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Emissions Trading: China's Practices in a Global Context

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Emissions Trading: China's Practices in a Global Context

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Emissions Trading: China's Practices in a Global Context

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This thesis provides an overview of attempts to mitigate climate change through emissions trading systems (ETS) with a focus on China's recent announcement to implement a national ETS. The report begins with a description of climate change and the inherent difficulties of reducing greenhouse gas (GHG) emissions. Popular policy mechanisms that aim to reduce GHG emissions with a goal of mitigating climate change are described, including the United Nations efforts to implement an international ETS through international climate negotiations. The second chapter reports on international, national and regional ETSs, with a focus on a multitude of critical ETS components. The third chapter outlines the theory of linking ETSs, design considerations, benefits, potential barriers and risks of linking. The fourth chapter focuses on air pollution in China and the state's response to limit pollution through regional pilot ETSs that may transition into a Chinese national ETS based on the pilot programs' results. The conclusion of the thesis focuses on the potential repercussions of the future implementation of China's national ETS. The thesis concludes that China's selection of an ETS over other policy mechanisms can enhance other nations' confidence in an ETS's ability to reduce emissions without impeding economic growth. The Chinese system can influence future UNFCCC meetings and may facilitate global agreements. The lessons learned from China's ETS has the

potential to encourage the development of existing and future ETSs. Asia could become the global center for emissions trading if China considers linking systems with existing and future ETSs.

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List of Abbreviations and Acronyms

AB32	Assembly Bill 32 (California)
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COP	Conference of the Parties
CPRS	Carbon Pollution Reduction System (Australia)
EPA	Environmental Protection Agency (USA)
ERU	Emission Reduction Units
ETS	Emissions Trading System
EUETS	European Union Emissions Trading System
FYP	Five-Year Plans for National Economic & Social Development (China)
GDP	Gross Domestic Product
GHG	Greenhouse Gas
Gt	Gigaton (1 billion metric tons)
IET	International Emissions Trading
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism (Japan)
JI	Joint Implementation
KAZ ETS	Kazakhstan ETS
MEP	Ministry of Environmental Protection (China)
MRV	Monitoring, Reporting and Verification
NDRC	National Development and Reform Commission (China)
NZETS	New Zealand Emissions Trading System
NZU	New Zealand Unit
RGGI	Regional Greenhouse Gas Initiative (USA)
UNFCCC	United Nations Framework Convention on Climate Change
WCI	Western Climate Initiative
WTO	World Trade Organization

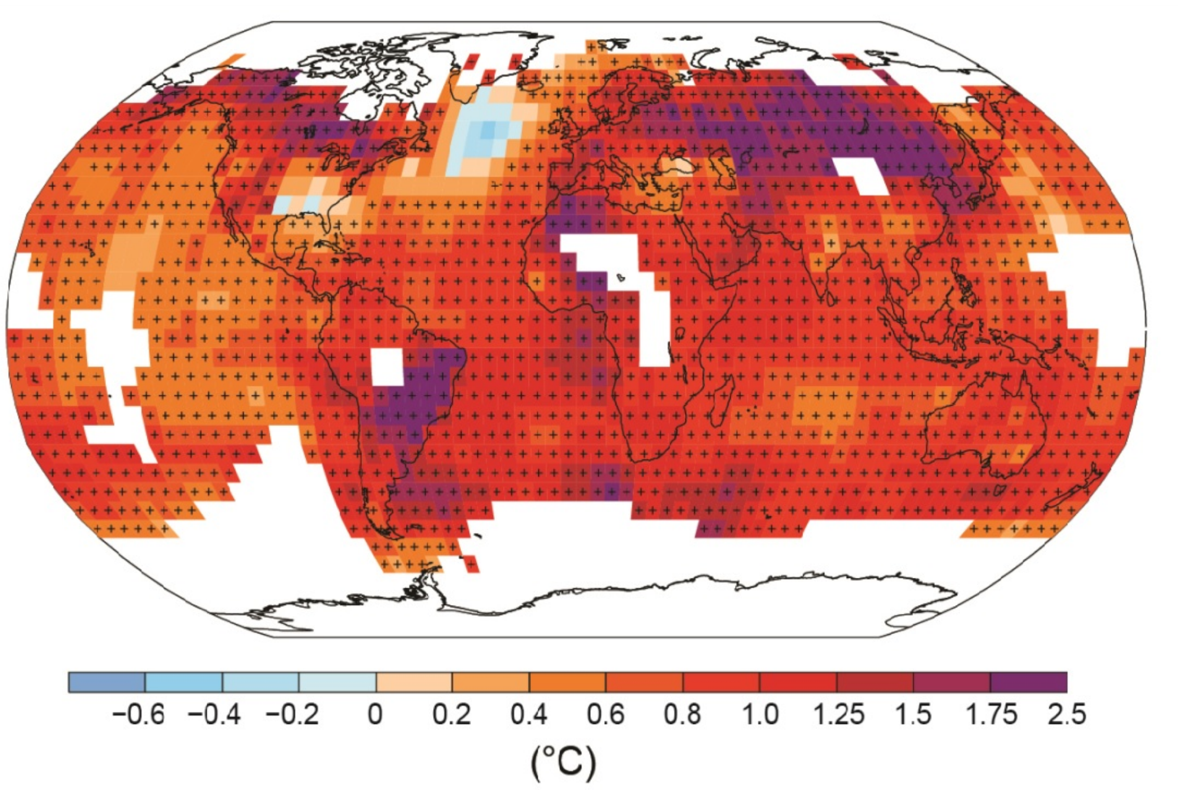
CHAPTER I: CLIMATE CHANGE

Mitigating climate change caused by the release of greenhouse gases (GHG) into the atmosphere has become a political, economic and cultural worldwide challenge. As world leaders search for efficient means to reduce GHG emissions, they also seek to meet energy demands of growing populations (World Bank, 2013). Policies that charge users for the release of carbon dioxide (CO_2/carbon) and other GHGs into the atmosphere are one option to mitigate climate change. Emissions trading systems (ETS) have been gaining attention as a policy mechanism to potentially reduce GHG emissions at low marginal cost to emitters. Various nations are testing domestic emissions trading as an option to reduce emissions in accordance with the nation's economic and political situation. Linking these ETSs may have the potential to control enough emissions to mitigate climate change dangers. China, with the highest net GHG emissions in the world, has announced the goal of implementing a national ETS to measure, price and reduce GHG emissions. If implemented, China's ETS will be the largest in the world and may influence emissions trading worldwide.

GLOBAL TEMPERATURE PATTERNS

According to the Intergovernmental Panel on Climate Change (IPCC), while there has been substantial variability in the global surface temperature, almost the entire globe has experienced warming temperatures since the year 1901 (IPCC AR5 WG1, 2013). Figure 1 illustrates the average global surface temperature changes from 1901 to 2012. Figure 1 shows that during this period, multiple regions have experienced average surface temperature increases of up to 2.5°C while almost no regions have experienced decreases in average surface temperatures. Ocean warming has been the largest near the surface (upper 75m) and has warmed by 0.11°C per decade over the period from 1971 to 2010 (IPCC AR5 WG1, 2013).

Figure 1. Average Global Temperature Increase Since 1901



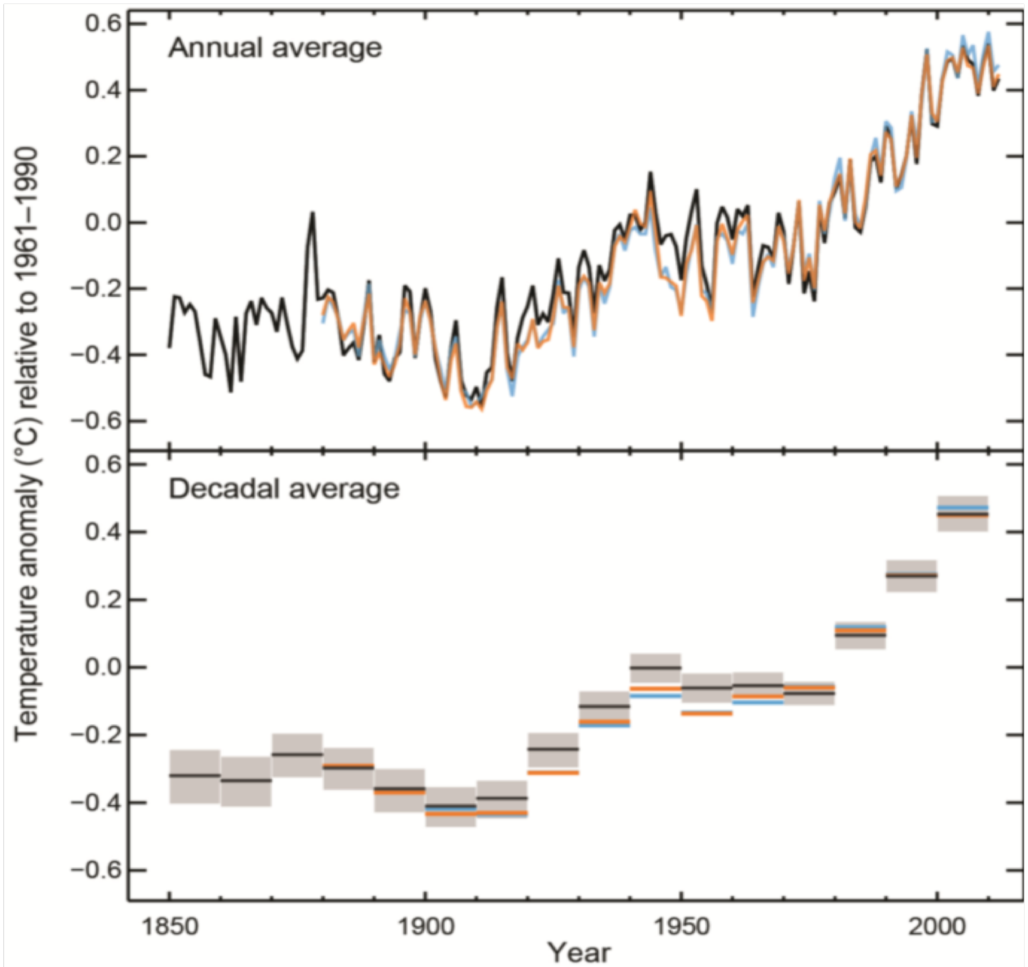
Source: IPCC, (2013): *Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved from http://www.ipcc.ch/pdf/assessment report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

According to the IPCC, temperatures have been warming at an increasing rate, with the warmest 30-year period in the Northern Hemisphere in the last 1400 years occurring from 1983 to 2012 (IPCC AR5 WG1, 2013). Figure 2 illustrates the annual and decadal average global temperature increase since the year 1850. The figure shows that the decadal average temperature of the years 2000-

2010 was 0.8°C higher than the period between 1900-1910 (IPCC AR5 WG1, 2013). The last three decades has been successively warmer than any preceding decade since 1850 (IPCC AR5 WG1, 2013).

While there is an overall multi-decadal warming, the global mean surface temperature shows substantial decadal and annual variability. Measuring short-term variations does not generally reflect long-term climate trends (IPCC AR5 WG1, 2013). As an example, if the rate of warming is measured over 15 years from 1998-2012, the rate of warming is 0.05°C per decade. If the rate of warming is measured over a longer span of 61 years from 1951-2012, the rate of warming is 0.12°C per decade (IPCC AR5 WG1, 2013). The long-term temperature increase trends are commonly referred to as "climate change" or "global warming."

Figure 2. Annual and Decadal Average Global Temperature Increase



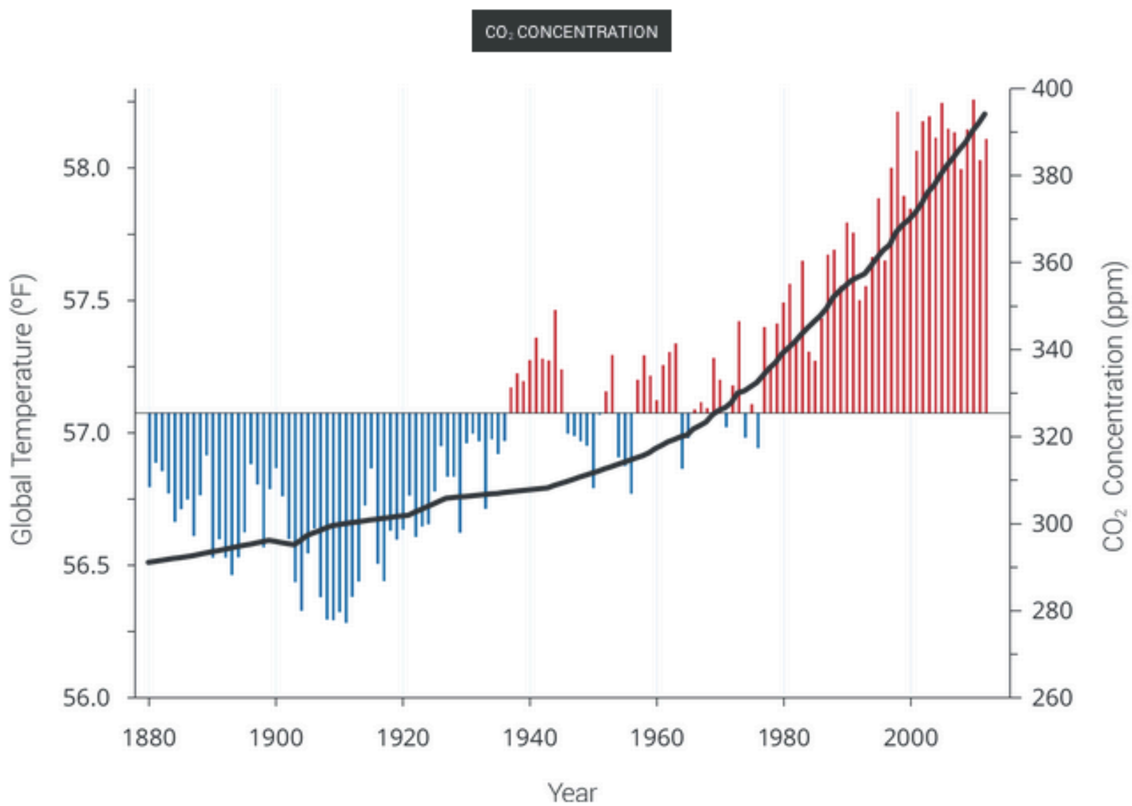
Source: IPCC, (2013): *Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved from http://www.ipcc.ch/pdf/assessment report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

Changes to the climate can pose a risk to multiple aspects of natural ecosystems and modern human society. Some analysts argue that even modest temperature increases of 1.8 - 2°C can have significant natural consequences such as the extinction of one-quarter of living species by 2050 (Brohe, Eyre, & Howarth, 2009). Some analysts argue that the increased variability of seasonal temperatures may cause terrestrial, freshwater and marine animal species worldwide to shift their geographical ranges, leading to migration and changes in species abundance (IPCC WG2, 2013). Hydrological systems can also be affected by changes to the climate that reduce the quantity and quality of water resources in rivers and lakes, increasing flood and drought risks (IPCC WG2, 2013). Altered natural ecosystems can affect human economies, such as the volume of available drinking water supply, reduced agricultural yields and extreme weather. Less developed nations may face additional risks, such as desertification, hunger, human migration or armed conflict over resources (Brohe, Eyre, & Howarth, 2009).

Greenhouse Gases

The IPCC has argued that the main cause of a warming climate is the increasing amounts of GHGs such as CO_2 in the atmosphere (IPCC WG1, 2013). Figure 3 illustrates how average surface temperature on both land and water vary with a rise in atmospheric CO_2 levels, indicated as a rising line of parts per million. The bars reaching downward represent temperatures below the long-term average while the bars reaching upwards represent temperatures above long-term averages, as measured from 1880 (Karl, et. al, 2009). Figure 3 shows that while there is a trend between the rising CO_2 levels and rising average global temperature, each year does not show an increase in temperature when compared to the previous year. The figure also shows greater changes in temperature between some years. Natural processes that affect global changes of temperatures and rainfalls such as El Niño and La Niña cause differences in yearly temperature increases (Karl, et. al, 2009).

Figure 3. Global Temperature and Carbon Dioxide



Source: NNSA, (2009): *Global Climate Change Impacts in the United States*. Cambridge University Press, Retrieved from http://nnsa.energy.gov/sites/default/files/nnsa/inlinefiles/karl%20et%20al%202009.pdf

Analysts argue that not only is the level of GHGs in the atmosphere today higher than it has been in the past 450,000 years (Brohe, Eyre, & Howarth, 2009), in addition every year anthropogenic emissions of GHGs add to this concentration at an average rate of 4 parts per million (Brohe, Eyre, & Howarth, 2009), and the rate of anthropogenic GHG emissions has been increasing. From 1970 to 2000, anthropogenic GHGs increased on average by 0.4 $GtCO_2e$[1,2] (1.3%) per year.

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[1] Gigaton refers to 1 billion metric tons

[2] CO2e refers to CO2 equivalent

Over the past decade, anthropogenic emissions increased on average of 1.0 $GtCO_2e$ (2.2%) per year (IPCC WG1, 2013). The last decade was marked by the highest total anthropogenic GHG emissions in human history, reaching 49 $GtCO_2e$ in 2010 (IPCC WG1, 2013). According to the World Bank, these emissions are expected to climb to 59 $GtCO_2e$ by the year 2020 (World Bank, 2014). The World Bank reported that the world will need to limit GHG emissions to 44$GtCO_2e$ per year to avoid dangerous levels of climate change (World Bank, 2014).

Fossil Fuels

A substantial percentage of anthropogenic emissions of GHGs come from the combustion of fossil fuels. When energy is released from fossil fuels such as coal, oil and natural gas through combustion, CO_2 is emitted as a byproduct. Fossil fuel related CO_2 emissions were about 32 Gt CO_2e/yr in 2010 and increased another 3 percent in 2011. Between 1970 and 2010 the GHG emissions from fossil fuel related CO_2 has increased by 108 percent (IPCC, 2013). Reducing the use of high GHG-emitting fossil fuels is being considered as a means to reduce climate change.

Reducing the use of fossil fuels in order to prevent the effects of climate change can be viewed as a difficult task because it will cost money, could complicate development in poor nations and affect human lifestyles worldwide. Fossil fuels are an essential part of modern industrial society; reducing consumption without a feasible alternative could lead to economic and social consequences. Fossil fuels generate over 66 percent of the world's electricity. Coal, the highest emitter of CO_2, accounts for 42 percent of the world's electricity (World Coal Association, 2012). Coal combustion alone was responsible for more than 45 percent of global energy-related CO_2 emissions in 2011 (IEA, 2012). The use of fossil fuels is expected to continue growing well into the future. Coal is expected to fuel 1,200 coal-burning power plants that are planned for construction globally over the next five years (WRI, 2012).

Reducing GHG Emissions

CLIMATE CHANGE AS A MARKET FAILURE

Climate change can be viewed as a market failure. GHGs from fossil fuels are released into the atmosphere because the use of the energy stored in coal, oil and natural gas is an economically valuable activity even though the purchase price of fossil fuels does not account for the external damages of climate change. When damages caused by global warming are not accounted for, fossil fuels continue to be used based off of an incomplete measure of their overall net-value to society. If the damages caused by global warming were accounted for and economically linked to the use of fossil fuels, alternative sources of energy could be more cost effective choices. The emission of GHGs is external to the market because there is not an economic incentive to avoid this activity. An externality is defined as the consequence of an industrial activity that is not reflected in the cost of the goods or services involved (Clark, 2012). The conflict of interests between the use of the valuable energy stored in fossil fuels and the goal to avoid climate change can be viewed as a market failure.

Even when the risks of climate change are understood, it is unlikely that a warming climate can be avoided if the risks and damages of climate change are not accounted for and linked within the perceived value of fossil fuel use and the subsequent emission of GHGs. The market failure could possibly be corrected through policy mechanisms that tie the price on the emission of GHGs, to internalize the risk and cost of future damages caused by climate change to the price of fossil fuels (Clark, 2012).

