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Carbon Price Pass-Through in the Chinese  
Emissions Trading Scheme:  
*Lessons from the Republic of Korea and the  
European Union*

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## **Abstract**

On July 16, 2021, the Chinese Emissions Trading Scheme (ETS) opened trading. Covering more than 4 billion tons of carbon dioxide, the ETS accounts for 40% of China's national carbon emissions and is the largest carbon market in the world by volume. However, as it stands, the cost of carbon is not being reflected in electricity prices for consumers due to government regulation of the Chinese power market. This study examines the relationship between the Chinese ETS design and power market design to make a recommendation to facilitate the pass-through of carbon costs to consumers. Specifically, the study confronts the feasibility of two potential reform pathways for price pass-through, (1) power market deregulation, and (2) evolution in design of the Chinese emissions trading scheme. Comparative case study analysis of price-signaling methods in the Republic of Korea and the European Union informs the ultimate recommendation. The findings indicate that Chinese ETS design should optimize long-term coordination and mutual efficiency between the Chinese ETS and power market by implementing the regulation of indirect emissions with an upstream coefficient in the short-term to respond to the long-term gradual deregulation of the Chinese power market.

## Glossary

<b>Term</b>	<b>Definition</b>
Carbon Emissions Trading Scheme (ETS)	A policy approach to decarbonization in which a carbon market is created with limited allowances of carbon emission credits.
ETS benchmark	Mandated maximum level of carbon output. Regulated entities must comply through either increasing operational efficiency or purchasing credits on the carbon market.
Rate-based ETS	An ETS in which emission benchmarks are measured in carbon intensity. Entities must report emission tons per megawatt hour.
Direct emissions	Emissions from sources that are owned or controlled by the reporting entity.
Indirect emissions	Emissions that are a consequence of the activities of the reporting entity but occur at sources outside the entity.
Price pass-through	Transfer of cost when a business changes prices for consumers in response to a change in the cost of production.
Power market dispatch	Process by which the utility selects which generators will be assigned generation hours to meet demand.
Regulated power market	A vertically integrated power market in which government regulations dictate power dispatch, transmission, and pricing decisions.
Liberalized power market	A power market in which competitive market forces primarily drive dispatch, transmission, and pricing decisions.

## INTRODUCTION

On Tuesday, September 22nd, 2020 at the 75th session of the U.N. General Assembly, China's President Xi Jinping pledged to peak China's carbon emissions before 2030 and achieve carbon neutrality by 2060 (Reuters, 2020). As the world's largest carbon dioxide emitter, China's commitment signals a fundamental shift in the global fight against the climate crisis. China will need to make significant policy changes in order to meet these aggressive goals. A potential pillar of this policy push is the national emissions trading system (ETS). Officially launched in 2017 and coming into operation in 2021, China's ETS is the world's largest emissions trading scheme. The Chinese Ministry of Ecology and Environment hailed the ETS as the bedrock policy for realizing the country's carbon neutrality vision. The effectiveness of the Chinese ETS will have significant implications for the future of global carbon emissions. However, implementing this scheme amidst Chinese political and regulatory tensions is proving difficult.

Emissions trading schemes in power markets operate with two parallel goals: (1) impose a cost on carbon in order to incentivize the reduction of carbon emissions in energy production, and (2) use price signaling to incentivize consumers to either reduce their consumption of energy or shift to low-carbon alternatives. For emissions trading schemes operating in countries with fairly regulated power markets – such as China – this second goal is difficult to achieve. Within the Chinese power market, the government regulates most wholesale and retail prices, controls investments, and administers dispatch of demand through allocation of quotas (Acworth et al., 2020). This government intervention prevents emissions trading schemes in highly regulated markets from operating at maximum efficiency as government regulators often choose to keep prices artificially low to protect consumers and maintain balance (Coady et al., 2017). In effect, the regulated power market shields consumers from experiencing ETS market trends through

price-related signals. In order to reach China's goal of cutting national carbon intensity by more than 65% of 2005 levels by 2030 (Reuters, 2020), Chinese policymakers should devise a way to facilitate the pass-through of carbon prices to consumer electricity pricing. Literature suggests that this pass-through can happen through two different possible routes: (1) widespread reform of the Chinese power market to reduce administrative control and enlarge the role of market-based mechanisms, or (2) evolution in design of the Chinese emissions trading scheme.

## **RESEARCH QUESTION**

How can the Chinese emissions trading system (ETS) effectively send price-related signals to customers in a heavily regulated power market? Specifically, how can China overcome the immediate concern of facilitating carbon price pass-through in a heavily regulated market while simultaneously working towards long-term coordination between power market reform and ETS design to optimize mutual efficiency?

This paper has two main objectives: (a), to explore price-signaling methods used in the European Union and Republic of Korea (hereafter Korea) emissions trading systems through comparative case-study analysis, and (b), to apply these findings to the Chinese ETS context to make policy recommendations.

## **THEORETICAL FRAMEWORK**

There has been increasing interest in the intersection between emissions trading and power market dynamics as ETSS are being implemented or considered in many countries with non-liberalized power markets including, but not limited to, China, Korea, Japan, Vietnam, Mexico, Chile, and Ukraine (Acworth et al., 2020). This paper will center on China, drawing practical cases from the European Union (EU) and Korea. The literature situating the ETS within the Chinese power market generally diverges into two frameworks: those that assert that

power market liberalization is a prerequisite to successful ETS implementation (Fan et al., 2014; Jotzo & Löschel, 2014; Lo, 2016; Teng et al., 2014; Wang et al., 2018) and those that argue the Chinese ETS can and should be adjusted to exist within a heavily regulated power market (Acworth et al., 2020; Boute, 2017; Kim & Lim, 2014; Munnings et al., 2016; Zeng et al., 2018).

