relative position of the scenarios for China and the US against the EU central scenario, showing the price (y axis), coverage (x axis) and emissions covered (size of the bubbles). The two current US schemes are shown as one combined data point for 2015.

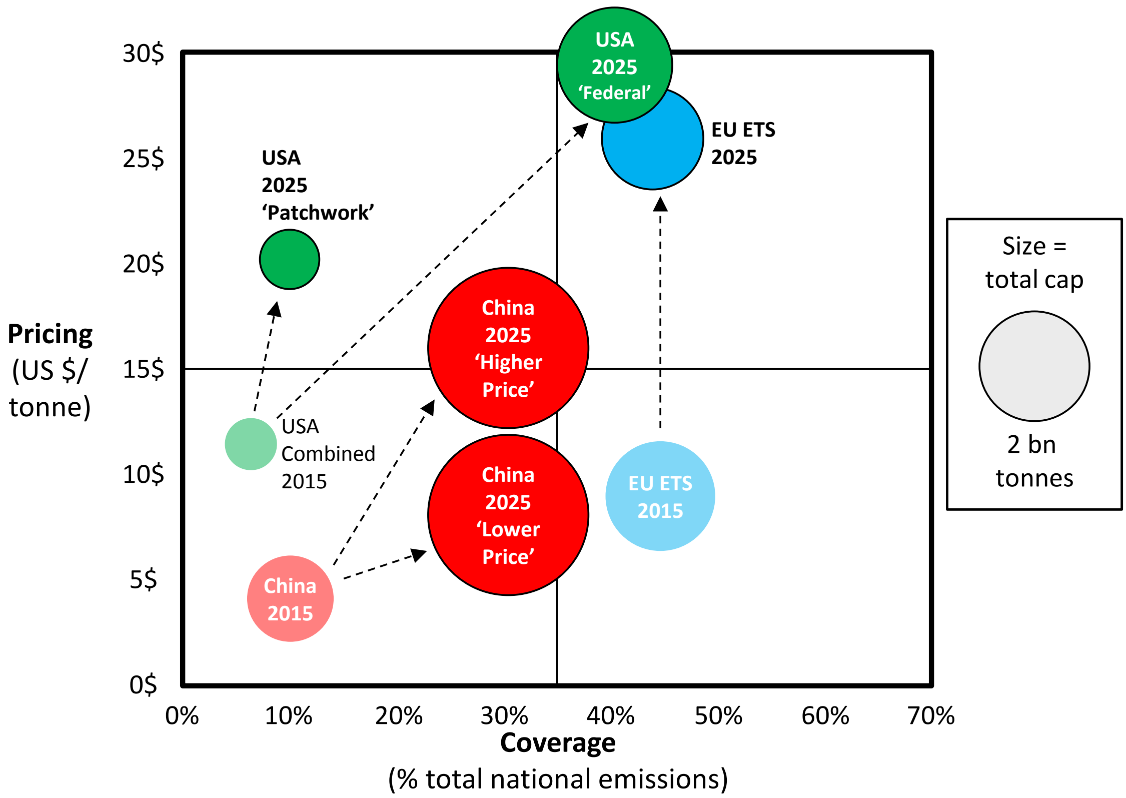


Figure 4: Price and coverage of carbon trading scheme scenarios in 2025

If the evolution of carbon trading in the US looks at all like the ‘Federal’ scenario, then by 2025 the US and the EU will have cap-and-trade schemes in place that are very similar with regard to scale, % of emissions covered, and price levels. Assuming a similar mix of sectors is included, this would mean that a more-or-less level playing field had been achieved between the two markets as far as carbon pricing goes. If however the US approach remains fragmented and hindered by political issues at both state and national levels, and evolves as per the ‘Patchwork’ scenario, then the relative positioning of the US and EU will be very different. In this case, the EU ETS would cover 4x the share of emissions and have a total cap 3-4 times as great, and the price differential would have reversed, with a price in the EU ETS around a third higher than that in the US.

Both scenarios for China feature very substantial growth in the coverage of the scheme and its total cap as the regional pilots make way for the new national scheme. At 4bn tonnes this would be twice the size of the EU ETS but would apply to a lower proportion of total national emissions at 30% compared to 45% for the EU ETS. In neither scenario does pricing in the Chinese scheme reach the levels forecast for the EU, with prices in the EU ETS 1.7x higher than the ‘Higher Price’ scenario and 3.4x higher than in the ‘Lower Price’ scenario.