PRICING CARBON

World Bank studies have argued that pricing the emission of GHGs (also called pricing carbon) can be a cost effective technique to limit emissions by utilizing the private sector's economic power through targeted policies, methodologies and regulatory frameworks (World Bank, 2013). Many processes that release GHGs are core to economic development, such as energy production from fossil fuels. Adding a significant expense to fossil fuels will affect the price of all products and services that use the energy from fossil fuels (World Bank, 2013).

Designing an efficient price on carbon is not easy because each country, region, state and business affected by any plan to reduce emissions would want to remain competitive in a global market (World Bank, 2013). If an initial attempt at pricing carbon is unsuccessful, policy makers run the risk of strong public resistance to similar attempts to price carbon. This situation will add to the difficulty of implementing a new system to price carbon (World Bank, 2013).

There are three major tools being used to reduce GHG emissions by pricing carbon: policy regulation, taxation, and emissions trading. Each tool affects the targeted entities in a different way. Table 1 compares three carbon-pricing tools. The table shows each tool's principle, examples of main applications, strengths and weaknesses

Table 1. Overview of Carbon Pricing Instruments

	Policy Regulation	Emissions Trading Systems	Taxation
Principle	-Mandatory laws are created that set specific quotas on emission amounts	-Cap-and-trade (C&T) - Covered entities receive a quota of emissions. To comply with the quota, the entity either reduces its emissions or buys additional emission reductions from another company directly -Baseline and credit (B&C) - No cap on overall emissions. A baseline is established and emissions permits are awarded once covered entities reduce emissions under the baseline	-The polluter pays a fee proportional to its emission of pollutants
Example of Main Application	-Limits set on nitrogen oxide (NO_x) and sulfur oxide (SO_x) emissions from power plants.	-Kyoto Protocol (C&T+B&C) -EU ETS (EU) (C&T) -RGGI (US) (C&T)	-Tax per ton of GHG released -Fuel taxes (indirect) -Registration fees for cars based on engine size (indirect) -Proposed tariffs on high-carbon goods (indirect)
Strengths	- Relatively Simple -Can have low transaction costs -Can be most appropriate where there are high damages from pollution	-Can encourage innovation and investment in new abatement technologies -Emissions cap provides an attractive political signal -Cap focuses on achieving a specific quantity of abatement	-Can encourage innovation and investment in new abatement technologies -Creates a flow of revenue for government that can be used to lower other taxes -Arguably less open to political lobbying than direct regulation

Source: Brohe, A., Eyre, N., Howarth, N. (2009). *Carbon Markets: An International Business Guide.* London, England: Earthscan

Table 1. (Continued) Overview of Carbon Pricing Instruments

Strengths (continued)	-Transparent -Can be easy to implement -Creates a moral signal about pollution -Does not involve operating through behavioral responses to price signals	-Auctioning permits under cap-and-trade can raise revenue for governments -Cap and trade in principle could achieve least cost emission reductions -Engages the banking and finance sector in abatement innovation -Can be used as a tool to combat global inequity -Carbon pricing is hidden behind CO_2 cap, increasing political acceptability	-Keeps investment in low-carbon solutions local -Sets a clear carbon price that investors can use to plan with greater certainty -Low transaction costs if integrated into existing tax systems
Weaknesses	- Provides little if any incentive to reduce pollution beyond the limits -Can slow technological innovation -Abatement is unlikely to be achieved in a least cost manner	-Open to political lobbying (e.g. limited auctioning and preference to existing firms vs. new entrants) -Information requirements are initially high to set a cap for each firm -Resources for abatement can be dispersed geographically -Can introduce uncertainty over price, therefore undermines long-term investment planning -High transaction costs -Baseline and credit systems can lack environmental effectiveness -Behavior not always sensitive to price signal	-Politically difficult to bring in as adverse equity effects on citizens are transparent -Difficult to control the quantity of pollution with a price instrument under uncertainty -Behavior is not always sensitive to price signals

Source: Brohe, A., Eyre, N., Howarth, N. (2009). *Carbon Markets: An International Business Guide.* London, England: Earthscan

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Policy regulation refers to policy set in place that regulates emissions, limiting discharge under state-imposed punishments, such as state-imposed limits on GHG emissions for power plants or industrial plants. This technique can be implemented in societies with strong judicial and administrative systems. Policy regulation can create a signal about pollution and does not involve operating through behavioral responses to price signals (Brohe, Eyre, & Howarth, 2009). One weakness of this technique is that GHG abatement may not be achieved in a least cost manner if the regulations specify what technologies need to be used to reduce emissions. Regulations also provide little incentive to reduce emissions further than what is necessary to comply with the law (Brohe, Eyre, & Howarth, 2009).

A carbon tax is a price on CO_2 or a price per ton of CO_2e (World Bank, 2014). A government could charge an emitter a tax directly on GHG emissions or indirectly such as through a tax on high GHG fuels, registration fees for cars based on engine size or tariffs on high-carbon goods (Brohe, Eyre, & Howarth, 2009). Taxes can be dynamically efficient by encouraging innovation and investment in new abatement technologies, while also creating a flow of revenue that could be dedicated to lower other taxes (known as a double dividend). Transaction costs of implementing a tax can be low if the taxes are integrated into existing tax systems (Brohe, Eyre, & Howarth, 2009). However, in many societies a new tax can be difficult to initiate politically, as a tax could result in adverse equity effects on poor citizens (Brohe, Eyre, & Howarth, 2009). A carbon tax can guarantee the price of emissions in an economic system but emission reductions are not guaranteed.

Carbon taxes can include flexibility measures to encourage emissions reductions (Brohe, Eyre, & Howarth, 2009). For example, Denmark's exempts entities that voluntarily agree to improve energy efficiency. Switzerland's carbon tax has exemptions for entities that agree to an overall emission reduction target. A tax can be introduced alongside another carbon pricing instrument such as an ETS in order to cover emissions that could not be included under another instrument (World Bank, 2014). Taxes can also include specific elements from ETSs by allowing the use of offsets to help meet reduction targets. South Africa and Mexico both allow covered entities to use emissions credits to achieve the reduction goals set up under their carbon tax (World Bank, 2014).

British Columbia, Denmark, Finland, France, Iceland, Ireland, Japan, Mexico, Norway, Sweden, Switzerland and the UK all have some type of active carbon tax. In total, existing carbon taxes cover about 6 $GtCO_2e$ or about 12 percent of the annual global GHG emissions (World Bank, 2014). South Africa, Brazil, Chile, Oregon and Korea are also examining the economic impacts involved in implementing a tax on GHG reductions (World Bank, 2014).

Emissions Trading Systems (ETS)

Emissions Trading Systems are financial incentives to reduce emissions cost effectively. Businesses or organizations can buy or be issued permits (also called credits or allowances) for the emissions they release over a set amount of time. Emissions released by the covered entities must be accounted for with these permits.

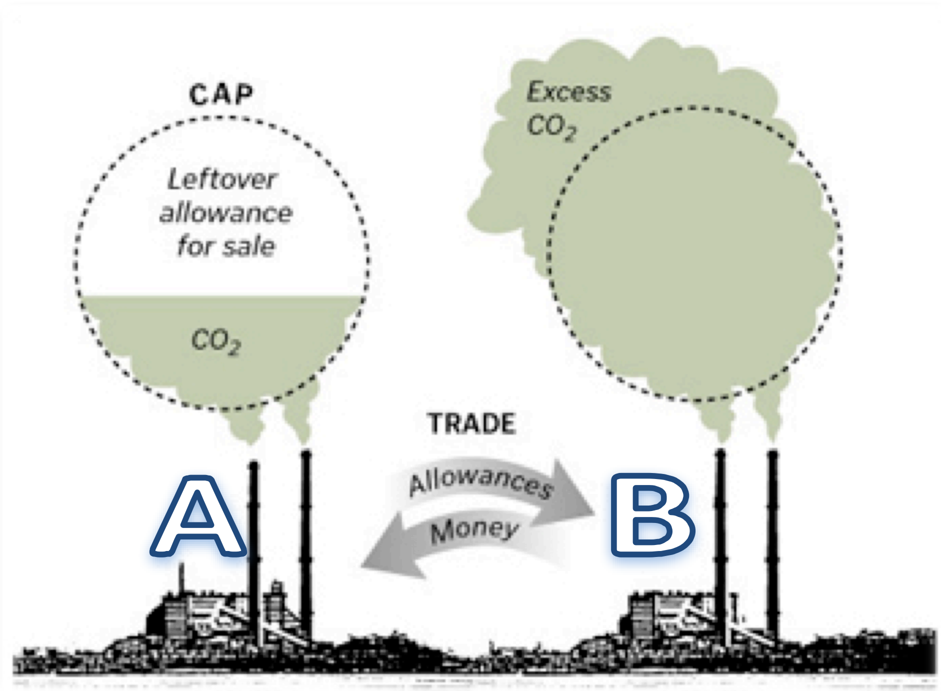
To reduce GHG emissions, permits may be issued equal to one metric ton of CO_2 or CO_2e based on the released gas's global warming potential (GWP). The US Environmental Protection Agency has defined the GWP of a GHG as "The ratio of the time-integrated radiative forcing from the instantaneous release of 1 kilogram (kg) of a trace substance relative to that of 1 kg of a reference gas. The reference gas used is CO_2" (EPA, 2013). Other GHGs can have higher GWP than CO_2. For example, CH_4 (methane) has a GWP of 25 tons of CO_2.

Under an ETS, covered entities are required to surrender permits equal to the GWP of the gasses emitted. If one ton of CO_2 is released into the atmosphere, the emitter will have to surrender one carbon permit to cover the emission. If one ton of a gas with a higher GWP such as CH_4 (Methane) is released into the atmosphere, the emitter would have to surrender 25 permits to match the GWP of CH_4.

ETSs generally come in two forms: "Cap and Trade" (C&T) or "Baseline and Credit" (B&C). A B&C ETS is designed with no overall cap on emissions. A baseline of emissions is established and emissions credits or allowances are earned that can be sold once a participant reduces emissions under the baseline. A C&T ETS is designed with a controlled limit or "cap" on the amount of emissions covered entities are allowed to emit. The cap or quota is usually set based on the necessary reductions of emissions in the atmosphere to reach target levels. To comply with the cap, the covered entity will either reduce emissions locally or pay for additional reductions to be made at another location (Brohe, Eyre, & Howarth, 2009). Under a C&T system, there can be a continuous reduction of finite permits. Increasing scarcity of permits encourage covered entities to reduce emissions in anticipation of receiving fewer permits during the next phase of the ETS. The set limit on the permits creates a value, as prices would be driven up each trading period when the overall supply of permits continuously is reduced.

To enable cost effective emission reductions, issued permits can be traded among covered entities. Figure 4 depicts how emission permits can be traded between two entities (A and B) to control total emissions under a cap and trade ETS. If an entity has an excess of permits due to local emission reductions (entity A), they can sell extra permits for a profit to other entities (entity B) that need to buy more permits than they were allocated. Trade creates cost effective emission reductions, as entities with low abatement costs to reduce emissions (entity A) can sell excess permits; entities with high abatement costs (entity B) can buy excess permits for less than it would cost to reduce their own local emissions.

Figure 4. Fundamental Design of an C&T Emissions Trading System



Source: McIntire, A. (2013): *Carbon Emissions Cap and Trade is Here to Stay.* FirstCarbon Solutions. Retrieved from: http://info.firstcarbonsolutions.com/blog/bid/266085/Carbon-Emissions-Cap-and-Trade-in-California-is-Here-to-Stay

In principle an ETS can enable emission reductions to occur at the least cost. Emissions limits allow CO_2 discharge targets to be set based on a scientific consensus of appropriate levels. Auctioning of permits as a means of allocation can be a source of revenue. Permit trading can be designed to balance global inequalities of GHG emissions and reduction targets. An ETS enables the implicit price on carbon behind a CO_2 cap, possibly making an ETS easier to implement politically. Since covered entities are motivated financially to reduce emissions, an ETS encourages innovation and investment in new low-carbon technologies (Brohe, Eyre, & Howarth, 2009).

The weaknesses of an ETS include the uncertainty of the price of permits, which can be a deterrent to long-term investments. An ETS can also be more open to political manipulation than some other methods of emission reduction if preference is given to certain parties over others during permit issuance. The information needed from covered entities to properly issue permits is more invasive than other forms of carbon pricing and could cause difficulties. The transaction costs are also relatively high. Baseline and credit style systems have much less certainty over emission amounts than the cap and trade style system, which may be a weakness (Brohe, Eyre, & Howarth, 2009).

An emissions trading system can be developed from a scale as small as a town or city to as large as a global regime. For example, a citywide ETS could be created to meet the requirements of a statewide cap or in response to federal rules. A global system could create a complicated interconnected web of trading systems around the world.

As of 2015, about 40 national and 20 subnational systems put a price on carbon. Some nations or regions are choosing an ETS or a tax separately. Others combine the two to satisfy a state's individual situation (World Bank, 2014). Both instruments put a price on carbon to raise revenues and affect economic decision-making based on the price of emitting GHGs. Both mechanisms also internalize the previous externality of releasing GHGs, so the choice between which of these instruments might not be as important as successfully implementing either one. The design details necessary to make the instrument successful at reducing carbon can be the most important aspect of setting up a carbon-pricing instrument (World Bank, 2014).

United Nations' Efforts to Reduce Greenhouse Gases

In 1992 the United Nations Conference on the Environment and Development (the Conference) was held in Rio de Janeiro, Brazil. At the Conference, the United Nations Framework Convention on Climate Change (UNFCCC) was formed to create an international system to reduce GHG emissions. As part of this international treaty, the Kyoto Protocol was negotiated in Kyoto, Japan and came into effect in 2005.The Kyoto Protocol was the first document produced within the United Nations that defined measurable country target levels of GHG reductions while also creating the first international ETS designed to reduce GHG emissions (Brohe, Eyre, & Howarth, 2009). The protocol defines various reduction targets that require an 8-10 percent reduction in GHGs compared to the participating nations' baseline level of emissions in 1990 (Brohe, Eyre, & Howarth, 2009). The protocol set global standards for emission reductions that can serve as an example to similar regional plans to follow. Some of the most innovative aspects of the Kyoto Protocol are the flexibility mechanisms involved.

Flexibility Mechanisms

There are three flexibility mechanisms enacted through the Kyoto Protocol to help covered entities reduce emissions, International Emissions Trading (IET), the Clean Development Mechanism (CDM), and Joint Implementation (JI). The IET was put in place to achieve reductions at the lowest cost. The JI and CDM are project-based mechanisms that allowed covered nations to reduce emissions in areas outside of the covered nation's boundaries (JI) and outside of the ETS boundary (CDM). These flexibility mechanisms are important because they have become models for similar mechanisms in other ETSs.

The International Emissions Trading (IET) mechanism allows covered entities to sell unused permits allocated to them previously. The ability to sell excess permits creates a new commodity in the form of emission reductions or “carbon,” therefore creating a carbon market (UNFCCC, 2014). The IET mechanism allowed the creation national and regional ETSs that could be used to help achieve emission reduction commitments.

The Clean Development Mechanism (CDM) is an offset mechanism, as it allows entities with an emission reduction commitment to offset emissions by creating an emission reduction project in a developing country (UNFCCC, 2014). CDM projects can include constructing renewable energy systems, retrofitting manufacturing equipment with more energy efficient technology, capturing and/or destroying GHGs, and fuel switching to lower emitting fuel (Brokers Carbon, 2010). When a covered entity develops an emissions reduction project in an approved developing country in accordance to CDM rules, additional permits are created and issued to the developer. These permits are called Certified Emission Reductions (CERs) or, less formally, “offsets.” These offsets can be applied to the developer’s emission reduction commitments or sold into the carbon market to any entity seeking to reduce emissions locally to meet the necessary quota. The CDM therefore allows developed countries to reduce emissions at low cost, even if the emissions are not in their home country (World Bank, 2014). It is important to note that while CERs are created in addition to the allowances issued by the UNFCCC, therefore increasing the amount of permits in the market, there are usually limits on how many CERs a covered entity can use to meet emission reduction requirements to promote local emission reductions.

The CDM creates a business incentive for third party project developers to create CDM projects in exchange for CER credits that can be sold to covered entities for a profit (Brokers Carbon, 2010). The mechanism has grown to achieve significant emission reductions in developing countries, in addition to directing investments to these countries to support sustainable low-carbon development (World Bank, 2014).

The Joint Implementation (JI) mechanism is similar to the CDM where covered entities can receive credits for reducing emissions offsite. Under the JI, entities can invest in emission reduction projects in other countries that are also covered under the Kyoto Protocol in order to receive reduction permits. Emissions reduction permits created under the JI mechanism are called Emission Reduction Units (ERU).

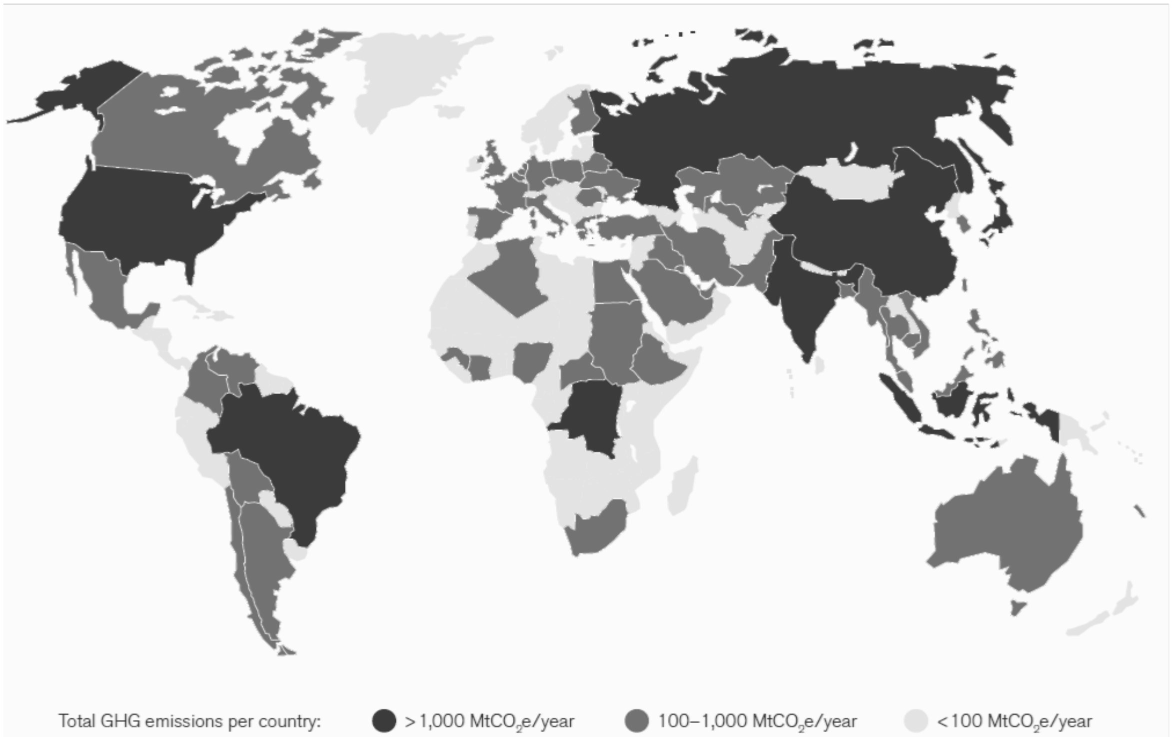
NEGOTIATIONS STALLED

As of April 2015 negotiations for further Kyoto Protocol implementation are essentially stalled. There are strong divisions among nations involved in the UN climate negotiations restricting further agreements or supplemental implementation plans.