### **The Chinese Power Market**

While China has recently made significant investments to increase renewable energy capacity and generation, the nation's electricity portfolio is still dominated by coal. As of 2018, coal fuels the majority of electricity in China at 66% of electricity production (Cassisa et al., 2021). However, the renewable energy market is steadily increasing. The Chinese government has implemented wide-ranging reforms to encourage the growth of renewable energy installation through both supply and demand side tools such as feed-in-tariffs, renewable energy quotas, and a renewable energy consumption mechanism, to name a few (Terada et al., 2019). As a result, China is now the world leader in installed renewable energy capacity for hydropower, wind, and solar (Cassisa et al., 2021). Therefore, China is simultaneously leading in the competing markets of coal-power fleets and renewable power production. This market dynamic is further complicated by the regulatory role of administrative mechanisms in power market pricing and electricity dispatch.

As it stands, the Chinese power market is deeply regulated by government authorities. The Chinese National Development and Reform Commission (NDRC) handles the power market pricing and dispatch regulatory structure (Muller & Xiang, 2019). At the end of each calendar year, provincial authorities typically forecast electricity demand for each upcoming year and – according to the projected demand – allocate electricity generators a set number of hours to operate (Cassisa et al., 2021). This practice called “fair dispatch” ensures that generators within

the same industry class – coal, hydropower, natural gas, nuclear, solar, etc. – are allocated the same utilization hours (Ho et al., 2017). Provincial authorities also typically set retail electricity prices, transmission fees, distribution fees, and benchmark feed-in tariffs (Ho et al., 2017). As a result of this government control over power market dynamics, five state-owned power generation companies have historically been responsible for up to 47% of the nation’s power capacity – China Datang Corporation, China Guodian Corporation, China Huadian Group, China Huaneng Group, and China Power Investment Corporation (Dupuy et al., 2015). Therefore, while electricity dispatch and pricing in the European Union are the outcome of supply decisions of generators responding to market fluctuations, the power sector in China is largely guided by government planning agencies. The influence of market forces in the Chinese power sector is minimal (Ho et al., 2017). This reality has significant implications for the expansion and integration of renewable energy in the Chinese power market.

The regulatory approach to power sector management in China prevents renewable energy suppliers from selling at their fullest capacity, thus leading to curtailment (Tian, 2018). Energy curtailment is the purposeful reduction in energy output from the maximum possible load due to a system-wide oversupply (Dupuy et al., 2015). When provincial authorities allocate hours of operation to electricity generators oftentimes fossil fuel generation is given priority (Terada et al., 2019). Therefore, renewable energy generators must curtail their production. This renewable energy abandonment has reached rates as high as 43% in Chinese provinces (Terada et al., 2019). In a highly deregulated power market, an ETS would begin to address this curtailment by increasing demand for renewable energy. However, amidst the current regulatory controls of the Chinese power market, the Chinese ETS will have minimal impact on curtailment rates. While the ETS will indeed address supply-side emissions by increasing the marginal cost

of operating a firm that is heavily dependent on carbon emissions, these effects will not change the energy mix in dispatch decisions as provincial authorities continue to primarily operate under a fair dispatch framework. Further, demand-side effects – incentivizing consumers to reduce or improve the efficiency of their energy use – will not be reflected as consumers will not experience price pass-through amidst regulatory control over energy pricing (Acworth et al., 2019). Therefore, the current conditions under which the ETS is operating likely will not facilitate a reduction in renewable energy curtailment or accelerate a transition away from a coal-dominated energy mix. Two paths of intervention need to be explored to address this inefficiency: power market liberalization and ETS redesign.

### **Power Market Liberalization**

Liberalization of the Chinese power market would increase the efficacy of the ETS as an economic tool to reduce carbon emissions (Teng et al., 2017). Power market liberalization refers to a series of reforms aimed to increase the role of market forces in energy generation, dispatch, transmission, and consumption (Teng et al., 2017). In the Chinese context, this reform would mean that hours of generation and electricity prices are set in accordance to which firms have the competitive market advantage, not by provincial fair dispatch allocations. Firms with lower marginal costs will generally receive a competitive advantage in being able to set lower prices. For this reason, a more competitive and integrated Chinese power market would reduce renewable energy curtailment and accelerate changes in China's energy mix away from coal as ETS forces decrease the marginal cost of renewable energy generation relative to coal generation (Teng et al., 2017). Many scholars argue that without this liberalization, China's ETS will not be able to address renewable energy curtailment or accelerate a transition away from fossil fuels (Fan et al., 2014; Jotzo & Löschel, 2014; Lo, 2016; Teng et al., 2014; Wang et al., 2018).

The Chinese government has taken steps in recent years to begin to deregulate the power sector, but the nation still has a long way to go to transition from a vertically integrated industry to a competitive market (Ho et al., 2017). Since the turn of the century, the Chinese central government has made two significant pushes to liberalize the power market: (1) the national energy efficiency campaign included in the 11<sup>th</sup> Five Year Plan, and (2) the 2015 Decree No. 9 on “Deepening Reform of the Power Sector” (Ho et al., 2017). The core mechanism of the 2006-2010 campaign for energy efficiency in the 11<sup>th</sup> FYP was the Energy Conservation Dispatch (ECD) launched in 2007 (Ho et al., 2017). The pilot program took place in five provinces and sought to overturn the fair dispatch principle to prioritize clean and renewable generators (Ho et al., 2017). However, the program was never expanded to the national level. More recently, Decree No. 9 lays out guidelines to institutionalize electricity markets, deregulate pricing mechanisms, and prioritize clean energy dispatch (Ho et al., 2017). Although the plan boasts widespread reforms such as the establishment of spot markets, ancillary services trading, power trading centers, and retail competition, the market is still not operating at maximum efficiency as guaranteed generation from fair dispatch still largely persists (Cassisa et al., 2021).