It is difficult to say which of the scenarios outlined above is more likely for either the US or China. They were not intended to predict the future but to illustrate the differences between the current situation and outlook for carbon trading in the China and the US, and to explore the implications for the EU of these different potential outcomes. The latter is the focus of the following section.

6. Implications for EU policy

Section 2 of this paper explored some of the ways in which the development of carbon pricing in major EU trade partners could be relevant for the ease with which the EU is able to achieve the key objectives of its climate and energy policy. As outlined in the 2014 communication on the policy framework to 2030, these objectives are: create a low-carbon economy; ensure competitive and affordable energy; create new opportunities for jobs and growth; and provide secure energy supplies (EC, 2014). The introduction of meaningful (in terms of price and coverage) carbon pricing schemes in key trading partners (especially China and the US) would be positive for most of those objectives, as follows:

- **Creation of a (global) low carbon economy**: carbon pricing shifts investment from high carbon towards low carbon activity, and is seen by many as a key component of a successful transition to a global low carbon economy. Its existence in e.g. China and the US would support the decarbonisation of their economies (c. 40% of global emissions). From a global climate change perspective, it does not matter where emissions occur, so reduced emissions in any country (but especially the leading emitters) is entirely supportive of the ultimate objective of the EU's low-carbon objective: mitigation of climate change and avoidance of its most dangerous impacts. Additionally, potential carbon leakage is reduced. This has an environmental benefit as well as an economic one, as energy-intensive industries are less likely / able to locate to regions where they can operate less sustainably (i.e. consuming higher carbon electricity and being subject to less stringent environmental regulation in general).
- **Creation of a low carbon economy (in the EU)**: carbon pricing development in other key countries is also supportive of the transition of the EU economy towards low carbon. As noted earlier, concerns over competitiveness and the lack of a 'level playing field' for business have hindered the development not just of carbon pricing but of ambitious climate policy more generally. UK Chancellor George Osborne's 2011 statement that "We're not going to save the planet by putting our country out of business" is a prime example of such concerns being voiced at the very highest political level (Guardian, 2011). When other countries, especially key trading partners, put a price on carbon, these concerns become less and less valid, lobbying efforts lose

some of their power, and the passage of ambitious climate policies within the EU becomes easier.

- **Ensuring competitive and affordable energy:** whether energy prices in the EU are competitive or not is a function both of the factors that affect the EU's energy prices and those factors that affect the energy price in competing nations. If other nations impose carbon prices that increase the energy prices faced by their industries, then any competitive disadvantage that may have been caused by the EU's carbon pricing policies will be reduced, to the extent that the prices are equivalent. This relationship is acknowledged in the Communication on the 2030 framework: "As long as there are no comparable efforts undertaken in other major economies, similar policies (including an improved system of free allocation of allowances with a better focus) will also be needed after 2020 in order to ensure the competitiveness of Europe's energy-intensive industries" (EC, 2014).

  Affordability is a more subjective concept but is less likely to be directly affected one way or the other by carbon pricing in non-EU countries, because unlike competitiveness it is not a relative issue. On the other hand, as other nations implement carbon pricing and increase their investment in low carbon energy sources, the cost of low carbon technologies should reduce through demand-pull innovation, and this should mean that the EU can achieve its decarbonisation objectives at lower cost and with lower and more affordable (though not necessarily more competitive) energy prices. This last relationship is explored in much greater detail in the WP6 issue paper on renewable technology cost reduction.
- **Creation of jobs and growth:** this is linked to but not the same as the 'competitive and affordable energy' objective. While job and growth creation are certainly easier with lower (i.e. more competitive) energy prices, they can come from the creation of new industries regardless of input costs (evidently this is the case in many technology industries where Europe, the US or Japan retain competitive dominance). The development of new low carbon technologies is supported by meaningful carbon pricing, and when countries implement it they are better able to develop and incubate new sources of low-carbon growth that they can subsequently export. If carbon pricing in China and the US spurs the development of their low carbon industries then this will increase competition for EU players in those markets, which may make it harder for

the EU to exploit opportunities for job and growth creation. This also depends on other policies (e.g. strategic industrial policy; local content requirements): among the main beneficiaries of Germany's feed-in-tariffs were Chinese solar PV manufacturers, so EU firms could potentially benefit from carbon pricing in China almost as much as Chinese firms.