One component of UNFCCC climate negotiations disagreement is the international disparity in GHG emissions. Global emissions are far from uniform among nations of the world. The ranges of the levels of emissions are diversified in location and the specific sectors causing the emissions. Figure 5 shows the differences in the levels of GHG emissions globally. There is little correlation between geographic location and GHG emissions. The figure illustrates that countries that emit less than 100MtCO$_2$e per year geographically neighbor countries that emit over 1,000 MtCO$_2$e per year. China's GHG emissions are over 1,000 MtCO$_2$e per year. China's neighboring country India has comparatively high emissions. Myanmar, Kazakhstan and Vietnam also neighbor China but emit 100-1,000 $MtCO_2e$ per year. Mongolia, North Korea and Nepal also neighbor China but emit less than 100 $MtCO_2e$ per year.

The differences in the amounts of emissions have created a divide between developing and developed countries. Developing countries argue that developed countries should have more commitments to reduce emissions because the developed countries have historically released more GHGs into the atmosphere and are therefore more responsible for climate change. The developing countries in part have been reticent to agree to binding emissions targets after 2020 until developed countries increase their level of ambition. Alternatively, developed countries want to see the negotiations create reduction targets for developing countries in order to not put developed economies at a clear disadvantage. This lack of ambition from both sides has slowed down the discussions on advancing any new international market based mechanisms to reduce emissions (World Bank, 2014). Such a drastic diversity of emissions internationally implies that international cooperation will be needed to take advantage of low-cost carbon control opportunities (World Bank, 2014).

Figure 5. Greenhouse Gas Emissions by Country



Source: World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www- wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014 /05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box3852 32.pdf

Adding to the difficulties of the UNFCCC negotiations is that there is an oversupply of the Kyoto credits. Linked to the lack of ambitions under the UNFCCC, the demand remains low for Kyoto credits. As it currently stands, the second commitment period of the Kyoto Protocol from 2013 - 2020, represents only 12 percent of global emissions (World Bank, 2014), well under the coverage necessary to prevent significant global temperature increases. In recent years the demand for credits from all three of the Kyoto flexibility mechanisms has declined. March 2014 had the lowest monthly CER issuance of the past three years. In addition there were also 10 percent fewer CDM projects (CER credits) registered in 2013 than in 2012 (World Bank, 2014).

A few major emitters, such as Australia, have removed themselves from the Kyoto Protocol so the demand has become more depressed. Japan, Russia and New Zealand have withdrawn from the second commitment period of the Kyoto Protocol but have stated they will continue their commitments towards reducing emissions. While trading is still permitted past 2014 there is little future trading expected unless significant adjustments are made to the current system (World Bank, 2014).

FUTURE UNFCCC MEETINGS

The Conference of the Parties (COP) are the annual meetings of the UNFCCC to discuss climate change. There is hope that the current issues with the Kyoto Protocol will be addressed during future meetings such as in Paris in 2015. The involved parties are being encouraged to submit post-2020 national mitigation "contributions" by the first quarter of 2015 in order to help achieve the milestone goal of agreeing to a binding resolution on global emissions at COP 21 in Paris scheduled for the end of 2015 (World Bank, 2014).

The future of climate change mitigation remains unclear. The political, economic and cultural challenge of controlling the release of GHGs into the atmosphere is encouraging a range of potential policy solutions that price and control GHG emissions. ETSs have been gaining attention as a policy mechanism to potentially reduce GHG emissions at low marginal cost to emitters. While there are hopes that the Kyoto issues can be solved, there is increasing evidence that the global trend of implementing ETSs is being directed towards increasing the strength of separate national and regional ETSs. These separate national and regional ETSs in principle could allow leaders to independently develop ETSs in order to fit the region specific situations. The next chapter will describe these national and regional ETSs and their various components.

CHAPTER II: GLOBAL OVERVIEW OF EMISSIONS TRADING SYSTEMS

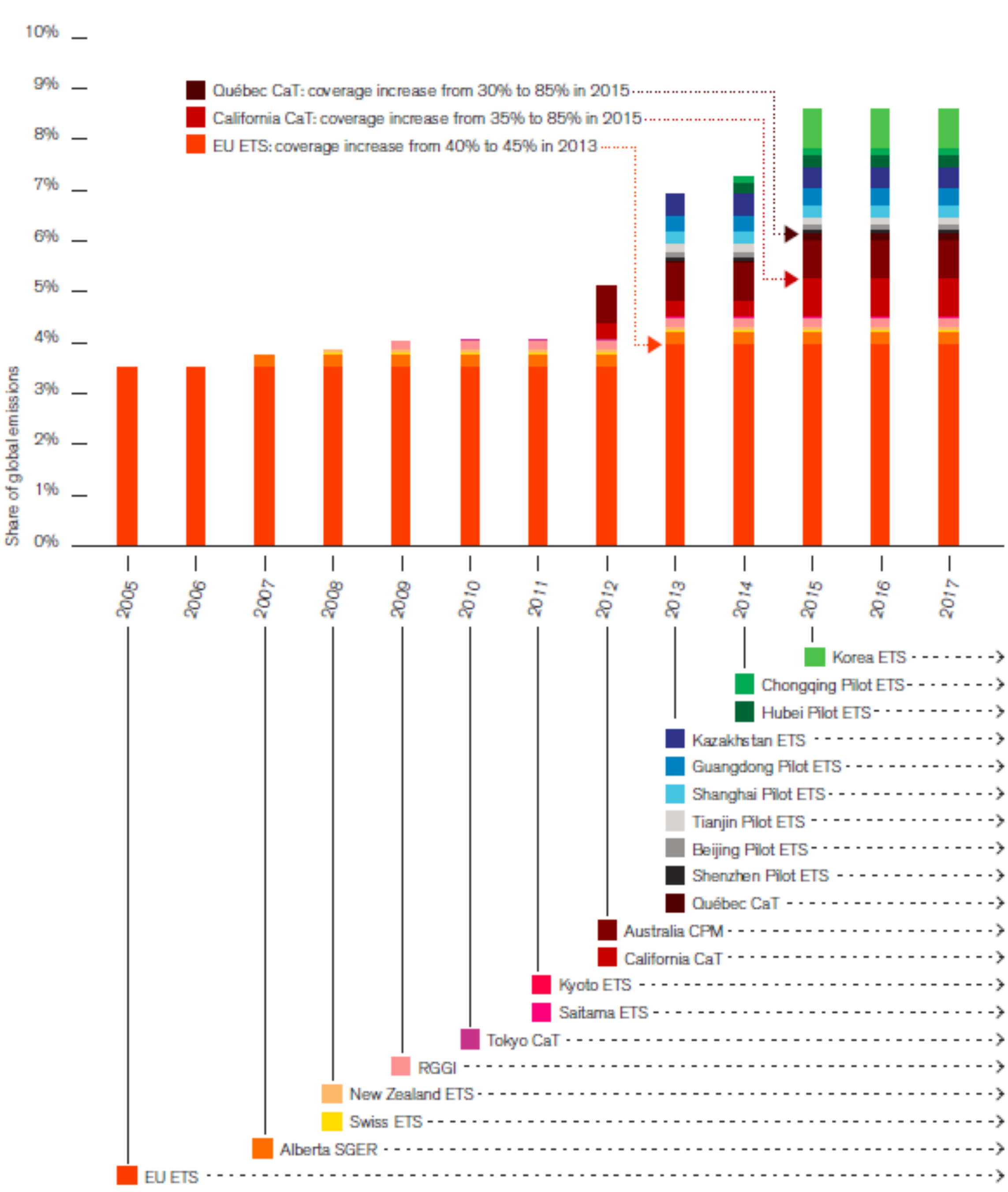
While the Kyoto Protocol sets limits on participating countries' GHG emissions, the Protocol does not define how emission reductions should be achieved. Many countries have developed federal, regional or state-run ETSs to reduce emissions to meet Kyoto Protocol reductions (Brohe, Eyre, & Howarth, 2009). In preparation for any possible level of mandatory emission reductions, many countries, states, regions and even businesses are also measuring and reducing their own emissions, based on their economy's most cost effective plan, so as to be prepared if an emissions cap is set.

This bottom-up development of ETSs is in contrast to the expectations of some policy-makers and analysts in the 1990s and early 2000's, who predicted that a global carbon market would come to fruition as a harmonized top-down system most likely led by the UNFCCC (World Bank, 2014). Each localized ETS has found that a bottom up development of an ETS has been more successful in finding region specific answers to questions like cap-setting, allocation, coverage and flexibility provisions (ICAP, 2014). The creation of localized ETSs is producing growing experience drawn from regions from diverse locations and levels of government around the world at different stages of development (World Bank, 2014). This experience of implementing carbon markets worldwide can potentially help to develop more robust and flexible future systems (World Bank, 2014).

The world's emissions trading systems are currently worth about $30 billion (World Bank, 2014). According to a report from Bloomberg New Energy Finance, the global carbon market could increase up to $246 billion by 2020 (McCrone, 2014). Emissions trading is gaining popularity as a global tool to reduce carbon emissions (World Bank, 2014).

From 2005 to 2015, the share of global emissions covered by ETSs has increased by more than 70 percent (World Bank, 2014). Figure 6 below shows the ETS share of global GHG emissions. The figure illustrates that the EUETS has been the dominant ETS covering at least 3 percent of total global emissions since 2005. The figure also illustrates that the start of the Chinese pilot programs in 2013 increased GHG coverage significantly. While there has been an increase in ETS coverage of GHGs, the share of all global emissions covered by ETSs remains about 7 percent (World Bank, 2014).

Figure 6. ETS Share of Global GHG Emissions



Source: World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box385232.pdf

Existing Emissions Trading Systems

Below is a short overview of existing emissions trading systems. Table 2 lists some of the definitions used to describe these ETSs.

Table 2. Global Overview of ETSs – Definitions

Allocation	The process in which emissions permits are divided and distributed to covered entities for the purpose of establishing a market. There are several methods for allocation including auctioning and free allocation (Michaelowa & Koch, 2001)
Auctioning	A method for distributing permits where permits are sold to the highest bidder
Backloading	A technique that has been designed to stabilize a carbon market by removing credits from the market in order to rerelease them into the market later
Banking	Saving permits in order to use them in the future, potentially in the next trading phase (Michaelowa & Koch, 2001)
Benchmarking	A way to set emissions targets and quotas based off of a determined average for the sector
Borrowing	When an entity is allowed to use permits from future phases in order to meet current obligations (Michaelowa & Koch, 2001)
Bottom-up Design	An ETS design where each individual nation or region creates its own ETS according to its own unique economic situation and then links systems together
Cap	The limit on the amount of permits released into a specific carbon market
Coverage	The determination of which sectors or entities meet the requirements of participating in an ETS and are therefore responsible for submitting permits for their emissions
Credits (Permits)	The individual units representing emission reductions that are bought and sold through the carbon market. Also referred to as Permits. (Brokers Carbon, 2010)
Free allocation	Usually a temporary measure that allocates permits to covered entities for free in order to introduce the concept of an ETS with as little resistance as possible
Global Warming Potential (GWP)	A measure of a specific gas's potential to add to global warming. CO_2 is often the standard measure that other gas's GWP are measured against
Grandfathering	A method of setting emissions quotas based off of the historic emissions of the covered entity
Linking	A linkage between ETSs occurs when permits from one system are eligible to be used in another system.
Market Stability Reserve	A backloading technique implemented by the European Union ETS

Table 2. (Continued) Global Overview of ETSs – Definitions

Offsets	A reduction of GHG emissions typically made offsite where reducing emissions is cheaper
Permits (Credits)	The individual units representing emission reductions that are bought and sold through the carbon market. Also referred to as credits (Brokers Carbon, 2010)
Phases	A predetermined set of time that an ETS sets specific deadlines and requirements for compliance. Splitting an ETS into phases allows any necessary adjustments to be made to the system
System	Refers to an emissions trading system
Soft Cap	When an ETS has a soft cap, it does not have limits on all the permits or offsets eligible for compliance
Synthetic GHGs	Manmade gases that contribute to global warming that do not occur in nature. Synthetic GHGs are usually a byproduct of certain industrial processes.
Top-down Design	An ETS design where a majority of global GHG emissions are covered by one predetermined trading system
Voluntary ETS	An ETS where entities join voluntarily to reduce emissions with the cost saving benefits of an ETS

Table 3 gives a brief summary of the existing ETSs including their operational details, strengths and weaknesses. These systems will be described in detail below.

Table 3. Existing Emissions Trading Systems

ETS	Operational Details	Strengths	Weaknesses
European Union **(EUETS)**	- Largest and longest running cap and trade system that covers 31 countries - Created in response to EU's emission reduction commitments under the Kyoto Protocol - Trading phases have been aligned to match Kyoto's phases	- Serves as a standard to compare all other systems too - Globally accounts for over 3/4 of the trading volume in international markets	- The system has been unable to cope with economic downturn in 2008 and is suffering from an oversupply of permits - The predefined supply of allowances is unable to adjust to macro-economic changes
Korea	- Designed to meet Korea's emission reduction target of 30% by 2020 - Covers 60% of GHG emissions including all six gases covered by Kyoto	- Multiple phases of the ETS allow market stabilization and allocation readjustments - Each phase has different offset and allocation requirements to allow for experimentation	- The industrial sector of Korea has been voicing opposition to the ETS which could impede the progress (IETA, 2013)
New Zealand	- Covers all 6 Kyoto gases with an overall coverage of 52% of emissions - Has a "soft cap" that allows unlimited international offsets	-The soft cap gives insight into linking ETSs	- Most covered entities have used low-priced international offsets instead of reducing emissions locally resulting in minimal local GHG reductions
Kazakhstan	- Originally based off of free allocation of permits but will start auctions in 2016	- Offers a unique look into how emissions trading can work in central Asia	- There have been difficulties collecting accurate emissions data at the installation level

Table 3. (Continued) Existing Emissions Trading Systems

ETS	Operational Details	Strengths	Weaknesses
Switzerland	-The system is mandatory for large energy intensive industries - Medium-sized industries can choose to opt in on a voluntary basis	- Allows CDM offsets but with restrictions to demonstrate other available forms of linkages	- Negotiations on linking with the EUETS have been ongoing but slow
Japan Joint Crediting Mechanism (JCM)	- Not necessarily an ETS but a unique crediting mechanism for the voluntary Japanese ETS. - Modeled after the CDM to offset credits in developing countries in exchange for technology transfer - Decentralized, bilateral agreements are formed with individual developing countries	- The separate bilateral agreements keep the mechanism simple and practical - Forgoes the complexities of the CDM design features - Flexible bilateral agreements are potentially easier to agree upon	- Simplification of the process drastically reduces the accuracy of measuring the emission reductions
Tokyo	- City-wide ETS - Created in response to the emission reduction commitments in 2010 as part of Japan's first mandatory ETS.	- While the ETS is not very large compared to national systems it holds the important role of adjusting Japanese industry to emissions trading	- Due to the shutdown of nuclear power the emission reduction targets are still considered a 3.1% increase above 1990 levels
Regional Greenhouse Gas Initiative (RGGI)	- A regional ETS covering nine US states - The ETS was reformed in Jan 2014 to reduce the cap on emissions	- RGGI is the first US ETS designed to mitigate climate change - The successful reforms are an example of a smaller system's flexibility	- Covers only CO_2 emissions - Uncertainty over if the emissions reductions in the region should be credited to RGGI or the decline in natural gas prices

Table 3. (Continued) Existing Emissions Trading Systems

ETS	Operational Details	Strengths	Weaknesses
California AB32	- Statewide cap and trade system as part of the Global Warming Solutions Act of 2006	- Valued at over $1 billion - Considered by many to be the start of a potential bottom-up system in the US	-Since there is not overarching national legislation, the state must commit extra resources to promote efficiency and prevent leakage in order to achieve true emission reductions (IETA, 2013)
Western Climate Initiative (WCI)	- An international cap and trade program between the US and Canada -Voluntary participation - The initial phase has focused on large scale emitters while the second will include smaller emissions sources	-Initially covered 70% of the Canadian economy and 20% of the US economy	- Most US states have formally left the WCI for economic and political reasons - The lack of participation shows the weakness of a voluntary system
Quebec	- Started as the key to Quebec's climate change policy.	- The ETS is a source of revenue to other parts in the province's overall Climate Change Action Plan - The ETS is expected to cover 86% of the province's emissions	- Most of Quebec's energy comes from hydropower leaving little room for emission reductions in the power sector (IETA, 2013)
Australia	- Originally planned to be a carbon tax that would have transferred into a nation ETS then link with international markets - The ETS has been removed due to a change of government	- Implemented new features such as emissions targets that adjust to a changing market - Originally set to be one of the most inclusive compliance based ETS	- Removal of the system shows vulnerabilities to changes in political leaders

EUROPEAN UNION EMISSIONS TRADING SYSTEM

The European Union Emissions Trading System (EUETS) is the best known, largest and longest running cap and trade arrangement, as it has been in place since 2005 and was created in response to the EU's emission reduction commitments under the Kyoto Protocol to reduce emissions by 2012 to 8 percent below 1990 levels. The EUETS covers 31 countries, 12,000 power and manufacturing plants, 46 percent of the region's emissions and 4.636 Mt of CO_2e (Watanabe & Robinson, 2005), or over 75 percent of the trading volume in international markets (Jegou & Hawkins, 2014). The EUETS has three planned phases. The first phase was a trial phase implemented from 2005-2007. The timeline of the second phase matched Kyoto's phase from 2008-2012. The third phase started in 2013 and will continue until 2020. Most recently the EU realigned the emission reduction goals to cut emissions 20 percent compared to 1990 levels over the third phase (IETA, 2014).

The EUETS has been unable to cope with the major economic downturn from 2008 to 2015, which has reduced confidence in the EUETS. The European system was created in 2005 and had predicted future emissions based on historic rates. However the 2008 economic crisis was not anticipated in its planning. The reduction of economic activity during the economic crisis resulted in unexpected low emissions within the EUETS and left a large supply of issued emissions allowances that covered entities did not need to use. The emission permit oversupply has grown to about the size of one annual emission budget for the EUETS (Gunter, 2014). The oversupply has lowered the prices of the permits so low that there is no longer an economic incentive to sell or buy permits, essentially disabling the foundational driver of an ETS (Grubb, 2009).