Due to the lack of comprehensive reform from China’s central officials, the liberalization of China’s power market as it relates to ETS functioning has become a significant topic of interest with literature, largely converging on the importance of a least-cost dispatch system (IEA, 2021; Teng, 2017; Acworth, 2019; Paulson Institute, 2015). At its core, a least-cost dispatch system amplifies the role of market-based mechanisms in power dispatch and optimizes the cost of electricity production (Cassisa et al., 2021). Many scholars stress the importance of integrating carbon costs into a new dispatch system to align market signals with a low-carbon transition (IEA, 2021; Teng, 2017; Acworth, 2019; Paulson Institute, 2015). Acworth et.al take

this a step further by advocating a dispatch system that prioritizes low-carbon parameters above low-costs, thus minimizing environmental externalities rather than minimizing costs. Policy avenues alternative to least-cost dispatch include: a gradual transition from a single-buyer model for distribution and transmission to a wholesale competition model (Fan et al., 2014), shadow pricing to guide low-carbon dispatch without affecting the wholesale price paid to generators (Acworth et al., 2019), and exposing grid companies to costs associated with renewable energy curtailment to incentivize efficiency (Dupuy et al., 2015).

Many of the studies that advocate for liberalization of the Chinese power market rely on the European Union as an example to demonstrate the contingency of successful emissions trading on free market settings (Fan et al., 2014; Teng et al., 2014). However, there is a lack of scholarship on how these conditions would transfer to China given the current ETS and power market context. Factors such as the new ETS timeline, China's recent power market reform attempts, and political and regulatory tensions should be taken into consideration in order to decide if a liberalization model is feasible. Further, the International Energy Agency (IEA) suggests the timing of Chinese power market reform may not align with the ETS rollout and could potentially "complicate the application of allocation methodologies and benchmark-setting" (Cassisa et al., 2021). Boute also suggests it is not realistic to liberalize the power market in conjunction with the de-carbonization of the electricity supply. He argues that the political, social, and economic conditions in China are not conducive to the transfer of the European Union power market framework (Boute, 2017). Therefore, it is necessary to analyze the current status of the Chinese power market against emerging ETS policy design and the EU example case to determine if power market reform will be the most effective route to facilitate price pass-through of ETS market trends.

## **ETS Reform in a Regulated Power Market**

In the absence of power market liberalization, the Chinese emissions trading scheme as it stands will likely not be able to efficiently incentivize investment in lower-emissions power plants, change the merit order of electricity dispatch, or reduce electricity demand (Teng et al., 2014). However, there are methods to reform ETS design to address these shortcomings within the context of the principally regulated power market. Recent literature surrounding the reform of China's ETS to incorporate pricing pass-through within a regulated power market converges on the topic of indirect emissions (Acworth et al., 2020; Boute, 2017; Kim & Lim, 2014; Munnings et al., 2016; Zeng et al., 2018). As discussed above, China's ETS already regulates direct emissions released from electricity generation through an intensity-based quota allocation system. Indirect emissions, on the other hand, refers to the consumption of power. Regulating indirect emissions would require consumers to submit allowances for power usage. In theory, this practice would effectively eliminate the need for tariff regulators to directly drive-up electricity prices and, instead, would pass-through the marginal cost of production to consumers through allocating indirect emissions (Acworth et al., 2020). Therefore, regulating indirect emissions could incentivize consumers to reduce their consumption of energy and shift to low-carbon alternatives within the framework of a regulated power market (Munnings et al., 2016).

There is some general consensus on the potential benefits of introducing indirect emission regulations to China's ETS. However, there remains disagreement on both the extent of these benefits in China, the potential costs of regulating indirect emissions, and the feasibility of the application. In their study, Shim and Lee suggest that regulating indirect emissions may lead to inefficiency through double-counting of emissions. These extra permits from allocation schemes could exacerbate excess supply or demand (Shim & Lee, 2016). Kim and Lim argue

that using a emissions cap on indirect emissions could prevent double counting (Kim & Lim, 2014). However, this policy suggestion relies on the political feasibility of an absolute cap which has thus far been unsuccessful in China. Kim and Lim suggest that it would be feasible to overcome criticism of double-regulating and high administrative cost, but this is yet to be seen. Adding to the debate on double-counting, Zeng et al. argue that regulating indirect emissions does indeed lead to double-counting of emissions but, contrary to popular belief, this double-counting will not result in additional carbon leakage (Zeng et al., 2018).

In sum, the net benefit of regulating indirect emissions to facilitate price pass-through remains largely unknown. The current discussion can be strengthened through case analysis of current implementation of indirect emissions regulation in Korea.

This paper looks to use EU and Korea case studies to determine the full benefits and costs of liberalizing the Chinese power market, as demonstrated in the EU case, and facilitating price pass-through within a regulated market, as demonstrated in the Korean case. It is essential to address this issue of price-signaling in the early stages of China's national ETS to avoid any foregone mitigation potential. In order to do so, we must first determine how these interventions can provide policymakers solutions to improve the functioning of the ETS, and then go on to analyze how the two streams can coordinate to maximize efficiency.