- **Securing energy supplies:** this is probably the most complex of the objectives to assess, because EU energy security is influenced by many other trends in global energy markets. Some of these will be covered in the WP6 issue paper looking at global fossil fuel developments. The influence of non-EU carbon pricing on EU energy security is likely to be relatively minor alongside these, and whether it is positive or negative may vary by fuel and over time. For example, as carbon prices increase in other countries, especially those that are major energy importers, their demand for fossil fuels should reduce as they become more efficient or switch to other energy sources. This should mean lower prices and greater availability for the EU than would otherwise have been the case. However it may also increase demand for lower carbon 'transition' fossil fuels such as gas, as countries move from coal and oil. Depending on the timing of these shifts this may decrease energy security for the EU by increasing competition for gas supplies.

Table 3 summarises these influences; the majority of the separate impacts identified are positive for the EU's climate and energy policy objectives. That this is the case should not be a surprise: the EU has been a major proponent of carbon pricing and specifically trading around the world, and has funded technical assistance projects to support its development in countries such as China, so it clearly sees the development of such schemes as being in its interest.

EU policy objective	Influence of meaningful non-EU carbon pricing	Key impacts (green = positive; red = negative)
Creating a low carbon economy	**Positive**	• Reduced global emissions • Reduced carbon leakage • Reduced competitiveness concerns • Reduced lobbying against low carbon policies
Competitive and affordable energy	**Positive**	• Reduced competitive disadvantage • Lower-cost low carbon technologies available
Opportunities for jobs and growth	**Mixed**	• Increased global demand for low carbon technologies • Stronger competition for EU firms
Secure energy supplies	**Mixed**	• Reduced overall fossil fuel demand • Increased demand for transition fuels

Table 3: Summary of influence on EU policy objectives

Given the growing interest in carbon pricing around the world, the steady increase in the number of schemes being developed or implemented, and following the very recent signing of the Paris agreement, carbon pricing only seems likely to be more widely used, and increasingly to be broadly equivalent to the EU ETS in terms of price and coverage of emissions. In all the four scenarios outlined in the previous section, carbon trading advances from its current status (coverage grows, and prices increase). So in all scenarios the impacts identified above would grow in strength. Not all the outcomes considered however would necessarily lead to a measurable change in the conditions for achieving the EU's policy objectives. In the US 'Patchwork' scenario, there would still be a very large proportion of US emissions and US businesses that were not subject to a carbon price; competitiveness concerns would likely still be voiced and used to attempt to hinder ambitious climate policy. Similarly, in the China 'Lower Price' scenario, there may remain sufficient skepticism (potentially justified) about the equivalence of China's scheme to the EU ETS, and the same issues would arise.

In the US 'Federal' scenario, and in the China 'Higher Price' scenario, however, it would be much harder to construct an argument that comparable carbon pricing policies are not in place in China and the US. Certainly a comprehensive federal scheme in the US, with a price of 30 USD per tonne, would go a long way to creating a level playing field at least as far as carbon pricing goes. And a 4bn tonne national trading scheme in China, with prices reaching 15 USD per tonne by 2025 and growth beyond, as envisaged in the 'Higher Price' scenario, would have a similar effect. If both countries followed these higher ambition and higher impact pathways, this would likely have a supportive and enabling impact on climate policy not just in the EU but more broadly around the world. Indeed by unlocking or at least helping to enable more ambitious carbon pricing and climate policy in other key emitters and EU trading partners, the additional international momentum created by positive carbon pricing development in China and the US would reinforce the positive impacts and create an even more supportive environment for renewables and climate policy in the EU.

7. Key questions for the future

This paper has explored how developments in carbon pricing could influence EU climate and energy policy. It has done so at a largely conceptual level, and has been unable to address all aspects of the question. A number of questions remain that may be useful to EU policymakers and other interested parties in further considering this issue. They include:

- What other aspects of scheme design and development, beyond price and scheme coverage, are relevant to assessing scheme 'equivalence'?
- At what point are schemes sufficiently 'equivalent' to the EU ETS to negate competiveness concerns? How easily can this be tracked?
- How important is perception versus reality in generating competitiveness concerns among business or other stakeholders? How can they best be informed about developments in non-EU climate policy that affect them?
- Which impacts or influences (caused by carbon pricing development internationally) are most important in creating an enabling environment (or otherwise) to achieve the EU's climate policy objectives?
- Would linkage of non-EU schemes with the EU ETS address all competitiveness (and other) concerns or would they create new issues? Under what conditions would such linkages make sense?
- Which areas of non-EU climate policy beyond carbon pricing affect the EU's renewables and climate policy objectives? How should they be assessed and monitored?

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