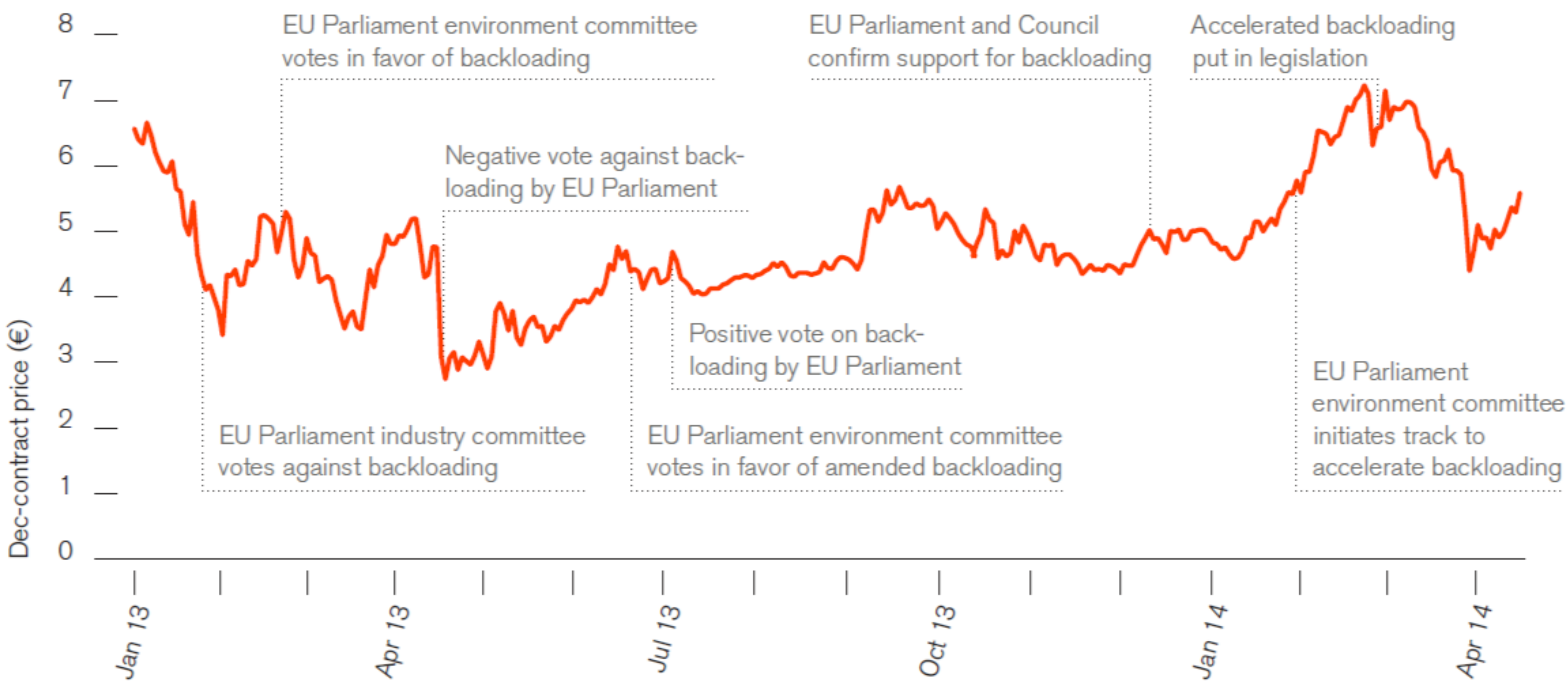
There was already strong volatility in the carbon market before 2008. When the ETS started, the allowance prices ranged from EUR 20-25/tCO_2 and peaked at EUR 30 (Grubb, 2009). In May 2006 the publication of emissions data from 2005 was posted that showed the emissions from the year were 5 percent below the allocated amount of allowances. Prices fell dramatically, declining more than EUR 10/tCO_2 over two days (Jegou & Rubini, 2011). From 2008 to 2009 the market became volatile; market prices dropped 75 percent from previous years to between EUR 8 to EUR 15 per credit (Brokers Carbon, 2011). The current allowance price as of April 2015 is EUR 7.33/tCO_2 (European Energy Exchange, 2015). The EUETS was the first trading system of this type in the world, so some volatility was expected, but not to this extent (Brokers Carbon, 2011).

Why did the price of carbon drop by 75 percent? The reduced emissions during the recession were one factor as a low carbon price during a recession is normal (Gunter, 2014). Another cause may have been the increase in renewable energy in the EU after 2005 (World Bank, 2014). No matter the cause of oversupply in permits, the EUETS failed to operate as planned; with an inflexible, predefined supply of allowances, the system was unable to adjust to macro-economic changes (World Bank, 2014).

Solutions to the oversupply have been a contentious issue for years and have ignited discussion on how or if the market should be adjusted. One EUETS proposal has been a 40 percent GHG reduction target increase for all of the EU countries below 1990 levels (World Bank, 2014). Other proposals are an increase in the rate of the annual cap reduction or requiring all emissions reductions to be achieved within the EU, without offsets outside of the EU (World Bank, 2014). Another proposal is an agreement for a EUETS market stability reserve to stabilize the market (World Bank, 2014).

A market stability reserve is comparable to the philosophy of “saving in a time of plenty to use in a time of shortage.” The reserve removes emission credits from a market to drive prices up. Saved credits can be released on a later date when the prices are hopefully higher. The European Parliament had been debating a vote to initiate a market stability reserve called the “backloading measure” that would postpone the auctioning of 900 million permits from 2013 - 2015 until 2019-2020 (Nichols, 2014). The debates have affected the price of the EU permits. Figure 7 shows the EUETS allowance price in relation to the European Parliament’s debates over the backloading measure. The figure illustrates that votes against backloading led the price of EUETS allowances to decrease, while steps taken by the European Parliament towards approving the backloading measure raised the EUETS price. After the vote’s initial failure, the European Parliament eventually approved the measure in 2013. The figure shows that the vote’s success has slightly increased the carbon price to EUR 5/tCO_2 (European Energy Exchange, 2014).

Figure 7. EUETS Allowance Price History



Source: World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box385232.pdf

KOREA

The republic of Korea has an emission reduction target designed to cut 30 percent of emissions (233 $MtCO_2e$) by 2020 (ICAP, 2014) through an emissions trading system that started in January 2015. The Korean ETS covers about 60 percent of GHG emissions including all six gases covered under the Kyoto agreement, either directly or indirectly. The ETS has multiple phases in order to allow market stabilization and allocation readjustment. Each of the phases includes different requirements on offsets (domestic only) and the amount of permits that will be allocated for free. The Korean ETS also allows the banking and borrowing of permits with a 10 percent limit (World Bank, 2014). According to the Korean Ministry of Environment, the country is currently on track to meet their reduction goals due to the Korean National GHG Emissions Reduction Roadmap 2020 (ICAP, 2014).

NEW ZEALAND

The New Zealand emissions trading system (NZETS) was created in 2008 and covers all 6 Kyoto Protocol gases, with an overall coverage of 52 percent of emissions (ICAP, 2014). The sectors covered include forestry, liquid fossil fuels, stationary energy, industrial processes, waste and synthetic GHGs. The NZETS is unique because it has a “soft cap” based on no limits to allowable international offsets. This program illustrates links among international ETSs. Due to the record low prices of international credits, most covered sectors in the NZETS have opted to use a majority of international offsets to meet quotas. This international reliance on offsets led to little actual domestic reductions, as there is no financial incentive to avoid emissions locally when inexpensive international offsets can be purchased (World Bank, 2014).

Kazakhstan

The Kazakhstan ETS (KAZ ETS) started with a pilot program in 2013. It allowed 100 percent free allocation of credits based on historical emissions. Currently banking, borrowing and international credits are not allowed. The ETS design includes plans to start auctioning and benchmarking permits in 2016. Kazakhstan has had issues related to collecting accurate emissions data at the installation level (ICAP, 2014).

Switzerland

The Swiss Emissions Trading System covers 55 companies from 25 business sectors (World Bank, 2014). The system was voluntary in 2008 and became mandatory in 2013 for large energy intensive industries (>20MW thermal input and other specific thresholds). Medium-sized industries (>10MW) can choose to opt in on a voluntary basis (ICAP, 2014). Switzerland's ETS allows CDM offsets with restrictions. Negotiations linking the Swiss ETS with the EUETS have been ongoing at a slow pace.

Japan - Joint Crediting Offset Mechanism

Japan is not participating in the second commitment period of the Kyoto Protocol but the country still aims to reduce emissions to target levels (ICAP, 2014). During the 19th Conference of Parties in Warsaw, Poland in 2013, Japan announced an emission reduction target of 3.8 percent below 2005 levels by the year 2020, a volume considered an emissions increase of 3.1 percent above 1990 levels (ICAP, 2014). The reason for the commitment above 1990, as opposed to below, reflects the shutdown of nuclear energy in Japan after the Fukushima incident in 2011. Japan has had a voluntary ETS since 2005 set up by the Ministry of Environment as a means to reduce GHG emissions and meet these reduction targets (ICAP, 2014).

While Japan does not have a national compliance ETS, its Joint Crediting Offset Mechanism (JCM) allows the voluntary emissions that can offset credits, modeled after the CDM. Through the JCM, Japan allows offset emissions in select developing nations. Participating Japanese entities can purchase the reduction credits to meet voluntary emissions goals. The JCM uses a decentralized structure, so Japan has created separate bilateral agreements with each participating nation to suit the specific circumstance of each developing country to keep the mechanism simple and practical. The overall crediting mechanism forgoes many of the complexities that slow the functioning of the CDM, as the JCM focuses on simplicity and the practicality of implementation. While this method may sacrifice accuracy, its ease of implementation should help program implementation. Bilateral agreements can be designed for any developing nation, improving political flexibility. Twelve nations have signed bilateral agreements with Japan to reduce local emissions locally in exchange for Japanese technology transfer: Mongolia, Bangladesh, Ethiopia, Kenya, Maldives, Vietnam, Laos, Indonesia, Costa Rica, Palau, Cambodia, and India (MOE, 2013).

TOKYO

The Tokyo ETS was created in response to Japanese emission reduction commitments in 2010 as Japan's first mandatory ETS. The ETS regulates commercial and industrial GHGs in large Tokyo buildings, representing about 18 percent of municipal emissions (ICAP, 2014). The ETS allows restricted domestic offsets, grandfathering and banking, but not borrowing (ICAP, 2014). The Tokyo

ETS is not large compared to national ETSs but it represents an example of how the Japanese industry adjusts to emissions trading (World Bank, 2014).

United States

The US is the second largest emitter of GHGs (Brohe, Eyre, & Howarth, 2009). The country has around 4 percent of the world population but was responsible for more than 13 percent of global GHG emissions in 2011 (WRI, 2015). If US emissions were measured and included in a national ETS, it would be three times the size of the EUETS (Brohe, Eyre, & Howarth, 2009). Before the announcement of China's national ETS, a US ETS had the potential to be the largest emissions trading system in the world (Brokers Carbon, 2011).

While the US does not have a national ETS, it remains a focus regarding climate change and emissions trading because any decision to limit GHGs in the United States would reduce emissions globally and could inspire creation of other ETSs (Brokers Carbon, 2011).

The United States has had an interesting history in regards to emissions trading. The US Congress passed the Acid Rain Program of 1990 (Title IV of the 1990 Clean Air Act Amendments). As initiated by the US congress and implemented by the US Environmental Protection Agency (EPA), the acid rain system allowed market-based emissions trading to reduce sulfur dioxide and nitrogen dioxide emissions from power plants, a cause of acid rain (Chestnut & Mills, 2005). The EPA claims that the Acid Rain Program has reduced targeted emissions by 80 percent from 1990 levels from what they would have been without the program (Chestnut & Mills, 2005). The program is generally considered a success and an example of how emissions trading can reduce emissions cost efficiently with minimal negative consequences in the covered economy.

The Acid Rain Program can be used as an example of a successful ETS in the US. However there are differences between the Acid Rain Program and an ETS seeking to mitigate climate change. Carbon reduction may require shifts in energy use, while for acid rain and other airborne pollutants such as ozone depleting substances, there are often alternatives to the substances that are being used (Victor, 2011).

Following the success of the Acid Rain program, Senator Henry Waxman introduced the American Clean Energy and Security Act in 2009. The bill passed in the House but failed in the Senate. One analyst argued that though the bill failed in the Senate based on arguments over the ETS's potential damages to the US economy and concerns over nations such as China not being limited by their GHG emissions (Victor, 2011).

Some domestic pressure may develop in the US towards limiting GHG emissions. In 2012, the US experienced both the warmest year on record and the second most extreme weather events in a year on record (Foderaro, 2014). On September 21, 2014 more than 400,000 people protested in what has been called the People's Climate March in New York City as a show of support for action against climate change by surrounding the United Nations Climate Summit that same week (Foderaro, 2014).

In the summer of 2014, the US EPA released a draft Clean Power Plan, the Plan proposed regulation to reduce 30 percent of carbon emissions from US power plants by the year 2030. The Plan limits carbon emissions from both new power plants and existing power plants. Although the Plan does not set up an ETS, it allows states to select means to limit emissions, with an ETS as one option. Other options for reducing emissions include installing more energy efficient technologies or switching fuel sources away from older coal-fired power plants. EPA has asked US states to submit plans to limit emissions by 2016 so that plans could be enacted by 2020 (US White House, 2014).

REGIONAL GREENHOUSE GAS INITIATIVE

The Regional Greenhouse Gas Initiative (RGGI) is a regional market-based GHG reduction program covering CO_2 emissions from power plants in nine US states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont. New Jersey was originally part of the program but withdrew in 2011 (Bifera, 2013). The RGGI was the first US ETS designed to mitigate climate change and covers 22 percent of CO_2 emissions from the region (ICAP, 2014). Domestic offsets can be used to offset 3.3 percent of emission requirements. If prices exceed a certain amount in a year, the offset limit will be increased to 10 percent (Brohe, Eyre, & Howarth, 2009). Some analysts have estimated that RGGI has prevented 12 million tons of emissions from reaching the atmosphere since its first auction in 2008, which equates to a 30 percent reduction in the regional power sector's emissions (Maracci, 2013a).

The RGGI was founded in 2003 but the first compliance period started in 2009. In its initial stages the program did not lower the cap on emissions because the initial goal of the program was to measure and control emissions accurately and later reduce the cap six years after the program's start. Originally the initiative planned to reduce the cap by 2.5 percent each year between 2015 and 2018 (Brohe, Eyre, & Howarth, 2009).

The RGGI states recently made a successful change to their initial rules in order to avoid an oversupply of permits. In January 2014, the states had completed revisions to state CO_2 budget trading programs and found that the RGGI cap was too high. As the high cap had the potential to create a permit oversupply, the states decided to reduce the cap. The new cap is a 45 percent reduction from the previous cap and is now set at 91 million tons of CO_2. Each year, the cap will decline 2.5 percent until the year 2020 (World Bank, 2014). RGGI's success in changing the system's initial rules is an example of the benefits of a smaller, more flexible system. (Maracci, 2013a).

CALIFORNIA AB32

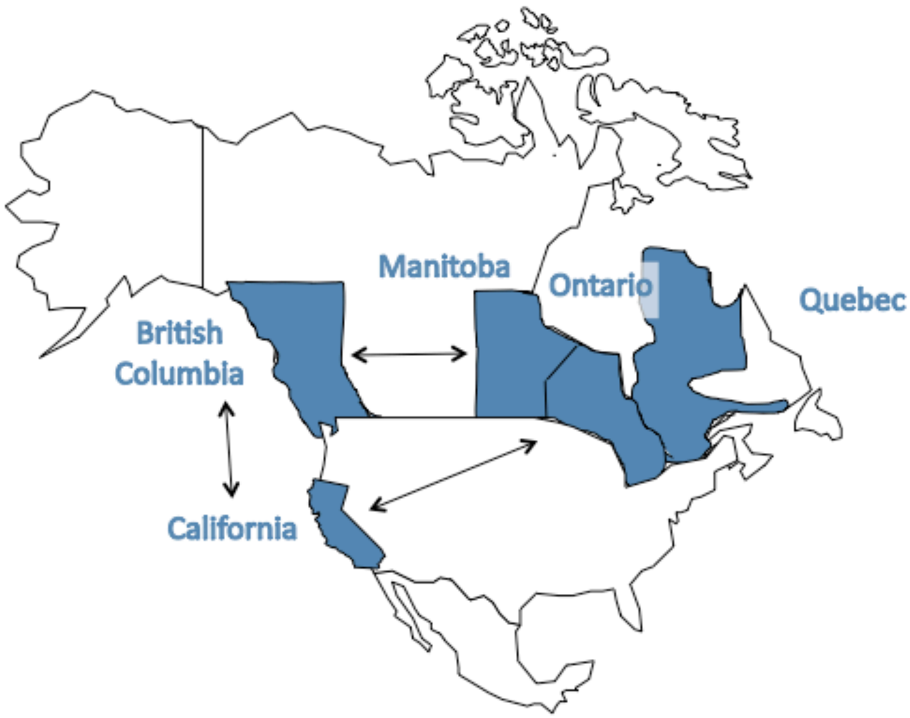
The California Assembly Bill 32 (AB32) passed a statewide cap and trade system, valued at over $1 billion, as part of the Global Warming Solutions Act of 2006 that targets facilities with emissions of over 25,000 tons of CO_2 per year. The California ETS was created with the goal of reducing CO_2 emissions to 1990 levels by 2020. Trial auctions began in 2012. Enforcement of emissions limits started on January 1, 2013 for large industrial facilities and electricity generation plants (California Air Resources Board, 2006). The cap started declining 3 percent each year from the start. During phase one (2013-2014), only electricity generation plants and industrial sources were included resulting in coverage of 15 percent of California's emissions. During the second phase starting in 2015, natural gas plants and transportation fuels will be included. AB32 plans to link to Quebec's market under the WCI which will increase the overall market by 20 percent (Maracci, 2013b).

WESTERN CLIMATE INITIATIVE

The Western Climate Initiative (WCI) is a bilateral cap and trade program between the U.S. and Canada designed to reduce GHG emissions in the participating states and provinces to 15 percent below 2005 levels by 2020 (Western Climate Initiative, 2013). The initial partner US states include Arizona, California, Montana, New Mexico, Oregon, Utah and Washington, which constitute 20 percent of the U.S. economy (Western Climate Initiative, 2010). Canadian province partners included British Columbia, Manitoba, Ontario and Quebec, which constitute 70 percent of the Canadian economy (Western Climate Initiative, 2010). On November 18, 2011 Arizona, Montana, New Mexico, Oregon, Utah and Washington left the WCI due to economic concerns and changes in political leadership (World Bank, 2014). This lack of participation shows the weakness of a voluntary cap-and-trade system.

The first phase began on January 1, 2012 and focused on large-scale industries where emission measurement systems were already in place, including electricity plants, electricity imports and industrial combustion sites (Western Climate Initiative, 2010). The second phase is planned to begin in 2015 and will include smaller emission sources such as transportation fuels, residential buildings, and remaining commercial emission sites that were not covered in the initial phase. Figure 8 shows the current state of the WCI with arrows representing potential linkages. The remaining participants in the WCI are California, British Columbia, Manitoba, Ontario and Quebec. Figure 8 illustrates the linkages being considered between California and British Columbia, California and Ontario, and Manitoba and British Columbia (Western Climate Initiative, 2010).

Figure 8. Western Climate Initiative



QUEBEC

Quebec started a cap and trade ETS in January 2013 as a source of revenue to other areas of the province's overall Climate Change Action Plan. The ETS covers 29.4 percent of the province's emissions and has linked with the California ETS in 2014 as part of the Western Climate Initiative. The 2015 coverage is expected to cover up to 86 percent of Quebec's emissions (World Bank, 2014).

AUSTRALIA

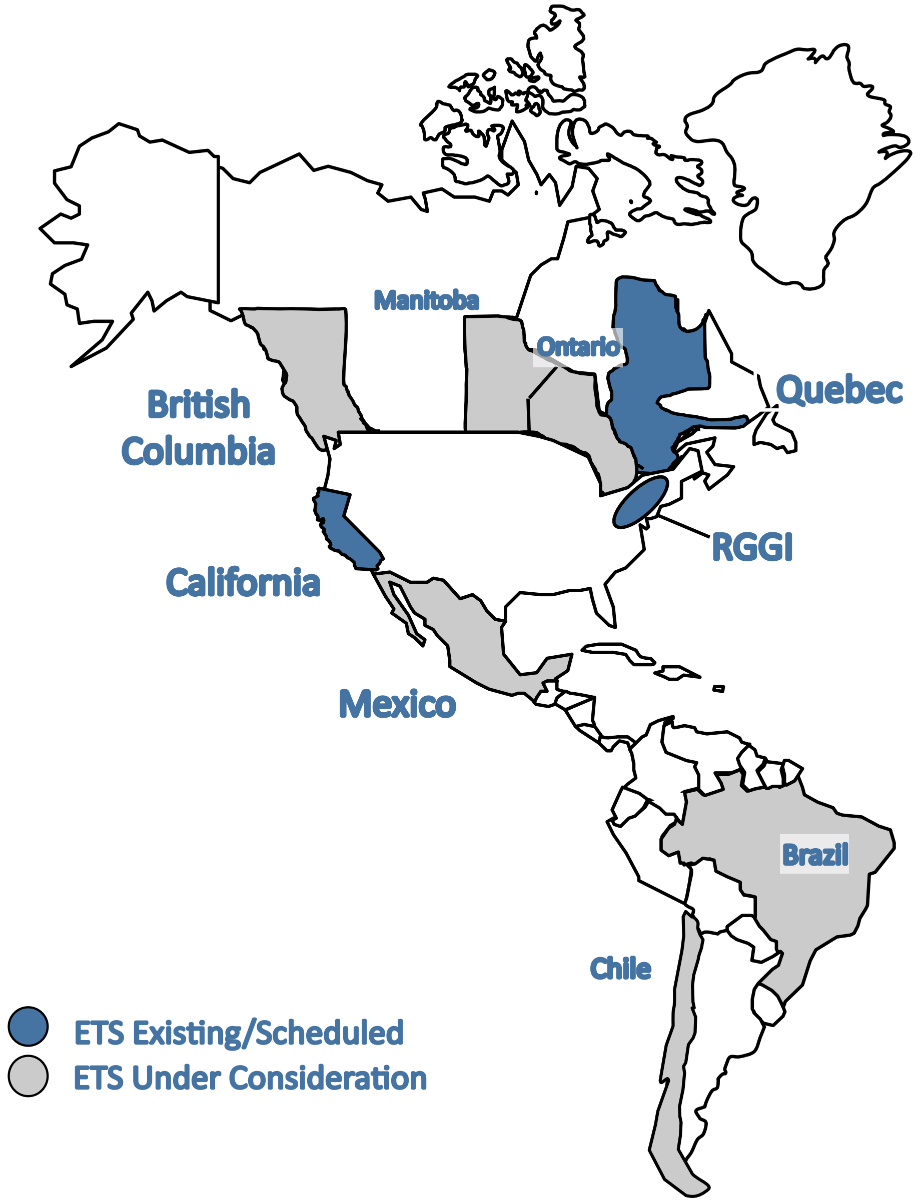
Australia had planned an ETS but a change of government resulted in a cancellation of the plan. The Carbon Pollution Reduction System (CPRS) had used lessons learned from past ETSs and implemented new features such as emissions targets that adjust to a changing market. The initial carbon tax would have transferred into a national ETS and then eventually link with other international markets such as the EUETS. The Australian ETS included 70-80 percent of Australian emissions (Brokers Carbon, 2011).