## **OBSERVABLE IMPLICATIONS**

- If the EU ETS case study provides an applicable model for the liberalization of the Chinese power market, I expect to discover a path to liberalization that is consistent with the Chinese timeline, political pressures, and prior reform efforts.
- If the Korean ETS addresses price pass-through in its regulated power market, I expect to observe adjustments to their carbon pricing methods.

- If the Korean ETS caps indirect emissions as a form of price-pass through, I will observe extensive policy describing and justifying this intervention. I will also observe industry and consumer response to these policies, which will be important for setting the context.
- If the Korean ETS has policy interventions transferable to the Chinese context, then I will observe similar regulatory structures and pricing methods as used in China. If I do not observe these trends, I will need to utilize differences to make policy recommendations.

## **METHODS**

This study focuses on 1) the interaction between emissions trading markets and regulated power markets in passing-through carbon price to electricity price, 2) the potential for reform of the Chinese power market to a more liberalized model, 3) the regulation of indirect emissions to send price-related signals in non-liberalized power markets, and 4) possible alternative policy interventions to facilitate price-related signaling in the Chinese ETS. Instead of examining price signaling in every existing ETS market, this study utilizes a comparative case-study approach by narrowing in on the European Union, Korea, and China. This study examines the European Union Emissions Trading Scheme (EU-ETS), the Korean Emissions Trading Scheme (K-ETS), and the Chinese Emissions Trading Scheme (C-ETS), respectively. This is a qualitative analysis that draws concepts and positions from each case to ultimately make policy recommendations for price-signaling in the Chinese ETS.

The dataset for this comparative case-study is comprised of literature from 1996 to October 2021. The timeframe was selected to follow the development of the EU, Korean, and Chinese emissions trading schemes operational in 2005, 2015, and 2021, respectively, and the liberalization of the EU power market which commenced in 1996. This study analyzes documents related to ETS development and power market reform in this timeframe, specifically

focusing on the latest iterations of policy as it stands today. The study considers government documents, reports, evaluations, working papers, and other forms of grey literature pertaining to ETS structure released before and after the start of the formal emissions trading systems. These three cases – Korea, the EU, and China – were selected for their varying ETS development timelines and power market structures.

### **European Union**

Originally launched in 2005, the European Union emissions trading system entered stage four in January 2021. This stage continues the single, EU-wide cap of emissions over nations, implements auctioning as the primary form of allocating allowances, and invests in low-carbon transition innovation mechanisms (Commission, 2021). Previous to the launch of the C-ETS, the EU-ETS was the world's largest carbon-market. The EU-ETS operates in all EU countries plus Iceland, Norway, and Liechtenstein. Having gone through three previous iterations of ETS design, the European Union provides a robust example of policy for an ETS in a very liberalized power market. The EU-ETS lends to drawing conceptual frameworks for both the initial stages of Chinese ETS policy design and projecting how these interventions may hold up over time. It is important to note that the EU-ETS operates on a cap and trade model while the Chinese ETS is a tradable performance standard, this is taken into consideration in policy analysis and recommendations. EU-ETS policy design, trends, failures, and impact are analyzed to make suggestions about the feasibility of further liberalizing the Chinese power market in order to facilitate price pass-through. While power market liberalization is already stated as a long-term Chinese policy goal, it is still unknown if deregulation of the power market can serve to effectively send price related signals in the Chinese emissions trading scheme.

## **Republic of Korea**

Launched in 2015, the Korean emissions trading scheme entered phase three in January 2021. The Korean ETS is East Asia's first nationwide mandatory ETS and, at the time of its launch, was the second largest carbon-market after the EU-ETS (Partnership, 2021). Similar to the EU-ETS, the Korean ETS has undergone a series of changes. This comparative case study tracks K-ETS policy development and reveals potential failures for China to avoid in C-ETS implementation. Similar to China, the Korean ETS operates within a fairly regulated power market. This is beneficial to the case because it allows the analysis to hold power market conditions relatively constant while focusing on the interaction between ETS design and price pass-through. The main policy tool for price pass-through in the Korean ETS is the regulation of indirect emissions. While the regulation of indirect emissions is the primary focus of the case study, the analysis covers the full scope of the Korean ETS design to reveal any additional possible policy interventions.

## **China**

Conceptual frameworks for ETS price pass-through drawn from the available EU and Korea cases are embedded within the current Chinese context. The lessons gleaned from the development of price-pass through – or lack thereof – in the EU and Korean cases guide my policy recommendation for the Chinese national ETS. The analysis focuses heavily on situating the concepts within Chinese ETS design, scale, politics, and upcoming power sector reform. Ultimately, the goal of the analysis is to decide the best avenue for facilitating price pass-through: power market liberalization, regulating indirect emissions, or a third solution that may be revealed through data collection.

To help conceptualize some of the differences between the EU, Korea, and China case studies, the table below outlines key features of each ETS and power market that will be mentioned throughout the analysis.

**Table 1. Key Power Market and ETS Design Characteristics**

	China	Korea	EU
Absolute cap	No	Yes	Yes
Indirect emissions	No	Yes	No
Industry-wide	No	Yes	Yes
Auctioning	No	Some	Some
Regulated wholesale	Yes	Yes	No
Regulated retail	Yes	Yes	No
Environmental dispatch	No	Pilot	Yes
Spot markets	Pilot	No	Yes

■ ETS Element ■ Power Market Element

The table clearly shows that, as stated above, the power market conditions of China and Korea are fairly similar – both having primarily regulated wholesale and retail markets while the EU power market is very liberalized. On the other hand, the ETS design in Korea and the European Union are more closely aligned with the exception of the regulation of indirect emissions in Korea. China, however, defers from both ETS schemes in these design aspects. Each of the policy design characteristics in this table are mentioned in the following case study analysis.