Australia's planned price on carbon has been a topic of debate in the country. In July 2014 the Australian senate voted to remove the existing carbon tax and the planned emissions trading system. The country still has an announced commitment to reduce emissions by 5 percent compared with year 2000 levels by the year 2020, but without the ETS there is not a strong plan to achieve these goals. Australia will still retain its Clean Energy Finance Corporation, a $10 billion government-backed loan agency to help shift electricity targets to renewable sources (Siegel, 2014).

EMERGING ETSS

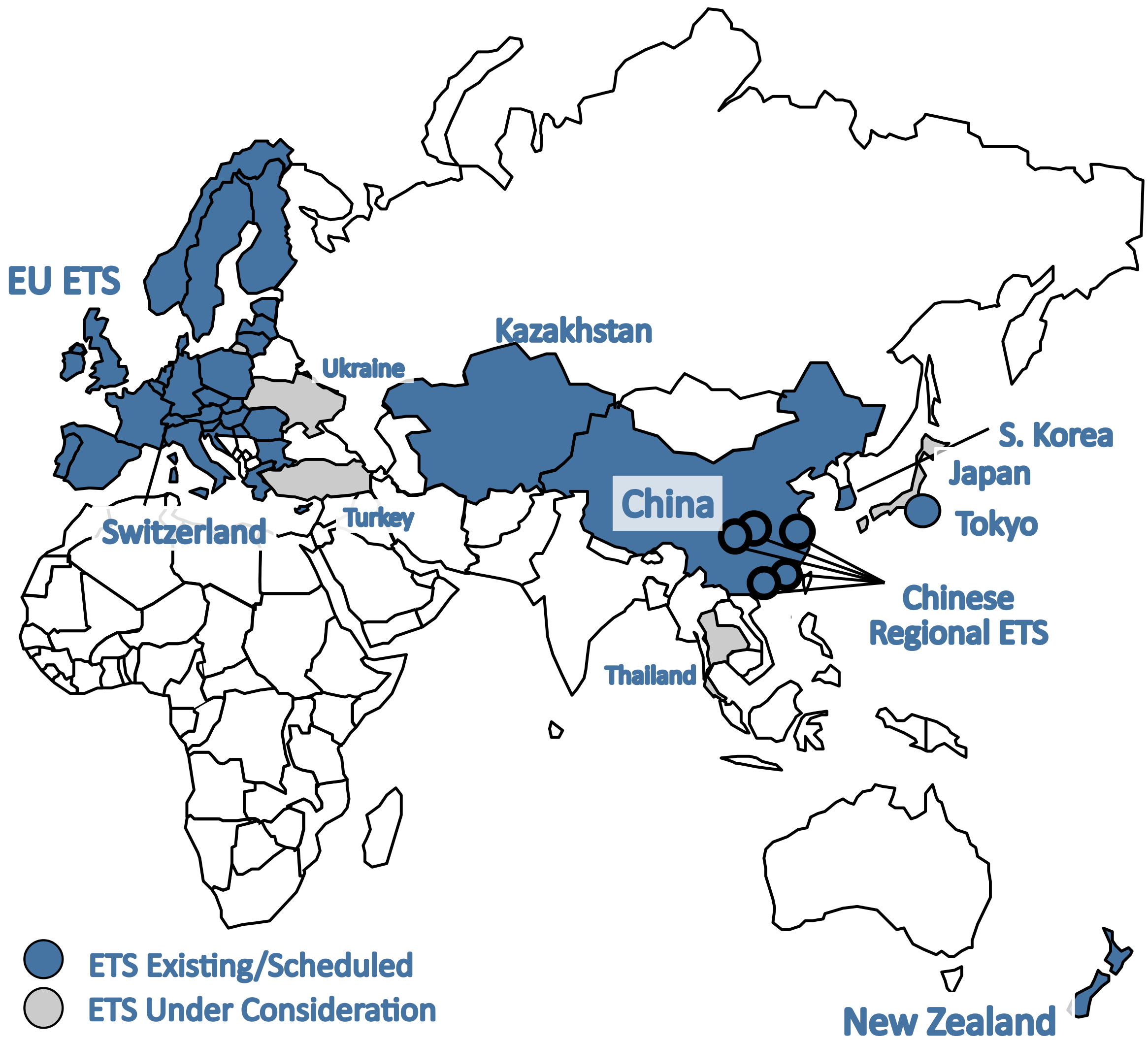
There are a number of emerging ETSs that are under discussion or consideration. Possible future emissions trading systems and crediting approaches include: British Columbia, Manitoba, Ontario, Mexico, Brazil, Chile, Japan, Thailand, Turkey and the Ukraine (World Bank, 2014). Figures 9 and 10 illustrate the existing ETSs described as well as the ETSs under consideration.

Figure 9. Existing and Considered ETSs – Western Hemisphere



Information Compiled From:
1) International Carbon Action Partnership (ICAP) (2014): *Emissions Trading Worldwide Status Report 2014*. Retrieved from https://icapcarbonaction.com/news/news-archive/209-emissions-trading-worldwide-icap-status-report-2014
2) World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box385232.pdf

Figure 10. Existing and Considered ETSs – Eastern Hemisphere



Information Compiled From:

1) International Carbon Action Partnership (ICAP) (2014): *Emissions Trading Worldwide Status Report 2014*. Retrieved from https://icapcarbonaction.com/news/news-archive/209-emissions-trading-worldwide-icap-status-report-2014

2) World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box385232.pdf

Emissions Trading System Components

There are a number of components that are common to ETSs but can vary amongst systems including coverage, leakage, allocation/issuance, registries, penalties for noncompliance, temporal flexibility including borrowing and banking, new entrants, offsets, additionality, monitoring reporting and verification (MRV), permanence and double counting. Table 4 lists these items and their definitions.

Table 4. ETS Components - Definitions

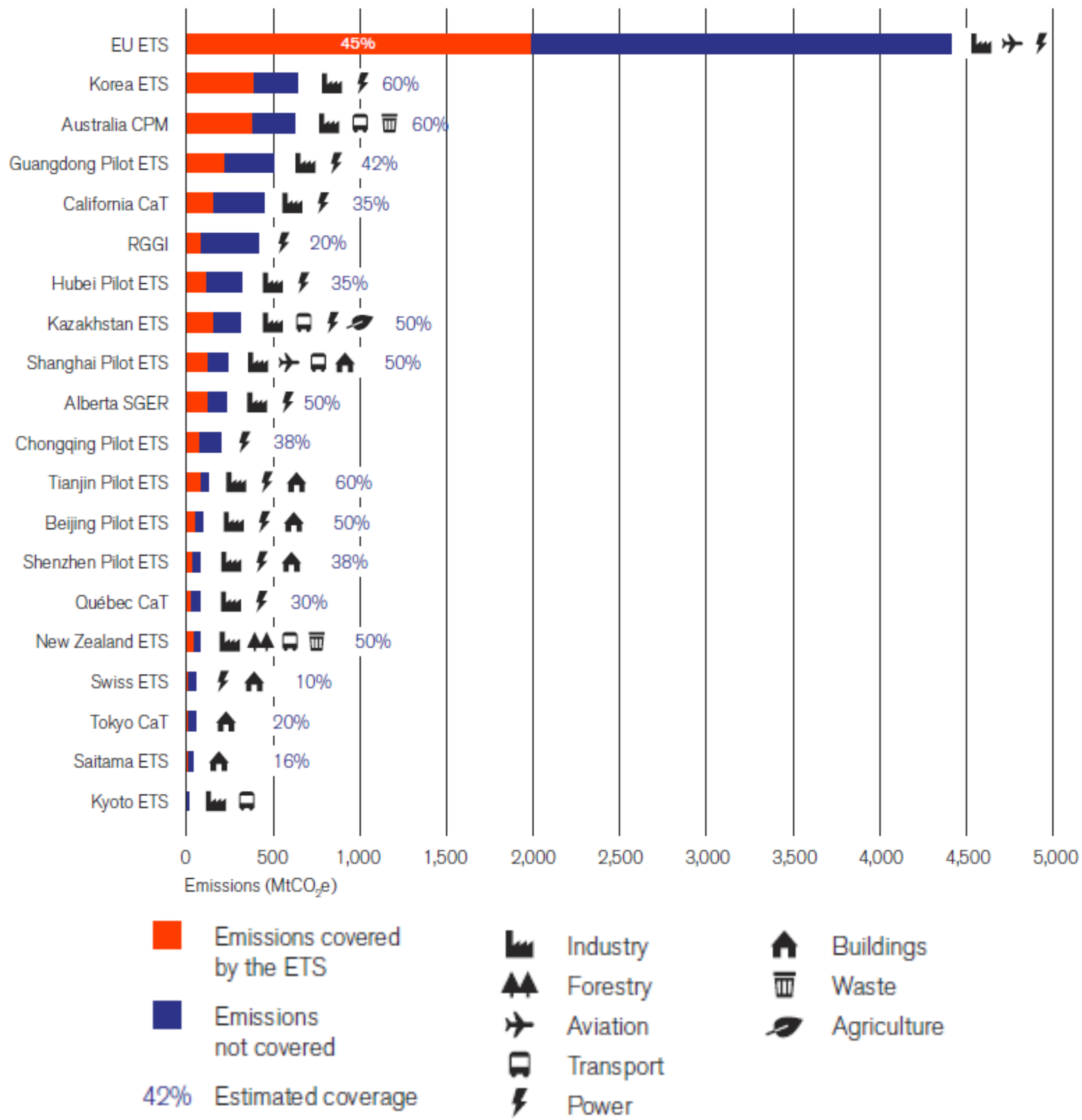
Additionality	A measure to ensure that the emissions reductions from a project would not have happened without the additional funding of the sale of emissions permits
Allocation	The process in which emissions permits are divided and distributed to covered entities for the purpose of establishing a market. There are several methods for allocation including auctioning and free allocation (Michaelowa & Koch, 2001)
Banking	Saving permits in order to use them in the future, potentially in the next trading phase (Michaelowa & Koch, 2001)
Borrowing	When an entity is allowed to use permits from future phases in order to meet current obligations (Michaelowa & Koch, 2001)
Coverage	The determination of which sectors or entities meet the requirements of participating in an ETS and are therefore responsible for submitting permits for their emissions
Double Counting	An issue that can occur if the same emission reductions are accounted for more than once
Leakage	Leakage occurs when a polluting industry moves from a region covered by an ETS to an area that is not covered in order to avoid paying for emissions
Monitoring, Reporting and Verification (MRV)	A process that ensures that permanent emissions reductions are actually occurring through a emission reduction project
New Entrants	A firm that is covered under an ETS but was not previously covered
Noncompliance	Noncompliance occurs when an entity fails to fulfill emission reduction requirements (Michaelowa & Koch, 2001). A penalty is usually assigned in addition to the added burden of having to submit the missing permits during the following year (Jegou & Rubini, 2011).
Offsets	A reduction of GHG emissions typically made offsite where reducing emissions is cheaper
Permanence	A requirement to ensure that emission reductions are permanent
Registries	Digital inventories of credits set up to track the allocation and trading of the permits (Brokers Carbon, 2011)
Temporal Flexibility	Temporal flexibility allows covered entities to make use of permits issued in the past or future phases of an ETS as opposed to only using the permits issued as part of the current phase.

COVERAGE

The term ‘coverage’ of an ETS can refer to the sectors of the area’s economy that are responsible for submitting permits for emissions. Figure 11 illustrates sectors commonly covered including industry, power, buildings, waste, transport, aviation, forestry, and agriculture. Stationary sources of GHG emissions such as power, industry and buildings are commonly covered. Figure 11 illustrates that almost every ETS covers at least one of these sectors. Forestry, agriculture, aviation, transport and waste sectors are not covered in nearly as many systems. For example, aviation is only covered in the EU ETS and the Shanghai ETS: forestry is only covered in the New Zealand ETS and agriculture is only covered in the Kazakhstan ETS. Difficulties in measuring emissions and determining if entities are eligible for the system make these sectors more difficult to include in an ETS.

Coverage can also refer to the specific GHGs covered by an ETS. While CO_2 is the most frequent GHG, other gases that affect climate change can be covered such as methane (CH_4) or industrial gases such as nitrous oxide (N_2O) and perfluorocarbons (PFCs). ETS coverage will vary depending on each region's GHG emission situation. The coverage of more sectors or GHGs does not necessarily make an ETS more efficient at reducing GHGs. Coverage of more gases can provide more abatement options, which may decrease overall mitigation costs (ICAP, 2014).

Figure 11. Sectoral Coverage of Regional, National, and Subnational ETSs



Source: World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box385232.pdf

LEAKAGE

Leakage describes a problem related to coverage that occurs when a polluting industry moves to avoid paying for emissions from a region covered by an ETS to a region not covered. When leakage occurs, fewer net emissions are reduced from the atmosphere. To avoid leakage issues, an ETS governing body may investigate firms more. If it is determined that a covered entity shifts polluting operations outside of the range of the ETS, some nations may issue a percentage of permits free of charge which could reduce the compliance costs for covered entities (ICAP, 2014).

ALLOCATION/ISSUANCE

The allocation of emissions permits may occur through either an auction system or through the free allocation of permits. Free allocation is usually a temporary measure. Some ETSs start with the free allocation of emissions to introduce the ETS with little resistance from covered entities before auctioning permits (Jegou & Rubini, 2011).

REGISTRIES

Digital registries track the allocation or trades of issued permits or credits. Buying and selling credits is similar to buying and selling shares in a stock market. Credits can be registered in an official registry that accounts and traces exchanges of credits because no physical asset changes hands (Brokers Carbon, 2011). Registries are not always restricted to only entities covered under an ETS. Third parties can sometimes purchase permits from the market registries in order to retire credits or remove the credits from the market, as they will not have any value because they are essentially erased. If an environmental organization or another government were to buy credits and then retire them to remove them from the market, such an action could stop GHGs from being emitted into the atmosphere and may raise the price on remaining credits.

Penalties for noncompliance

If an entity fails to submit the appropriate amount of permits at the required time, a penalty is usually assigned in the form of a fee and the entity may be required to submit missing permits during the following phase (Jegou & Rubini, 2011). This ensures that emission reductions will still be taking place, by preventing a covered entity from deciding to pay the fine instead of reducing emissions.

Temporal Flexibility

Banking or borrowing permits are types of temporal flexibility that allow a covered entity to make use of permits issued in the past or future phases of an emissions trading system, as opposed to only being able to use permits issued in the current phase.

Borrowing

Borrowing permits allows a covered entity to use permits from future phases in order to cover any possible permit shortages of the entity in a current phase (Michaelowa & Koch, 2001). If permits are borrowed, less permits will be issued the following year, so risk is involved. Borrowing is possible when an ETS issues permits for the next year before the submission deadline for the current year. Allowing borrowing can be attractive in the design of an ETS because this helps control excess demand for permits around the submission date which could cause distortions in the permit price and overall market (Heindl and Loschel, 2012).

Banking

Banking of permits allows an entity to save unused permits for future use (Michaelowa & Koch, 2001). This rule would be prevent a “use it or lose it” mentality, where a covered firm would continue polluting even when it may not be necessary to avoid having to complete the polluting task in the future when permits are less available (Jegou & Rubini, 2014). Entities would benefit from banking permits if there were forecasts that permit prices would rise in the future so that they could later sell the permits for a profit. The covered entity might also want to bank permits as insurance for the future to avoid having to buy additional permits at a high price. A concern with banking is if there could be an unforeseen situation that creates an oversupply of permits in the market such as the current situation within the EUETS. The oversupply or any other distortion could continue to be an issue in future phases (Jegou & Rubini, 2014).

New Entrants

There is usually a reserve of credits set aside under the rules of the ETS for new entities that should be covered but did not exist at the start of the ETS and therefore were not able to have the benefit of receiving free allowances when the ETS started. The reason for the reserve is that without free allowances for new entities, the cost of starting a new firm would be much higher than the existing firms paid before the ETS. This situation could effectively rule out competition for existing firms.

Offsets

An offset is a reduction of GHG emissions typically made offsite where reducing emissions is cheaper. An entity covered under an ETS could pay to reduce emissions offsite while receiving credits in return that could then be used to meet permit requirements. An offset is allowed because the effects of GHGs are global and do not depend on the source of emissions, so reducing emissions is not dependent on location. An example could be described through a power plant covered by an ETS. If the covered power plant is equipped with advanced technology and costs were very high to reduce emissions locally, the plant could pay for another power plant outside of the ETS to reduce emissions (depending on the ETS offsetting rules). In exchange, the covered plant could receive permits for the GHG reductions that it would then be able to use to meet the GHG reduction quota.

The ability to offset emissions creates opportunities for ETSs to link, promote technology transfer and enable sustainable development in nations not within the ETS. Offsets can reduce inequalities of emission commitments and responsibilities if a global emissions trading system is adopted.

Additionality

Additionality is a measure to ensure that the emission reductions from a project would not have happened without the additional funding from the sale of emissions permits. If an energy efficiency project would have occurred because of price savings without the assistance from the sale of the resulting carbon credits, no actual emissions were avoided, a process that could undermine the purpose of emissions trading (Brokers Carbon, 2011).

Monitoring, Reporting and Verification

Monitoring, Reporting and Verification (MRV) are processes that verify that an offset project is meeting its goal of reducing net emissions. A third party auditor and the governing body that originally approved the project will usually review project records to confirm that emission reductions are taking place (Michaelowa & Koch, 2001). MRV is considered a critical component to offset projects. Any mistakes in the MRV procedure will undermine the entire project because actual emissions or emissions reductions may not be taking place (Brokers Carbon, 2011).

Permanence

Permanence is a requirement of offset projects to ensure that any emission reductions are permanent. If an offset project avoids emissions for a temporary amount of time only to release the emissions into the atmosphere years later, the emissions reduction would not be valid. The ETS would only be temporarily successful in delaying the long-term effects of climate change. This situation will essentially defeat the purpose of the emission reduction project.

Permanence requirements can be a deciding factor in creating certain types of offset projects that capture and store CO_2 from the atmosphere. Proving that emissions are still stored in a carbon sink requires expensive monitoring that may not be feasible especially without a set project end date. Validation of permanent reductions is a concern constraining the development of a type of credit. For example, should landowners of forested areas receive carbon credits for CO_2 that a forested area naturally sequesters from the atmosphere? If a plot of trees is awarded credits for removing CO_2 from the atmosphere, but are cut down years later to release the captured CO_2, permanent emission reductions have not actually occurred.

Double Counting

Double counting is a situation that occurs when the same emission reductions are accounted for more than once. For example, if an offset project prevents 100 tons of CO_2 and is awarded 100 credits from one carbon credit market such as Kyoto CER credits, and then the same entity is also awarded 100 separate carbon credits from another local or regional system, 200 carbon credits would be issued that account for only 100 tons of actual emission reductions. This situation should invalidate half of the total credits, or it could be said that each credit is only half valid. Emission reductions have then been accounted for and paid for while the credits in the market do not actually represent reduced CO_2 in the atmosphere. This situation produces more permits in the market than actual emission reductions, which could undermine the market if the permits do not measure emission reductions.

The development of independent regional and national ETSs allows each system to adjust various components of their ETSs in order to fit the region specific situation. Linking these independent systems by allowing permits to trade freely among ETSs is being considered to potentially increase the effectiveness of reducing GHG emissions and increase the odds that emissions reductions will occur where the cost is the lowest. There may be the potential to create a set of coordinated ETSs to avoid climate change if enough independent systems are linked. The next chapter will describe the types of linkages as well as the benefits and challenges associated with linking ETSs.

CHAPTER III: LINKING EMISSIONS TRADING SYSTEMS

When the UNFCCC created the Kyoto Protocol, some analysts imagined an international emissions trading system designed from the 'top-down,' where a majority of global GHG emissions would be covered by one system for trading carbon permits (Hovi, Sprinz, & Underdal, 2014). Since Kyoto, some professionals consider the top-down approach to be unworkable (Hovi, Sprinz, & Underdal, 2014). More nations seem to be moving towards a 'bottom-up' design where each nation or trading bloc creates its own ETS according to its own unique economic situation (Hovi, Sprinz, & Underdal, 2014). When national or regional ETSs are developed, they could potentially connect or link, by allowing permits to trade freely among ETSs. Table 5 lists some of the definitions used to describe linked ETSs.

Table 5. Linking ETSs - Definitions

Allocation	The process in which the total amount of emissions permits allowed within the ETS are distributed to the covered entities (Yamin, 2005)
Emission Reduction Goals	Predetermined targets for lower GHG emissions that ETSs are designed to help achieve
Monitoring, Reporting and Verification (MRV)	The process that ensures that permanent emissions reductions are actually occurring through an emissions reduction project
Noncompliance	Noncompliance is when an entity fails to fulfill emission reduction requirements (Michaelowa & Koch, 2001). In which case, a penalty is usually assigned in addition to the added burden of having to submit the missing permits during the following year (Jegou & Rubini, 2011)
Offsets	A reduction of GHG emissions typically made offsite where reducing emissions is cheaper
Phases	A predetermined set of time that an ETS sets specific deadlines and requirements for compliance. Splitting an ETS into phases allows any necessary adjustments to be made to the system
Registries	Digital registries of credits that are set up to track the allocation and trading of permits (Brokers Carbon, 2011)
Soft Cap	When an ETS has a soft cap, it does not have limits on all the permits or offsets eligible for compliance

The system of GHG reduction may become a set of coordinated ETSs to avoid climate change. Some political leaders may wait for the outcomes of the Paris 2015 COP meeting to determine if the UNFCCC can be successful in creating an effective binding treaty. Other leaders are more proactive designing their national ETSs in a form that can be linked to other ETSs as linking becomes feasible, as discussed below.

Linking ETSs has considerable benefits as listed in Table 6. Linking ETSs can stabilize prices by increasing the size of the market, increase economic and cost efficiency, and reduce the risk of carbon leakage (Jegou & Hawkins, 2014), at reduced costs. When the available abatement opportunities are increased through linking, the emission reductions can take place where the cost is the lowest, thereby increasing the ETS effectiveness (Mehling & Haites, 2009). Table 6 gives a brief overview of the benefits and risks associated with linking ETSs.

Table 6. Overview of the Benefits and Risks of Linking ETSs

Benefits of Linkage	Risks from Linkage
- Emissions reductions can occur in more places with larger, linked systems. This can increase the odds that emission reductions will occur where the cost is the lowest	- Each governing body of an ETS will have to give up full control over their ETS because policy decisions made in one ETS will affect the prices of permits in every ETS linked to it
- Enough systems could potentially link in order to create a global system that will reduce enough GHGs to avoid climate change	- If permits are found to be invalid in an ETS, the invalid permits could spread to other linked systems making them more difficult to remove
- Permit prices can be stabilized through linking by increasing the size of the market	- Linkages could cause undesirable changes in the price of permits
- The risk of carbon leakage is reduced in larger, coordinated systems	- Any restrictions on permits in an ETS can be undermined if a linked system does not have the same restrictions

Types of ETS Linkages

Emissions trading systems can be linked, either directly or indirectly. A direct linkage means that permits can be traded freely from one system to another. An indirect linkage occurs when a permit from one ETS is transferred through a second to a third, but the first ETS has no contact with the third. Even though the first and the third ETS do not trade directly, permits can move among the markets.

Linkages can be unilateral, bilateral or multilateral. A unilateral ETS exist when one nation allows credits issued by a second, but the second does not allow credits issued from the first. Bilateral or multilateral linkages are when two or more ETSs allow exchange of permits from other systems (Jaffe & Stavins, 2008).

ETS Design Considerations and Potential Barriers to Linkages

While linking doesn't require complete harmonization across ETSs, certain ETS rules are more likely than others to cause linkage issues. Important considerations include the assurance of the emissions reductions, registries used, phases, allocation methods, emission reduction goals, penalties for non-compliance and offsets.

MONITORING, REPORTING AND VERIFICATION

Policy leaders attempting to link ETSs may want to assure that emission reduction permits represent actual GHG reductions through the quality of monitoring, reporting and verification (MRV). Strict MRV procedures enhance transparency that emissions reductions occur and the ETS is reducing emissions. The accuracy of MRV can affect the compatibility of linked systems (Mehling & Haites, 2009). Procedures for MRV can differ among ETSs.

Separate Registries

Separate ETS registries can be a barrier to linkage if the buyers are unable to set up new accounts in foreign registries. There are no physical items being exchanged during emissions trading, as emissions permits exist as electronic data in registries. The registries for emissions permits are usually specific to individual systems. A new account must be created in an ETS registry if a foreign buyer wants access that system's permits (Mehling & Haites, 2009). This could become a barrier if foreign accounts are not allowed in a registry. This issue can usually be solved by electronically linking the registries of different ETSs so that permits can be transferred without the need for new accounts (Jegou & Hawkins, 2014).

Phases

Differences in the timing of permit purchases may not pose a barrier to linkage and may actually prove to be helpful. Requiring different submission dates for permits can increase the liquidity of the markets and reduce market distortions that could occur if all permits requests are due at the same time (Jegou & Hawkins, 2014).

Allocation Methods

Allocation methods should not affect the permit prices if permits can trade freely through supply and demand after an initial allocation, assuming the market for permits functions as planned. Allocation methods might increase political issues with linking, as it will affect the initial wealth transfer if one ETS awards credits for free while another auctions credits (Jegou & Hawkins, 2014).

Emission Reduction Goals

Differing intensities of emission reduction goals could affect trading. If a national ETS has a more intense goal for emission reductions than another, there could be an uneven demand for credits amongst the systems. The ETS with more intense goals will have an incentive to purchase credits from the system with less intense goals where the prices could be lower. This could create capital flows as prices converge and balance. This could cause political concerns but will not necessarily affect the functionality of the system (Wilde et al, 2009).

Noncompliance

If penalties for noncompliance are low, some firms may not comply and just pay the noncompliance penalty rather than reduce GHGs. The price of all the connected credits could be affected if one ETS has low noncompliance penalties (Jegou & Hawkins, 2014).

Offsets

If offset projects do not exist in one ETS but are allowed in another, the ETS without offsets will still have access to the offset permits through the linked system (Jegou & Hawkins, 2014). This could be a barrier to linkage if the ETSs accept and restrict different types of offsets.

Risks of Linking

Linking ETSs can have drawbacks. Changes or developments in an ETS can have repercussions in every system to which it is linked (Mehling & Haites, 2009). Linkages could affect the prices of permits, enable unreliable permits, and reduce regulatory control of the ETS governing bodies.

Linkages could change permit prices. When ETSs are linked, permit prices will be equalized. Prices of permits could go down for some participants while going up for others. Price adjustments will affect the costs of energy, energy-intensive goods, and products that have emission-intensive manufacturing processes such as cement (Jegou & Hawkins, 2014). The overall operating costs of covered entities will be affected by the price adjustments. This equalization of permit prices could create opposing opinions on linkages (Jaffe & Stavins, 2008). Any negative price event in one market can spread to every market to which it is connected (World Bank, 2014).

Linking could enable unreliable permits. Mistakes in MRV procedure could create unreliable permits that don’t represent real emissions reductions. Unreliable permits will be difficult to track if they have been traded through linked systems. Tracking the unreliable permits could become more complicated as more ETSs are linked.

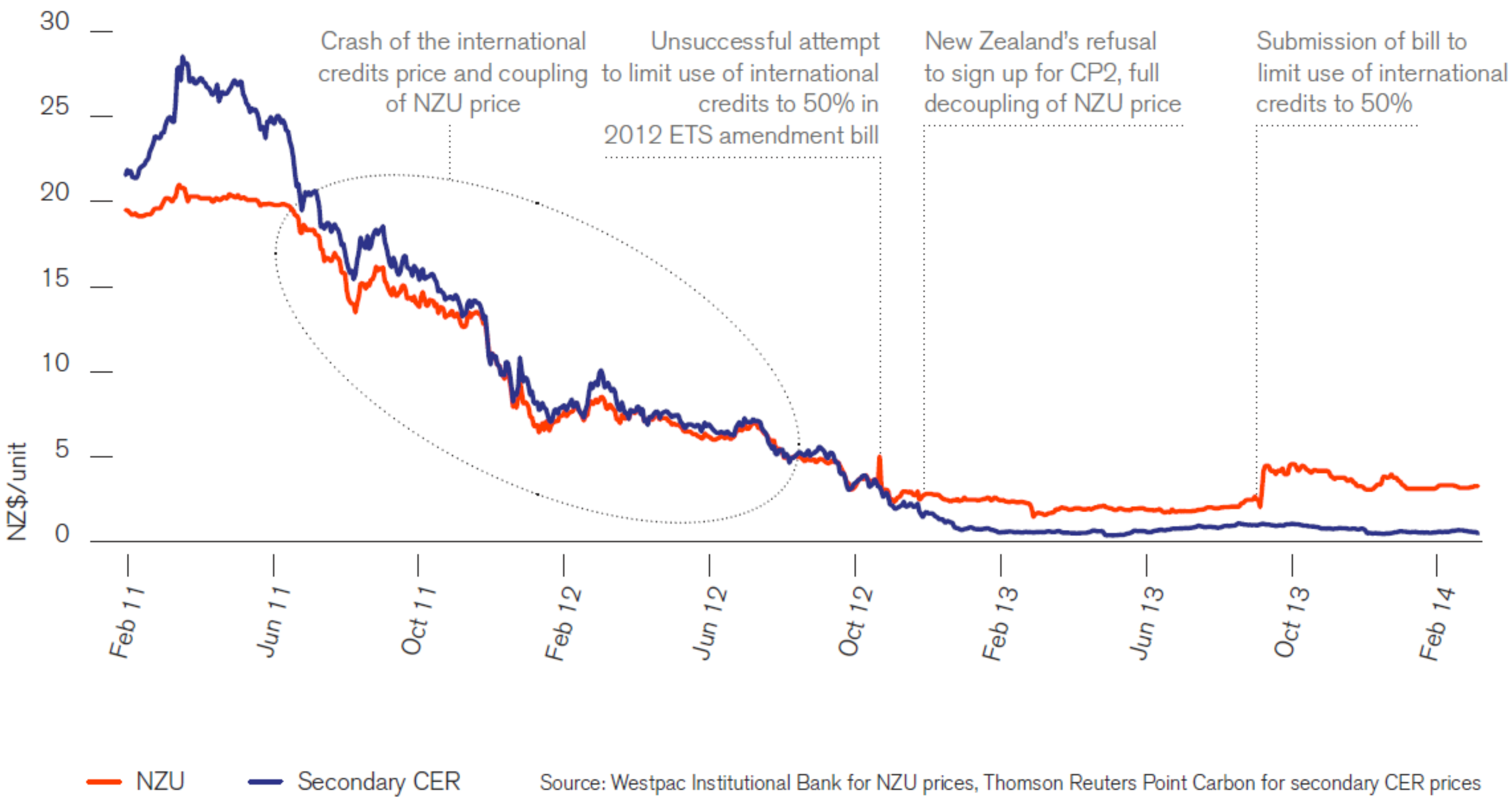
Linkages can reduce national control over an ETS. Policy decisions made in one ETS will affect the price of permits in the other. Reduced national control over an ETS could cause geopolitical concerns especially if the price of emission permits influences economic output. The reduced national control is dependent on the type of linkage and size of the systems (Jaffe & Stavins, 2008).

RISKS OF LINKAGE EXAMPLE - NEW ZEALAND ETS

An example of the risks of linking ETSs is the linkage between the New Zealand Emissions Trading System (NZETS) and the Kyoto Protocol. The NZETS was designed with a soft cap that allowed covered entities to use unlimited international offset credits to meet emission reduction requirements. Most covered entities in the NZETS chose to buy inexpensive international Kyoto credits (CERs and ERUs) as opposed to New Zealand credits (NZUs) or reducing emissions locally. As a result, the NZETS had little effect on reducing domestic emissions.

Figure 12 illustrates the price coupling of the NZUs and the Kyoto Credits, international permit prices linked with the NZ credits and lowered the price of the NZ credits dramatically from late 2011 to 2013. In November of 2012, New Zealand did not sign up for the second commitment period of the Kyoto Protocol to decouple the NZU prices from the Kyoto credit prices. Figure 12 illustrates that the price of the NZUs did not improve until the revision of the soft cap in late 2013 that limited the use of international credits to 50 percent (World Bank, 2014). This example shows how linking systems could affect the price of permits.

Figure 12. Price Coupling of New Zealand Credits and International Credits



Source: World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box385232.pdf

Independent systems considering linkages can potentially be affected by the development of other ETSs. China has the highest net GHG emissions in the world and has taken steps towards measuring and controlling GHG emissions by announcing the intention to develop a national ETS. China’s ETS has the potential to affect the international stage for developing and existing ETSs especially if linking is considered. The next chapter outlines China’s ETS development, design and potential global effect.

CHAPTER IV: CHINA

The bulk of the information in this chapter regarding the specific design details of China's regional ETS pilot programs has been retrieved from Swartz, J (2013) A User's Guide to Emissions Trading in China: 1st Edition - International Emissions Trading Association (IETA).

Air Pollution in China

Air pollution is a growing concern in China. The pattern of rising economic growth, energy consumption and accompanying GHG emissions has led to international concerns over the state's contribution towards climate change. The risks to development caused by local and GHG pollution has prompted China to initiate a "War on Pollution" (Blanchard & Stanway, 2014). China has implemented a regional pilot ETS program that may be followed by a national ETS. Both the national and pilot ETS programs can affect ETSs as a policy mechanism, UNFCCC negotiations, and existing and future global ETSs.

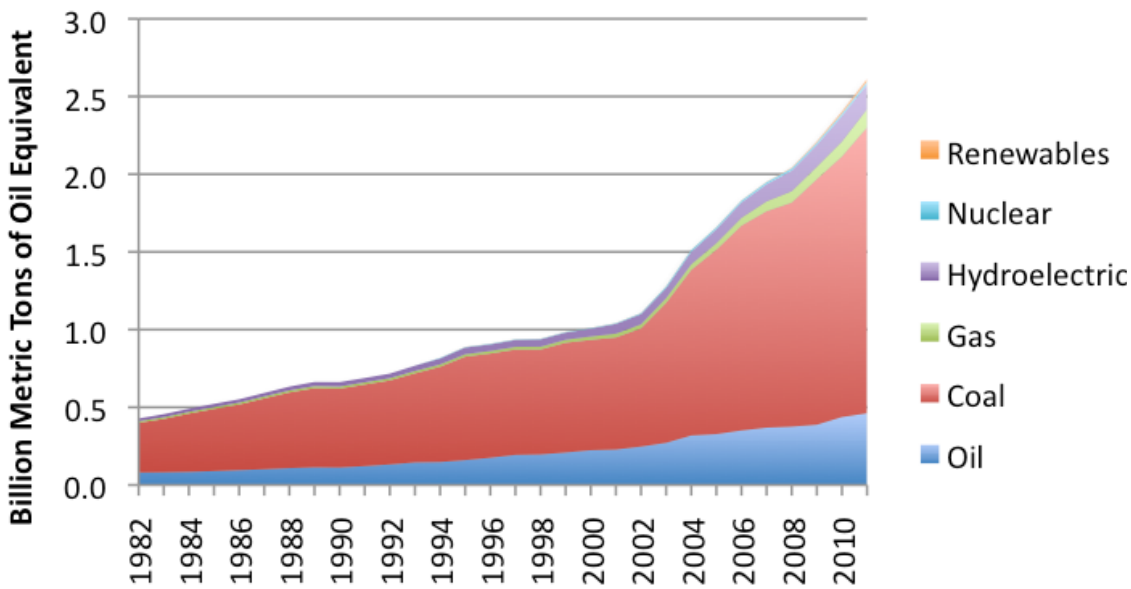
ECONOMIC GROWTH

China's economy is growing quickly and has positioned the country as a prominent actor in the global economy. The country went from the 10^{th} largest economy in the world in 1990 to the 2^{nd} largest in 2013 (Beach, 2014). China's annual GDP growth rate in the past decade has been around 10.5 percent (Walker, 2011). China is also now a member of the WTO and has the world's largest international trade value calculated at $3.87 trillion in 2012 (White, 2013).

ENERGY CONSUMPTION

Increases in energy consumption have accompanied the state's economic growth. Figure 13 illustrates a continuous growth in energy consumption. In the decade between 2000 and 2010 China's consumption of energy more than doubled from around 1 billion tons of oil equivalent to nearly 2.5 billion tons of oil equivalent. China was the world's largest energy consumer in 2010 with most of the energy coming from fossil fuels, especially coal (Swartz & Oster, 2010).

Figure 13. China's Energy Consumption By Source

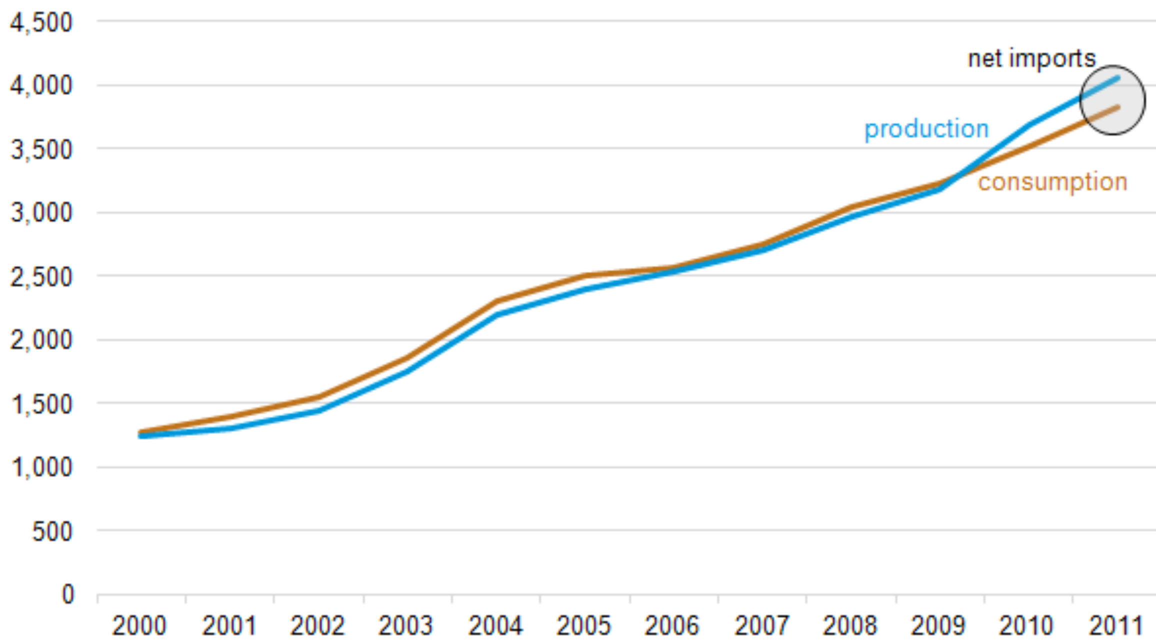


Source: Beach, Fred (2014): *Energy & China.* Energy Technology and Policy, UT Energy Symposium. Austin, Texas

Most of China's energy capacity is from the use of coal. In 2011, coal made up about 65 percent of China's energy capacity (Beach, 2014). In 2012 China consumed 4 billion short tons, around half of the world total coal (EIA, 2013). Figure 14 shows that the use of coal in China has tripled in the past decade from

1,250 to 3,750 million short tons per year. China's rail capacity has been unable to keep up with the rising coal demand, which has created high transportation costs for coal. The high transportation costs for coal have created an economic incentive for imported coal as seen in the increasing net imports in Figure 14 (EIA, 2013).