## DATA

### Document Analysis

This study relies heavily on government documents, reports, evaluations, working papers, and other forms of grey literature for data collection. The documents were identified by relevance to the respective emissions trading systems – documents pertaining to pilot emissions

trading systems of Korea and EU are not be considered in the study. Each document was systematically coded in a hierarchical framework using Microsoft Excel software in order to elicit concepts and positions for each case and identify theoretical gaps. The hierarchical breakdown of the codes can be found in Appendix A. This document analysis informed the creation of the European Union, Korea, and China case studies for comparative analysis. The following government websites were used as the primary sources for attaining the documents 1) European Union: Europa.eu, 2) Korea: Korea.Net, and 3) China: Ministry of Ecology and Environment of the People's Republic of China and National Development Reform Commission. Documents from Korea and China rely on English translations for analysis.

### **Interviews**

Along with document analysis, this study utilizes a selection of interviews with scholars to provide additional context for the three case-studies. Two to three scholars were interviewed for each case-study: European Union, Korea, and China (see Appendix B for list of interviewees). The interviews fill gaps where the documents are not able to lend insight including the following areas: upcoming reform efforts, political feasibility, and practicality of policy implementation. Scholars with intersectional knowledge across cases were prioritized in the selection process. Interviews were recorded using QuickTime Player Audio Recording software. The interviews lasted 25-30 minutes.

A semi-structured interviewing method was used to tailor each interview guide to the context of the case-study and policy recommendation. The interviews were guided by six case-specific questions (see Appendix C, D, and E for the interview guides). The interviews underwent thematic content analysis by using hierarchical coding for positions in NVivo

software. The hierarchical breakdown of the codes can be found in Appendix A. Interview findings were utilized to support the formulation of the three case-studies.

## **EMPIRICAL RESULTS**

The following three case studies are the result of primary document analysis and expert interviews. This case study analysis will inform the final policy recommendations for the pass-through of the cost of carbon in the Chinese emissions trading scheme.

### **CASE STUDY #1: REPUBLIC OF KOREA**

**Key Takeaway:** As it stands, the Korean Emissions Trading Scheme (K-ETS) has not been effective at sending price-related signals to the wholesale electricity market. The K-ETS regulates indirect emissions, but this policy mechanism has been largely ineffective at encouraging energy mix transition and energy consumption abatement due to the high shares of free allocation and the Korean government's cost compensation policy for the wholesale electricity market. The K-ETS case study produces three key takeaways for Chinese application:

1. Indirect emissions regulation is not highly effective in ETS schemes with considerable levels of free allocation, as is currently true for the Chinese ETS.
2. In the long-run, the introduction of free market pressures into the power market will require indirect emissions to be phased out of ETS design because carbon cost pass-through will be reflected in wholesale and retail pricing.
3. The regulation of indirect emissions is a rather flexible policy tool and can be evolved to fit new power market conditions.

### **Power Market Conditions**

The Korean electricity market is a day-ahead wholesale market run by Korea Power Exchange (KPX) and Korea Electric Power Corporation (KEPCO) (Agency, 2021). There are

currently six state-owned power generation companies making up the majority share of power generation in Korea. These generators, in addition to independent power producers (IPPs) and community energy systems, produce the power for Korea. KEPCO operates 100% of Korea's power transmission, distribution, and retail (Agency, 2021). In addition to the wholesale market, KPX operates the power system and real-time dispatch. This market structure is commonly referred to as a "cost-based pool" market (Agency, 2021).

Wholesale and retail prices in the Korean power market are fairly regulated by the government. Korea's wholesale electricity costs are determined by the regulator on a monthly basis per technology. Pricing is set on a daily basis through a price setting schedule that follows a least-cost dispatch framework (Acworth et al., 2021). The marginal power plant always receives the highest settlement price and priority in the merit order. Currently, three power sources operate at the margin in Korea: liquefied natural gas, oil, and pumped storage power plants (Vivid-Economics, 2018). Over the past few years, KEPCO has reported growing losses due to low, regulated retail electricity prices (Acworth et al., 2021). It is important to note that the public in Korea is very sensitive to electricity price changes, one interviewee stated, "in Korea, the people think of electricity as a public good and they think that it needs to be supplied at very low costs so they are extremely resistant to price change."

Korea has officially set a target goal for reaching carbon neutrality by 2050 (Agency, 2021). As it stands, The Korean market, much like the Chinese market, is dominated by coal with 40% of total generation in 2019 accounted for by coal-fired power plants (Acworth et al., 2021). Korea's carbon neutrality goal will be achieved by increasing the share of renewable energy sources in the nation's installed capacity, phasing out coal, improving energy efficiency, and supporting the development of the hydrogen industry (Agency, 2021).

## **K-ETS Design**

Launched in 2015, the Korean ETS covers six sectors: heat and power, industry, buildings, domestic aviation, waste, and public services (Acworth et al., 2021). In the Phase I compliance period (2015-2017), the K-ETS covered 525 business entities (Afriat et al., 2015). For context, this is significantly fewer than the 2,000 companies regulated at the outset Chinese ETS which only covers the power sector (Partnership, 2021). Unlike the C-ETS, the K-ETS is managed under a cap-and-trade model in which a mass-based cap is set for total emissions (Partnership, 2021). The Korean ETS allows domestic offset credits and international clean development mechanism (CDM) projects operated by Korean companies to fulfill up to ten percent of each entity's compliance obligation (Partnership, 2021). Further, the K-ETS includes the regulation of both direct and indirect emissions.

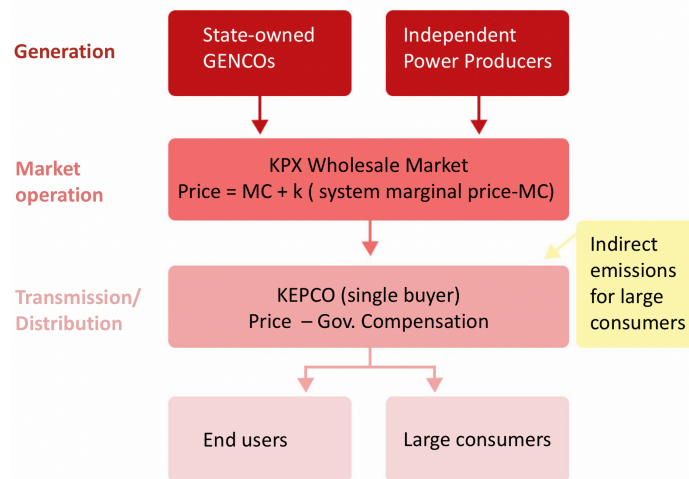
As the Korean ETS enters Phase III (2021-2025), the market design continues to evolve. Key reforms in Phase III include the introduction of third-party participation and increasing shares of auctioned allocations to at least ten percent (Acworth et al., 2021). Interviews conducted for this paper with subject experts on the K-ETS design revealed that the increase in the share of auctioning will be viewed as a key reform to improve K-ETS efficiency in the near future. Interviewees described the main conversation surrounding ETS policy design in Korea reflecting that “at this moment, ETS designers are mainly focusing on what portion of the allocations will be free in power generation sectors.”

## **Cost Pass-Through Mechanisms**

Given that the Korean ETS is operating within a fairly regulated power market, the transfer of EU-ETS design to the Korean context would not facilitate the pass-through of carbon costs on electricity prices (Boute, 2017). Although the Korean power market operates under a

least-cost dispatch framework, the wholesale market has been granted a compensation mechanism to prevent the pass-through of carbon costs (see Figure 1 below). The compensation tool requires KEPCO to absorb the price that generators spend on the purchase of allocations in exchange for a government rebate (Yoo, 2021). Thus, there is no reflection of carbon cost distributed in retail prices. This lack of downstream price realization offers the K-ETS as a suitable case study for C-ETS design even amidst a least-cost dispatch system. The designers of the Korean ETS introduced the regulation of indirect emissions to overcome the challenge of price pass-through. The design and management of the K-ETS indirect emissions regulation is explored in-depth to elicit policy recommendations for the Chinese context.

**Figure 1. Korean Power Market Pricing Mechanisms**



***Regulation of Indirect Emissions***

The Korean “Framework Act on Low Carbon Green Growth” defines GHG emissions as “both direct emissions of greenhouse gases..., and indirect emissions of greenhouse gases, which refers to discharges of greenhouse gases using electricity or heat (limited to emissions from a heat source generated with fuel or electricity) supplied by another person” (“Framework Act on Low Carbon Growth,” 2014). Covering both direct and indirect emissions allows for the

reflection of carbon allowance costs in wholesale electricity prices in a power market in which the price of electricity is controlled by the government. This regulation transfers a portion of the burden of emissions abatement to large consumers, broadens the base for regulated sectors, and provides incentives for consumers to reduce electricity consumption (Oh et al., 2015).

The K-ETS specifically covers indirect emissions for large electricity consumers. Consumers of electricity and heat emitting more than 125,000 tCO<sub>2</sub>/year over the three years prior to the beginning of the trading period are required to hold and surrender obligations for emissions associated with electricity consumption (Environment, 2020). In Phase 1, indirect emissions accounted for 17% of emissions covered by the K-ETS (GIR, 2020). Indirect emissions are calculated by multiplying independent facility consumption levels with the average carbon intensity of electricity generation (Acworth et al., 2021). In theory, these large electricity consumers will reinstate the allowance price signal downstream (Acworth et al., 2019).

It is difficult to measure the impact of indirect emissions on price pass-through, and there has been little research to assess its effectiveness in the context of the K-ETS. A recent study indicates that the downstream effects have been limited. This study suggests that a decline in shares of free allocation may improve the efficacy of carbon price revelation from indirect emissions regulation (Acworth et al., 2021). Interviews conducted for this study corroborate these concerns and also suggest that the previously mentioned government compensation mechanism may likely be cancelling out the effects of the regulation of indirect emissions (Kim, 2021; Yoo, 2021). While the efficacy of the regulation of indirect emissions remains ambiguous, experts point to upcoming ETS and power market reforms as a potential source for pass-through (Acworth et al., 2021).

## **Upcoming Power Market Reform – Environmental Dispatch**

Generally described as “environmental dispatch,” the Korean government is projected to introduce the pass-through of carbon costs into the wholesale electricity market through the elimination of KEPCO’s compensation fund. According to the Korean Ministry of Trade, Industry and Energy’s 8<sup>th</sup> Basic Plan for Long-Term Electricity Supply and Demand, the policy is expected to be introduced in 2022 and become operational by 2024 (Ministry of Trade, 2017). Interviewees reaffirmed that this is the current trajectory of policy discussions in the nation as it stands. In effect, the policy would reflect net allowances costs in system marginal price in the wholesale electricity price (Ministry of Trade, 2017). This policy mechanism has been highly anticipated since Acworth et al. conducted a large sample of interviews with K-ETS experts and, ultimately, recommended environmental dispatch be implemented as the most necessary policy evolution for power market pricing in Korea (Acworth et al., 2021). If implemented, this reform would prevent KEPCO from internalizing net allowance costs and, thus, ensuring these costs are (mostly) passed-through to the retail market.