Figure 14. China's Coal Production and Consumption (in millions of tons) 2000-2011



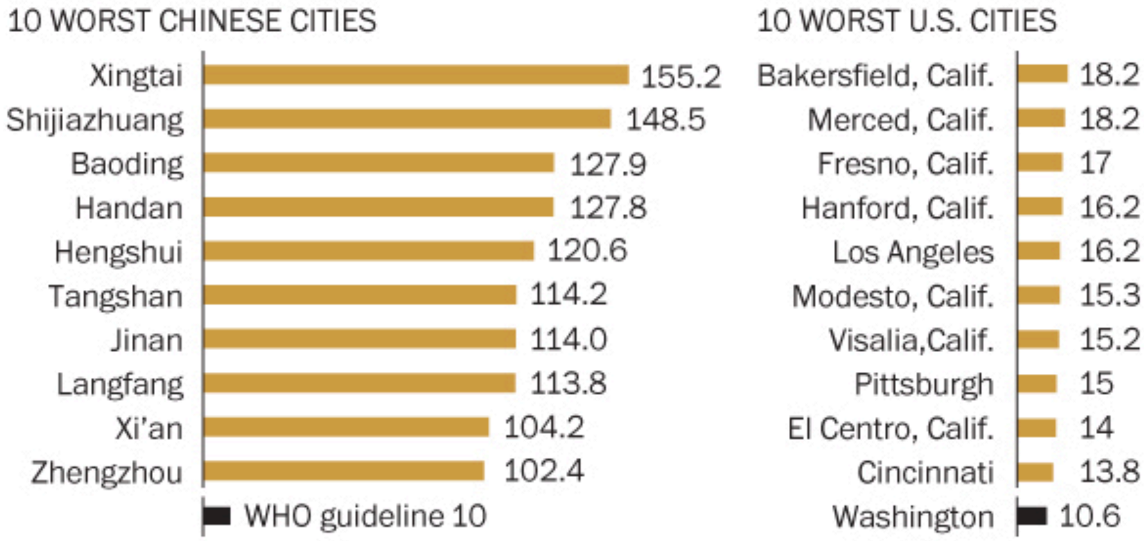
Source: US Energy Information Administration (EIA) (2013): *International Energy Statistics Analysis Brief: China.* Retrieved from http://www.eia.gov/countries/analysisbriefs/China/china.pdf

The consumption of other fossil fuels has also increased in China. China has become the largest automobile market in the world. This has added to increases in petroleum consumption. China's petroleum use grew from 2,250 to 10,000 barrels per day between 1991 and 2012 (Beach, 2014). Natural gas use, production and importation are growing in China. There also remains a large quantity of domestic shale gas that has yet to be exploited which could lead to increases in domestic gas production (Beach, 2014). These increases in fossil fuel energy consumption have resulted in high levels of pollution.

Local Air Pollution

China's increasing fossil fuel use has led to localized pollution concerns. Chinese officials declared that in 2013 over 95 percent of Chinese cities failed to meet environmental standards. Out of the 74 cities monitored, 71 had environmental issues (Stanway, 2014). Figure 15 illustrates the daily average small pollutant particles per cubic meter of air (known as PM2.5) in China, compared to the most polluted US cities. Xingtai is considered the most polluted city in China with over 155.2 micrograms of PM2.5 pollution per cubic meter, where Bakersfield, California (the most polluted city in the US) shows 18.2 micrograms of PM2.5 per cubic meter (Denyer, 2014). In major cities, this pollution can cast a visible layer of smog over the city in certain weather conditions (Turner & Ellis, 2007).

Figure 15. Daily Average Pollution of Chinese and US Cities



Sources: Denyer, S. (2014). *In China's War on Bad Air, Government Decision to Release Data Gives Fresh Hope*. The Washington Post. Retrieved from http://www.washingtonpost.com/world/in-chinas-war-on-bad-air-government-decision-to-release-data-gives-freshhope/2014/02/02/5e50c872-8745-11e3-a5bd-844629433ba3_story.html

GHG EMISSIONS

China now emits more GHGs in weight than any other nation. The country emitted 22.3 percent of the world's total GHG emissions in 2011, or 7.6 tCO_2e per capita (WRI, 2015). China's population of 1.4 billion inhabitants adds more GHGs into the atmosphere than the US's 19.7 tCO_2e per capita emissions (WRI, 2015). This level of emissions has not only prompted concerns from the international community but is now receiving attention from Chinese political leaders.

RISKS TO DEVELOPMENT

Increases in both localized pollution and GHG pollution are creating risks to China's continued development. Increased levels of localized pollution can reduce agricultural yields if plant growth is impeded from pollutants affecting photosynthesis. Agricultural areas are already stressed in China. The country feeds more than 20 percent of the world's population with only 7 percent of the world's arable land (Lewis, 2009). Increased storm surges and sea level rise caused by climate change may create a direct threat to China's economy, as the majority of China's population is located along the coastline (Lewis, 2009). Drought and flooding resulting from a changing climate are other risks to China's resources. China's potential resource strains can create international concern. Resource problems in China could affect other nation's resources as China's global influence spreads to supply and support its large population (Lewis, 2009).

WAR ON POLLUTION

Chinese officials have stated that local air pollution has been "harming people's health and affecting social harmony and stability" (Kashi, 2013). To address the public's concern, officials have declared a "war on pollution" and have enacted a variety of measures aimed at mitigating local pollution (Stanway & Chen, 2014). In September 2013, the Chinese State Council released its Action Plan for Air Pollution Prevention and Control (Clean Air Asia, n.d.). The Plan aims to improve air quality by reducing small pollutant particles that cause the most damage to human health (Hamlin et al, 2014). As part of the Action Plan, officials have implemented policies to reduce the amount of coal in the energy mix, prohibit coal that doesn't meet quality standards (Wadhams, 2014) and restrict annual coal consumption to below 4.2 billion metric tons until 2020 (Bo, 2014). Other policies restrict the use of high emission cars (Hamlin et al, 2014) and aim to increase the total primary energy share of non-fossil fuels from 9.8 percent in 2013 to 15 percent by 2020 (Bo, 2014).

Policies designed to improve air quality can have the added benefit of limiting GHG emissions. China has implemented policies to reduce GHG emissions to capitalize on the GHG reductions from the restrictions on local pollution. China has implemented carbon and energy intensity targets. These targets measure the amount of CO_2 emissions per unit of GDP or energy use per unit of GDP (WRI, 2007). In 2009, China committed to a target reduction of carbon intensity to 45 percent below 2005 levels by 2020 (Stanway & Chen, 2014). These intensity targets can be less controversial than absolute targets because they are viewed as still allowing economic growth but the emissions reductions are less predictable than with absolute targets (Han et al, 2012). While the intensity targets have been effective in their goals of reducing intensity, overall emissions have increased. Since the implementation of intensity targets, the absolute emissions of China have still increased by 125 percent (Stanway & Chen, 2014). China has moved towards developing emissions trading systems that could reduce the absolute level of emissions.

Chinese ETS - Design

National ETS

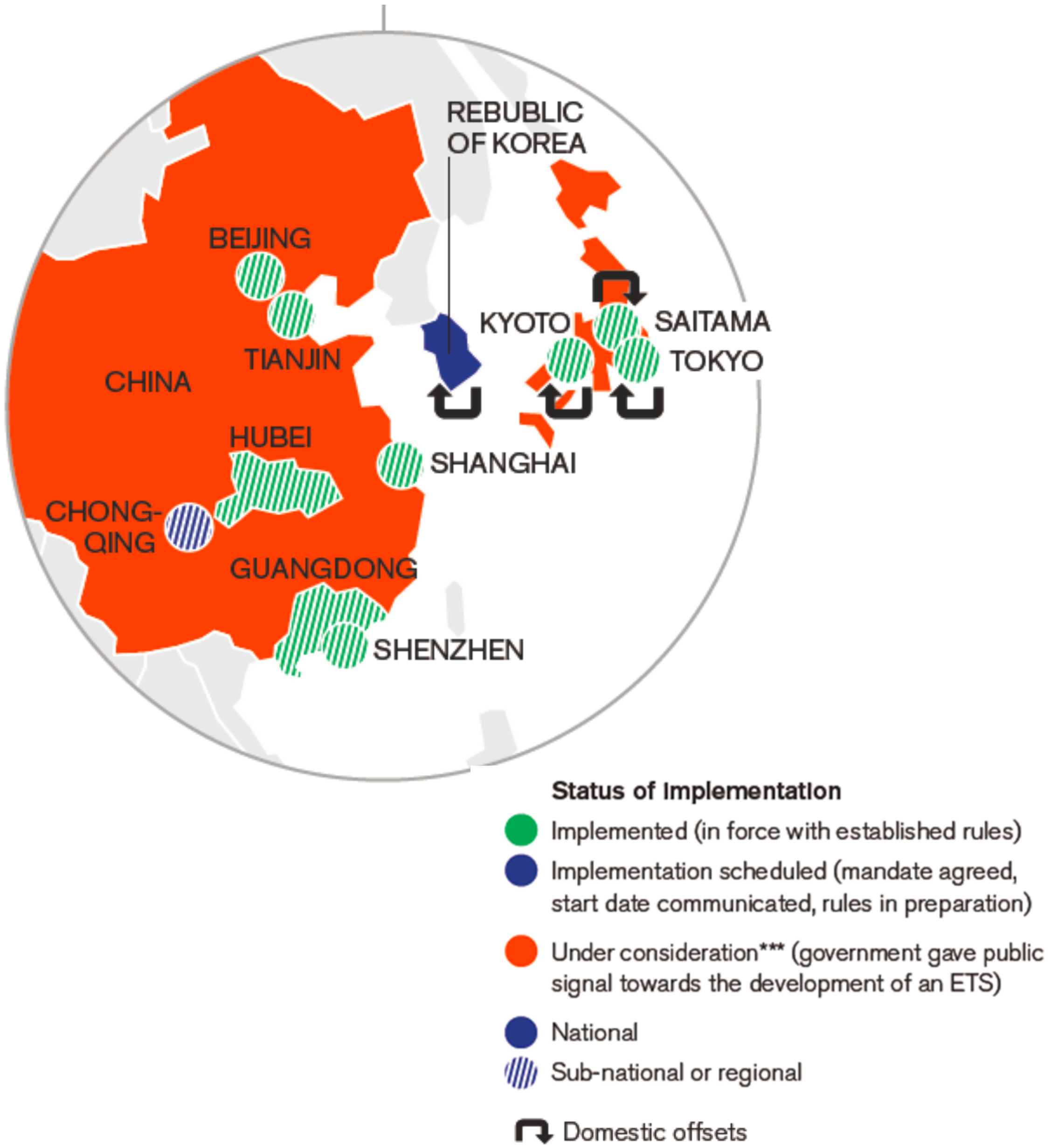
China has taken steps towards implementing a national ETS to measure and control GHG emissions. China initially applied for and received funds from the World Bank to help develop a national ETS. The World Bank Program Partnership for Market Readiness (PMR) is designed to support capacity building to help nations mitigate the effects of climate change. Participating countries receive funds after submitting a "Market Readiness Proposal" (MRP). China submitted its MRP to the World Bank and was awarded $8 million to begin research on a national emissions trading system (Swartz, 2013). When China's National Development and Reform Commission (NDRC) released the 12th national five-year plan for the years 2011-2015, the plan outlined the intention to create a national ETS (Lo, 2013). The national Chinese ETS is due to start from January 2016 with three phases running up to 2025 (World Bank, 2014). The ETS will likely cover between 3 and 4 billion tons of CO_2 by 2020 and be worth more than $70 billion (Hope, 2014). China's ETS would dwarf the EU ETS in size, with nearly 20,000 Chinese covered enterprises (Hope, 2014).

REGIONAL PILOT ETS PROGRAMS

China's NDRC has created seven regional pilot ETS programs since 2013 to prepare for the national ETS. Each of the pilot programs was designed with unique characteristics for policy makers to better understand which practices work best for emissions trading in Chinese business and industry (Hope, 2014). Each regional ETS focuses on a large city in the Beijing, Shanghai, Hangzhou, Guangdong, Shenzhen, Tianjin, Hubei, and Chongqing regions. Figure 16 shows the areas covered by each regional system and the close proximity to the Korean and Japanese ETSs. By April 2014, six of the eight pilot systems started trading.

The pilot programs cover a significant amount of emissions. Combined the six systems covered 1,115 $MtCO_2e$ in 2013 making the pilot system program the second largest carbon market in the world behind the EUETS (Hope, 2014). Collectively, the pilot programs cover 27.4 percent of China's national GDP and 18.4 percent of its population (Lo, 2013). Guangdong is the largest of the six regional programs and covered 388 $MtCO_2e$ in 2013, which is about equal to all of France's GHG emissions in 2012 (Lo, 2013). Below is a brief overview of the regional pilot ETSs. Table 7 summarizes the pilot program's coverage and allocation that will be discussed below. Table 8 in the appendix lists key regional pilot program facts.

Figure 16. Chinese Regional Pilot Emissions Trading Systems



Source: World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box385232.pdf

Table 7. Chinese Pilot Program Coverage and Allocation

	Beijing	Shanghai	Hangzhou	Guangdong
Entities Covered	435	197	*To be specified*	827
Coverage Threshold	>10k tons CO_2/yr average from 2009 – 2011	-Industry > 20k tons CO_2/yr -Non-industry >10k tons CO_2/yr	Industries that consume >3k tons of coal /yr	> 20k tons of CO_2 in any year from 2011-2014
Allocation	Free allocation during pilot stage then adjusted according to the previous year's emissions	Free allocation but auctions could take place	*To be specified*	Free allocation and purchasing of permits

	Shenzen	Tianjin	Hubei	Chongqing
Entities Covered	625	130	153	300
Coverage Threshold	>5k tons of CO_2/yr	>20k tons of CO_2/yr in any year since 2009	>60k tons of coal/yr (first stage) then individual enterprises >8k tons of coal/yr	>20k tons of /CO_2 per year
Allocation	*To be specified*	*To be specified*	Free allocations but auctioning is considered	*To be specified*

Information Complied From: Swartz, J., & Chen P., (2013). *A User's Guide to Emissions Trading in China: 1st Edition.* International Emissions Trading Association (IETA). Retrieved from http://www.ieta.org/a-user-guide-to-emissions-trading-in-china--september-2013

BEIJING

In spring of 2012, the draft rules for the Beijing ETS pilot program were released. The Beijing pilot system covers 50 percent of the total GHG emissions in Beijing. The system is mandatory for at least 435 companies but voluntary participation has encouraged more to join (Swartz, 2013). The system covers direct CO_2 emissions from electricity generation and heating entities that released an average of over 10,000 tons of CO_2 from 2009-2011 (Swartz, 2013). Manufacturing processes and public buildings will also be held accountable for any indirect emissions. Permits are allocated free of charge for the initial phases of the pilot program and will be adjusted continually according to the previous year's emissions. The pilot program requires that third party companies and individuals must verify the emission reductions. Qualified verifiers will be registered with the Beijing government.

The Beijing system also includes a "Major Emitters Alliance" which is a group of corporations that are required by law to be covered by the ETS (Swartz, 2013). The alliance will work with the government on providing suggestions on policy for future implementation of the ETS. A financial organization alliance is also being developed as a way for Chinese banks to understand how to provide financial services to entities covered under the pilot system. Another alliance between foreign consulting agencies and third party verifiers will help with policy suggestions and also provide consulting services to the ETS's participants (Swartz, 2013).

SHANGHAI

The Shanghai system will include any industry that emits more than 20,000 tons of CO_2 a year and any non-industry entity that emits more than 10,000 tons a year (Swartz, 2013). Non-industry includes aviation, ports, airports, railways, commercial enterprises, hotels and financial institutions; 197 entities are currently covered under these specifications (Swartz, 2013). The Shanghai Environment Energy Exchange will establish all trades, auctions, contracts and transaction fees. The covered entities are allowed to bank unused allowances for future use. The allowances will be issued based on industry specific growth expectations; this contrasts with most ETSs that have declining absolute caps on emissions. These allowances will be allocated for free but auctions could take place if needed (Swartz, 2013).

HANGZHOU

Few details are known about the Hangzhou system. There is an energy intensity reduction target of 19.5 percent. The system has been designed around high-energy industries that consume over 3,000 tons of coal annually. There are 865 firms currently covered under these thresholds. If a firm shuts down, the Economic Information Commission can buy back extra allowances (Swartz, 2013).

GUANGDONG

The Guangdong system will cover both direct and indirect emissions from industries within the region that have annually emitted more than 20,000 tons of CO_2 in any year from 2011-2014. The baselines are determined from any year that an entity emits over 20,000 tons of CO_2 per year so the years 2011, 2012, 2013 or 2014 could be used. The direct emissions covered include emissions from both fuel combustion and production while indirect emissions can be from purchased electricity and heating. The Guangdong system is unique in the sense that it covers transportation and buildings. Any entity that releases over 10,000 tons of CO_2 is required to report emissions. Under these requirements there are 827 firms listed in the Guangdong region therefore making the system cover the most amount of firms. The allocation methods include both free allocation and the purchasing of permits while auctioning is being considered (Swartz, 2013).

SHENZEN

The Shenzen system was designed around a 21 percent carbon intensity target. The emissions threshold to be eligible for the system is 5,000 tons of CO_2 per year. This low threshold covers 625 entities from 26 sectors making it the second most populated system behind Guangdong. Any Chinese or international financial institution can apply and register as a member of the Shenzen system. The Shenzhen Development and Reform Commission (Shenzhen DRC) will administer the ETS and also promote training and education on carbon management in order to increase efficient participation in the system (Swartz, 2013).

TIANJIN

The Tianjin system has a target of a 17 percent carbon intensity reduction. The target aims to lower emissions to 1.69 tons of CO_2 emission per RMB 10,000 GDP. The system has an emissions threshold similar to the Guangdong program in the sense that entities are covered if they release more than 20,000 tons of CO_2 per year in any year since 2009. Covered entities will be limited to industries within the municipality. While this only includes 130 companies, the covered companies emit 60 percent of the city's emissions (Swartz, 2013).