This environmental dispatch reform will remove the need for the regulation of indirect emissions within the K-ETS. If carbon costs are being reflected to the consumer both through market electricity prices from environmental dispatch and through the regulation of indirect emissions then the consumer will be doubly burdened for carbon costs, known as “double counting” of carbon emissions. Therefore, the Korean government will need to devise a plan to phase-out indirect emissions from the ETS market. However, during an interview a K-ETS subject-expert explained the need for the continued involvement of indirect emissions in the K-ETS in order to maintain the broad base of regulated entities and retain market liquidity stating, “when we exclude the regulation of indirect emissions from the K-ETS we will see significant

decrease of the number of regulated entities in the K-ETS given the current participation requirements.” A reduced K-ETS market size is not conducive to fostering market competition. Therefore, a policy mechanism will need to be devised to prevent this market shrinkage. The ultimate direction of this policy pathway will have significant implications for the policy design evolution of the Chinese ETS as both phase-out and transformation of indirect emissions will demonstrate the potential flexibility or – if unsuccessful – inflexibility of indirect emissions regulation.

## **CASE STUDY #2: EUROPEAN UNION**

**Key Takeaway:** The European Union case study is important to the temporal considerations of Chinese ETS development as it represents a potential long-term power market reality in which China completely integrates free market competition. The EU case study suggests such a transition would improve the efficiency of ETS functioning, but would require key changes to C-ETS design as reflected in EU-ETS design. Ultimately, the power market conditions underlying the functioning of pass-through in the EU-ETS are not conducive to transplant in the C-ETS in the short-term, but can be used to guide long-term recommendations.

1. Once implemented, power market liberalization is the most seamless tool to pass-through the price of carbon imposed by an ETS onto consumers.
2. However, power market liberalization is estimated to require a 12-15 year timeline until competitive market forces dictate and pass-through prices to consumers without manipulation or discrimination.
3. As it stands, the EU model of an ETS functioning within a liberalized power market is not conducive to transplant to the Chinese context given the timeline of national

decarbonization commitments. Lessons from the EU case should influence long-term coordination between Chinese power market reform and ETS design evolution.

### **EU-ETS Design**

The European Union ETS operates over 30 total jurisdictions: 27 EU Member States and three European Economic Area-European Free Trade Association states (icap, 2021c).

Launched in 2005, the EU-ETS is currently entering its fourth trading phase (2021-2030) and covers the power sector, manufacturing industry, and aviation. The EU-ETS is a mass-based, absolute cap system with a single EU-wide cap for stationary sources (icap, 2021c). At the onset of the EU-ETS, free allocation was utilized for the power generators and included the opportunity cost of allowance on electricity prices (Commission, 2021). This beginning phase of ETS design (2005-2007) aligns most closely with the current Chinese ETS design and, thus, provides the best reference of comparison.

The EU-ETS introduced significant policy changes in July 2021 with the “Fit for 55” package (icap, 2021c). This reform package includes: a cap reduction; introduction of the maritime sector in 2023; the build-out of a separate fuel ETS for buildings and transportation; strengthening of benchmarks; reduction of free allocation; introduction of a “carbon border adjustment mechanism (CBAM)” for imported goods; and updated regulations for revenue streams to overcome distributional effects and encourage innovation (icap, 2021c). These policies will all continue to expand and strengthen the EU-ETS as a decarbonization tool.

### *Carbon Price Pass-through*

The EU-ETS is able to facilitate pass-through of the price of carbon to the final consumption stage due to the large role of free market competition in the EU power market. The EU power market is (generally) very liberalized, meaning there is minimal government

regulation of pricing, transmission, and dispatching decisions. Therefore, carbon prices incurred by ETS benchmark requirements should increase the cost of carbon-intensive energy. This increase, in turn, should impact retail pricing in the EU member states' electricity markets. As it stands, the parent document for the regulation of the EU-ETS (Directive 2003/87/EC) does not make an explicit reference to a tool to facilitate the pass-through of carbon prices beyond the influence of competitive market forces in setting electricity pricing (Parliament, 2003). The only reference to price pass-through is within Article 10b in which district heating and efficiency cogeneration are granted free allocation indefinitely due to the inability to "pass on costs of allowances in product prices" (Parliament, 2003). Beyond this reference, there is no intervening variable in policy construction to describe the pass-through of carbon costs to consumers.

In theory, carbon costs should be passed-through to end consumers in the EU-ETS due to the least-cost dispatch framework within the liberalized power market. In the EU-ETS, each carbon certificate holds value in the exchange market, whether or not the certificate is allocated freely or auctioned. The possibility to sell certificates at the market price will incentivize suppliers to only produce an additional megawatt hour of electricity if the profit from that production will equal or exceed the revenue from selling the emissions credit on the exchange market. Therefore, the price of electricity requested by suppliers will include both the production cost and opportunity cost originating from the value of the emissions certificate (Vance, 2012). As such, the carbon price should be reflected in the price of electricity in a competitive market. This pricing framework has been supported in studies that link the implementation of the EU-ETS with changes in electricity prices across the pilot phase, phase one, and phase two of EU-ETS operations (Ahamada & Kirat, 2018).

The pass-through of carbon costs in the EU-ETS is especially pertinent to projecting long-term coordination between China's ETS design and power market reform. From this analysis, it is clear that carbon price pass-through is quite seamless in the liberalized power market. Carbon costs are reflected in electricity prices without need for additional regulations or administrative interventions. If China were to pursue continued power market liberalization, it is likely that the cost of carbon would be passed-through to end consumers without need for government intervention.