HUBEI

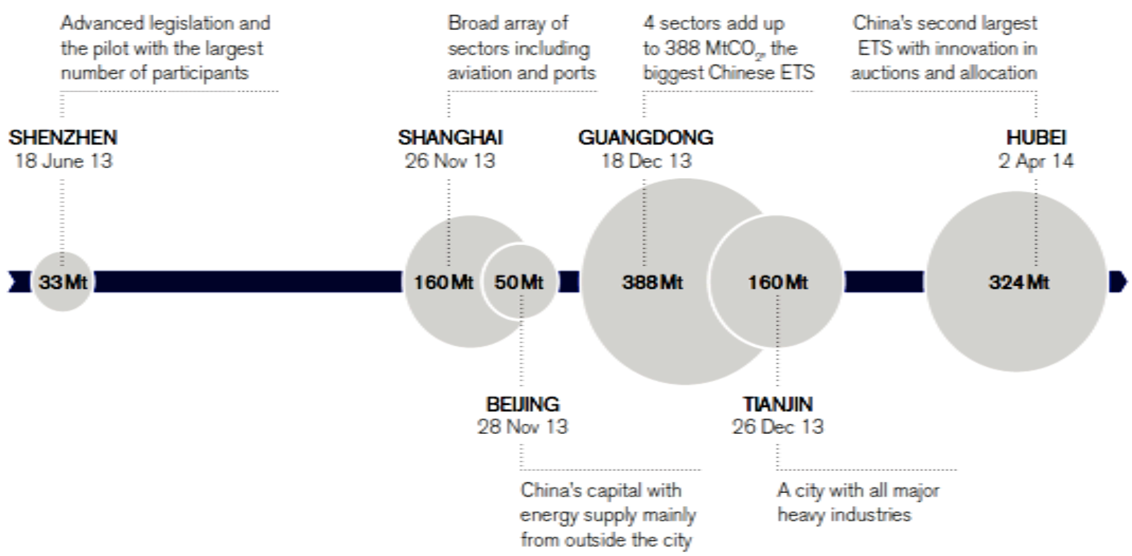
The Hubei system has a target of reducing carbon intensity by 17 percent by 2014. The emissions threshold has two stages. The first stage covers sectors that use over 60,000 tons of coal/yr and the second stage covers individual enterprises that use over 8,000 tons of coal/yr. Under these specifications 153 entities are currently covered. Allowances will be issued free of charge while auctioning is being considered. Futures transactions and banking/borrowing will not be allowed (Swartz, 2013).

CHONGQING

The Chongqing system has a target of increasing forestry coverage from 39 percent to 45 percent in addition to carbon intensity and energy consumption targets. The system will cover entities that release over 20,000 tons of CO_2 per year, or 300 entities currently covered under these specifications. The system will cover 6 sectors of the region's industrial economy; petrochemical and power sectors are not currently covered. The covered emissions are expected to make up 35-45 percent of total emissions (Swartz, 2013).

Figure 17 gives a brief overview of the start dates and overall size of most of the regional ETSs. The figure shows the vast differences in the coverage of each ETS, ranging from 33Mt in Shenzen to 388Mt in Guangdong. The Shenzen was the first pilot program and started in June 2013. The program has the largest number of participants but covers the lowest total amount of GHG emissions at 33Mt. Four pilot programs started in late 2013: Shanghai, Beijing, Guangdong and Tianjin. Figure 17 illustrates that the amount of emissions covered in these four programs range from 50Mt in Beijing to 388Mt in Guangdong. In early April 2014 the Hubei program opened with a coverage comparable to the Guandong system of 324Mt of emissions.

Figure 17. Characteristics of the Chinese ETS Pilots in Operation



Source: World Bank (2014): *State and Trends of Carbon Pricing 2014*. Washington, DC: World Bank Group. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/05/27/000456286_20140527095323/Rendered/PDF/882840AR0REPLA00EPI2102680Box385232.pdf

Initial Results of Pilot Programs

Overall the pilot programs have made progress in introducing emissions trading to Chinese companies. In May 2014, the deputy head of the NDRC announced that the Chinese pilot programs had traded over 3.85 million credits at a price of over $20 million, making China's pilot programs the second largest carbon market after the EUETS (D'Amato, 2014). Despite the size of the market, trading volumes are still relatively low as covered entities are still getting accommodated with emissions trading (Wilkening & Kachi, 2014).

There have been reports of some complications with the pilot programs. Chinese companies are still learning how to participate, comply with and benefit from emissions trading (Wilkening & Kachi, 2014). Some covered entities have reported they are unable to afford purchasing permits (Nelson, 2014). Other entities have refused to purchase permits and have instead opted to pay the noncompliance fines (Nelson, 2014). There has also been price volatility, especially in the Shenzhen and Tianjin ETSs, but the prices have since stabilized (Nelson, 2014). The different structures of the pilot programs have also led to large spread in allowance prices across different programs (Nelson, 2014). Prices of permits have ranged from about \$20/tCO_2 in Shenzhen to less than \$3/tCO_2 in Hubei (D'Amato, 2014).

NATIONAL ETS IMPLEMENTATION CHALLENGES

There could be challenges associated with transitioning the pilot programs to a national ETS. The pilot programs were created with different features in order to test what design for emissions trading works best with Chinese businesses. This approach has created diversified pilot programs that have been designed through different approaches. The pilot programs cover a wide range of differences in economic structures, growth rates, energy consumption and carbon intensities (Han et al, 2012). The pilot programs' design features will have to be consolidated in order to create common elements in some areas to allow a functioning ETS (Song & Lei, 2014). Uncertainties remain over the consolidation of various components of the pilot programs including emission rights, allocation procedures, trading rules, MRV, penalties for noncompliance and transparency (Gonzalez, 2014).

Creating a comprehensive legal framework for the national system will be necessary but can be a challenge to develop. A legal infrastructure has yet to be developed that can be the foundation of consolidating the pilot systems' components in order to create an efficient national ETS (Song & Lei, 2014). The NDRC has been progressing in this development by drafting a national Climate Change Law that will ensure standards for emissions reductions. Standards can insure the consistency of emissions reductions so they can be traded through exchanges and registries (Song & Lei, 2014). A legal infrastructure can also help create a system for MRV that will allow third parties to verify the accuracy of emission reductions. Penalties for non-compliance can be enforced through a legal system (Gonzalez, 2014). Transparency requirements can also be created through a legal system to ensure reliable emissions data from which baselines and targets can be determined (Han et al, 2012).

Capacity building can be another hurdle for transitioning the pilot programs into a national system. The Chinese government sets commodity prices (Song & Lei, 2014) so the pilot programs have experienced a shortage of professionals who are qualified to trade and manage an emissions portfolio (Han et al, 2012). External consultants and training could be necessary to make sure Chinese staff can operate and oversee the national ETS (Song & Lei, 2014).

China's pilot programs focus on ensuring necessary ETS mechanics including price-discovery, trading and allocation rules, registries and trading platforms all while taking into account the lessons from other nation's failures and successes (Huang, 2013). The current national ETS rules are remaining flexible so pilot programs can test differing rules in varying regions and environments. The entities are being encouraged to develop local solutions to trading requirements in order to showcase the most effective solutions in each environment. The positive results from the pilot systems could be reflected in the national ETS requirements. Even though China's ETS is still in the pilot stage and there are still unresolved challenges with transitioning into a national ETS, the program can still have significant effects on the perception of an ETS as a policy mechanism, the UNFCCC negotiations and the development of other ETSs.

Chinese ETS - Global Effect

ETS AS A POLICY MECHANISM

China's choice of an ETS, as opposed to a tax or direct regulation, shows China's confidence in an ETS's ability to support economic growth and control emissions. The assumed least cost-occurrence of emission reductions and the motivation for innovation and investment in low-carbon technologies could make the policy more economically attractive than other GHG reduction strategies. An ETS can support options for continued economic growth. If a domestic offset mechanism is developed, economic growth could be promoted by focusing on domestic projects not covered by the ETS. The offset program could be inspired by UN programs such as the Joint Implementation program to target underdeveloped regions in China. This would encourage capital and technology transfers in exchange for emission reduction permits. If China's ETS can successfully reduce emissions without impeding economic growth, other nations will look more favorably towards an ETS over other GHG reduction mechanisms.

UNFCCC Negotiations

The relatively large amount of GHG emissions covered by the Chinese system can influence future UNFCCC negotiations at the upcoming 2015 Conference of the Parties 21 in Paris. One of the main criticisms of the Kyoto Protocol was the different GHG reduction requirements between developed and developing nations. In the original design of the Kyoto Protocol, capital was expected to flow from developed countries to developing countries to assist with the costs needed to reduce emissions. This design was undesirable for developed countries because there were financial advantages for developing nations. With China's announcement of a self-imposed ETS, developed countries could have difficulty arguing that developing countries are not regulating emissions as strongly as the developed nations. Some developed nations might accept the idea that the playing field is even enough to accept and promote UNFCCC efforts to mitigate climate change.

Effects on Other Systems

A Chinese national system has the potential to affect the development of existing and future ETSs around the world, especially if linkages are considered. The largest incremental growth of future GHGs is expected to come from the developing countries of Asia (Massetti & Tavoni, 2012). An international pledge to reduce global emissions by 50 percent in 2050 assumes a 70-80 percent reduction in Asian emissions based off of projected business as usual scenarios (Massetti & Tavoni, 2012). China has the potential to be the center of an Asian/Pacific carbon-trading network to help reduce these emissions. This network could consist of China as the leader of national ETSs acting similarly to the EU and its surrounding nations (Lo, 2013) or to Western Climate Initiative's linkages across North America. The close location to other systems such as New Zealand, South Korea and other more localized systems in the area such as Tokyo could be an incentive for linking to existing systems. The potential for technology transfer and capital flows could encourage lower income South Asian nations and small island states in the Pacific region to link with China's ETS, especially if China's ETS includes an international offset mechanism similar to the UN's CDM or Japan's JCM. This potential Asian region of linkages could have the potential to create a market area to rival the dominant European ETS.

There could be conflicting opinions on linking ETSs with China from the perspective of foreign governments. Linking systems could be encouraged by many ETSs experiencing low permit prices. A higher permit price is still needed in the EUETS to encourage emission reductions. China's national ETS could be the needed linkage partner for the EUETS that will raise the prices of EU credits. Examples such as the NZETS and EUETS linkage show that a linkage can spread a permit price. European entities with few options for low-cost domestic emissions reductions could under linkage purchase permits from China if the permit prices were lower. On the other hand, nations interested in linking could have serious concerns with linking to China's ETS. Smaller systems could be concerned over losing too much control over local prices due to the massive size and influence of the Chinese ETS. This situation would be comparable to the NZETS and EUETS linkage. The potential lack of transparency in China's MRV could cause concerns for potential linkage partners. If Chinese credits are accepted into a foreign system, there is the risk that the credits could later be considered unreliable due to low quality information in the MRV process. The massive amount of credits in the market could cause irreversible disruptions throughout any linked system. Double counting could also be a concern if a lack of transparency in the Chinese systems facilitates a situation where emission reductions are counted twice.

Outcomes of the Chinese pilot ETS components such as system coverage, credit allocation, registries, penalties for noncompliance, temporal flexibility, and rules for new entrants will all affect the future development of the national ETS. Future linkage considerations also remain to be specified that could encourage international cooperation on emissions trading in order to reduce emissions at the least cost. Differences in MRV, registries, trading periods, allocation methods, reduction goals, noncompliance issues and offsets will all need to be determined before any linkages are considered.

Decisions made by China on climate change mitigation may have the potential to affect other nations' policies toward climate change mitigation. China's regional ETS pilot programs and potential future national ETS can affect the development of emissions trading worldwide. The effects of the Chinese ETS remain to be seen depending on the results of the pilot program. This thesis concludes with an overview of climate change, the global overview of ETSs, linking ETSs and China's ETS.

CHAPTER V: CONCLUSION

CLIMATE CHANGE

The rising levels of greenhouse gases in the atmosphere and resulting climate change has the potential to affect societies around the world. Reducing GHG emissions has become a concern for policy leaders worldwide. One of the most effective ways to reduce GHG emissions is to price carbon in order to utilize the private sector's economic power. There are three major tools being used to reduce GHG emissions by pricing carbon: policy regulation, taxation, and emissions trading. Each tool affects the targeted entities in a different way. Emissions trading could in principle enable emission reductions to occur at the least cost.

The UNFCCC developed the Kyoto protocol as a top-down approach to limit GHG emissions through an international ETS. The Kyoto protocol has created various ETS flexibility mechanisms that serve as models for other ETSs such as International Emissions Trading (IET), the Clean Development Mechanism (CDM), and Joint Implementation (JI). As of 2015, negotiations for further Kyoto Protocol implementation are essentially stalled. There are divisions among nations involved in the UNFCCC climate negotiations restricting further agreements or supplemental implementation plans. The stalled negotiations at the UNFCCC are encouraging the exploration of alternative methods to develop ETSs.

GLOBAL OVERVIEW OF ETSS

The bottom-up development of independent regional and national ETSs is increasing. Notable ETSs currently include: the European Union, Korea, New Zealand, Kazakhstan, Switzerland, Japan, Tokyo, the Regional Greenhouse Gas Initiative, California AB32, Western Climate Initiative, and Australia's now canceled ETS. These regional systems are being developed independently in accordance with each area's unique requirements. Regional systems can adjust the various components of their ETSs in order to fit the region's specific situation. These components include coverage, leakage issues, allocation, registries, penalties for non-compliance, temporal flexibility, new entrants, offsets, additionality, MRV, permanence, and double counting.

LINKING ETSS

Many regional and national ETSs are moving towards developing a bottom-up design of international emissions trading by linking separate ETSs. Linking systems requires each nation or trading bloc to create individual ETSs that link together by allowing permits to trade freely among ETSs. Linking individual systems expands the market size to theoretically allow emission reductions at least-cost. Linking systems presents new challenges and considerations to developing an ETS. Components between linked systems that should be reviewed include MRV procedures, registries, phases, allocation methods, emission reduction goals, non-compliance penalties, and offsets. Linkages risk affecting permit prices, enabling unreliable permits, and reducing regulatory control of the ETS governing bodies. Linking systems has the potential to develop a bottom-up system of interlinked ETSs that cover enough GHG emissions to reduce climate change.

CHINA

China has been experiencing continuous economic growth accompanied by increases in energy consumption. The increasing economic growth and energy consumption of China has resulted in high levels of localized pollutants and global GHG pollutants. Rising levels of pollution can pose a risk to the continued economic development of China. China has taken steps towards measuring and controlling local pollution as well as GHG emissions. China has announced the intention to develop a national ETS and has created seven regional pilot ETS programs in preparation for the national ETS. The pilot programs cover the Beijing, Shanghai, Hangzhou, Guangdong, Shenzhen, Tianjin, Hubei, and Chongqing regions. These programs are being developed with various rules and regulations to test how emissions trading fits best with Chinese industry. The national ETS will be implemented based on the results of the pilot programs but significant challenges still remain in transitioning the pilot programs to the national ETS.

China's future national ETS can affect the perception of an ETS as a policy mechanism, the UNFCCC negotiations, and the development of existing and future ETSs. China's commitment to economic development and selection of an ETS as opposed to other GHG reduction policy mechanisms can raise other nations' confidence in an ETS's ability to reduce emissions without impeding economic growth. The relatively large amount of GHG emissions covered by the Chinese system can influence future UNFCCC negotiations. China's self-imposed ETS has the potential to affect the international stage for developing and existing ETSs. Asia could become the global center for emissions trading. The impact of China's system will be magnified if linking is considered but whether the impacts are positive or negative will depend on the potential linkage partners.

The lessons learned from China's system could serve as a blueprint for the continued development of current systems worldwide and the implementation of new systems. Whether China's national ETS is successful or not, the future development of emissions trading systems will undoubtedly be influenced by the results of China's ETS.

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APPENDIX

Table 8 lists key Chinese regional ETS information on each system's borrowing/banking, MRV, offsets, penalties, registry information, trading platforms and linkages.

Table 8. Chinese Regional ETS Details

Beijing
Borrowing/Banking: No borrowing but banking is allowed during pilot period. **Monitoring/Reporting/Verification:** Build enterprise emissions inventory. Third party verification required to DRC in March. Penalty not specified. **Offsets**: Allow certified project based reductions such as CCER (Chinese Certified Emission Reductions). **Penalties**: Not Specified **Registry**: Established by the end of 2012. **Trading Platform**: Beijing Environment Exchange **Linking**: Not Specified (Swartz, IETA, 2013)
Shanghai
Borrowing/Banking: No borrowing. Banking is allowed during pilot period. **Monitoring/Reporting/Verification:** Emissions audits. Submitted reports are verified by 3rd parties. Penalties are not specified **Offsets**: Allow certified project based reductions, such as CCER, limited to 5 percent of allocation amount.

Table 8. (Continued) Chinese Regional ETS Details

Shanghai (Continued)
Registry: Established by the end of 2012 **Trading Platform**: Shanghai Environment and Energy Exchange **Linking**: Not Specified (Swartz, IETA, 2013)
Hangzhou
Borrowing/Banking: To be specified **Monitoring/Reporting/Verification:** No MRV guidelines in place. Energy supervision center will monitor energy consumption enterprises. Economic Information Commission (EIC) will be in charge of MRV. **Offsets**: To be specified **Penalties**: To be specified **Registry**: Not Specified **Trading Platform**: Hangzhou Emissions Trading Platform **Linking**: Not Specified (Swartz, IETA, 2013)

Table 8. (Continued) Chinese Regional ETS Details

Guangdong
Borrowing/Banking: Borrowing is not allowed. Banking allowed with the NDRC's permission **Monitoring/Reporting/Verification:** Emissions audits. 3rd party verification required. **Offsets**: Allow certified project based reductions such as CCER or credits registered in Guangdong. 10 percent CCER limit of registered allowances. **Penalties**: Excessive Emissions: 3x average market price. No permissions on new projects and installations **Registry**: Not Specified **Trading Platform**: Guangdong Emission Exchange **Linking:** Plan to link with pilot ETS in Hubei Province (Swartz, IETA, 2013):
Shenzen
Borrowing/Banking: Banking is allowed during the first trading period (2013 - 2015) **Monitoring/Reporting/Verification:** MRV guidelines in place **Offsets**: Allow certified project based reductions such as CCER; the available amount of CCERs will be limited **Penalties**: Penalty 3x the average market price for the emissions that exceed the limit **Registry**: Not Specified

Table 8. (Continued) Chinese Regional ETS Details

Shenzen (Continued)
Trading Platform: China Shenzhen Emission Exchange. Only spot, not futures. Opening day value of transactions 613,235 Yuan **Linking**: Not Specified. (Swartz, IETA, 2013)
Tianjin
Borrowing/Banking: To be decided **Monitoring/Reporting/Verification:** Build enterprise emissions inventory and investigation systems. 3rd party verification required **Offsets**: Allow certified project based reductions such as CCER; Enterprises are allowed to purchase CCER to fulfill no more than 10 percent of their annual CO_2 emissions. **Penalties**: To be specified **Registry**: Not Specified **Trading Platform**: Tianjin Climate Exchange **Linking**: Not Specified (Swartz, IETA, 2013)
Hubei
Borrowing/Banking: Banking and borrowing not allowed

Table 8. (Continued) Chinese Regional ETS Details

Hubei (Continued)
Monitoring/Reporting/Verification: Firms with coal consumption +8000 tons per year must complete MRV procedures. 3rd party verification required **Offsets**: Allow certified project based reductions such as CCER (including forest carbon sinks). Offset limit 15 percent of allocation 10 percent limit for new entrants **Penalties**: Excessive Emissions: 3x average market price **Registry**: Not Specified **Trading Platform**: Wuhan Optics Valley United Property Rights Exchange **Linking**: Plan to link with pilot ETS in Guangdong Province. (Swartz, IETA, 2013)
Chong Qing
Borrowing/Banking: Not Specified **Monitoring/Reporting/Verification:** Firms with standard coal consumption >8,000 tons per year must complete MRV procedures. 3rd Party Verification required. **Offsets**: Allow certified project based reductions such as CCER (including forest carbon sinks) **Penalties**: Allow certified project based reductions such as CCER (including forest carbon sinks) **Registry:** Established by Chongqing DRC **Trading Platform**: Chongqing United Assets and Equity Exchange **Linking**: Not Specified (Swartz, IETA, 2013)

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