### **Power Market Liberalization**

The EU energy sector operates under a set of internal market rules that dictate energy policy to avoid significant fragmentation along national lines (Muller & Xiang, 2019). The European Agency for the Cooperation of Energy Regulators (ACER) is the main authority for ensuring cooperation between national regulatory bodies and European Union developments (Commission, 2021). The European Union power market has been gradually liberalized since 1996, opening production and supply to competitive forces (Commission, 2021). The liberalization process of the EU power market generally took the following steps: sector restructuring, introduction of competition in wholesale and retail markets, incentive regulation of transmission and distribution networks, establishment of an independent regulator, and privatization (Pollitt, 2005). There were two main drivers of EU liberalization, (1) EU electricity market directives requiring member countries to take designated steps on a controlled timeline, and (2) European Commission efforts to improve coordination between markets by improving cross-border trading (Pollitt, 2005). The gradual liberalization of the EU power market has temporal implications for the long-term planning of Chinese ETS design.

The EU internal power market liberalization process was primarily driven by two EU Electricity Market Directives, phase one in 1996 and phase two in 2003 (Parliament, 1996, 2003). The Directives of 1996 and 2003 both address the vertical unbundling of industry, horizontal separation of competition, and the gradual opening of national markets (see Table 2 below).

**Table 2. EU Electricity Market Directives**

	Most common Form pre-1996		1996 Directive		2003 Directive
Generation	Monopoly	→	Authorisation Tendering	→	Authorisation
Transmission (T)	Monopoly	→	Regulated TPA Negotiated TPA	→	Regulated TPA
Distribution (D)	Monopoly	→	Single Buyer		
Supply	Monopoly	→	Accounting separation	→	Legal separation from transmission and distribution
Customers	No Choice	→	Choice for Eligible Customers (=1/3)	→	All non-household (2004) All (2007)
Unbundling T/D	None	→	Accounts	→	Legal
Cross-Border Trade <sup>3</sup>	Monopoly	→	Negotiated	→	Regulated
Regulation	Government Department	→	Not specified	→	Regulatory Authority

Source: (Vasconcelos, 2004)

While the European Commission continues to report that the 1996 and 2003 policy packages effectively led to the liberalization of all member countries' power markets by 2008 (except Bulgaria and Malta), an independent inquiry revealed significant gaps (European-Commission, 2020). The DG Competition EU Energy Sector Inquiry began in 2005 and was completed in 2007. The report identified “serious competition problems” within the EU electricity market. Barriers still remained to opening the market to competition including: low liquidity; lack of integration between EU member markets; high market concentration; binding long-term contracts; and limited transparency leading to distrust of market pricing (Competition-

DG, 2007). In response to these findings, a third legislative package was proposed in 2007 to strengthen legislative support for unbundling of transmission assets (Pollitt, 2009). The third Electricity Market Directive was passed in 2009 that included an economically efficient unbundling regulation to address discrimination in network operations and remove any conflict of interest between producers, suppliers, and transmission system operators (Parliament, 2009).

The 2009 Directive was repealed and replaced in 2019 with an updated Directive that was released as part of the Clean Energy for All Europeans package (Parliament, 2019). Clean energy is further intertwined with liberalization plans in the passage of the Regulation on the Governance of the Energy Union and Climate Action by the European Parliament in December 2018. This legislation emphasized the EU's binding 2030 energy and climate targets and called for increased power system flexibility through "mechanisms for dispatching, re-dispatching and curtailment and real-time price signals" (Parliament, 2018). This document serves as the primary regulation on governance of the "Energy Union Strategy" published by the European Commission in 2015 which aims to build an energy union to deliver "secure, safe, competitive and affordable energy" (Commission, 2015). Also guiding the implementation of the Energy Union Strategy is the Clean Energy for All Europeans package which provides a legal framework to stimulate necessary public and private investment (Directorate-General, 2019).

### *Temporal Considerations*

The extended timeline of power market liberalization can be used to extrapolate feasibility of liberalizing the Chinese power market in order to facilitate carbon cost pass-through in the Chinese ETS. As stated above, the liberalization of the EU power market initiated formally in 1996 and was deemed "complete" in 2008. However, this timeline does not account for the additional market regulations passed in the 2009 Directive or pre-1996 planning phases.

Therefore, a more complete timeline of EU power market liberalization can be estimated to have taken 12-15 years. If applied to the current Chinese context – which has already undergone some of the initial phases – this would roughly place Chinese market liberalization around 2032-2034. Considering China’s President Xi Jinping pledged to peak China’s carbon emissions before 2030 and the Chinese ETS will presumably be a key policy pillar in the effort, this timeline is not feasible (Reuters, 2020). If Chinese policymakers intend to utilize the national emissions trading scheme to send price related signals to consumers and slow the trajectory of the climate crisis before 2030, then this pass-through cannot be contingent on power market liberalization.

### *Priority Dispatch*

While the five overarching Electricity Market Directives regulate the general liberalization of EU member country power markets and the establishment of an internal EU market, there has also been an additional set of actions directed towards managing renewable energy in a liberalized market. The primary concern of such regulation is the topic of priority dispatch. The provisions of Directive 2012/27/EU are the first binding commitment to priority dispatch for renewables in the European Union mandating “priority or guaranteed access to the grid of electricity from high-efficiency cogeneration” (Parliament, 2012). However, a 2017 white paper published by the Agency for the Cooperation of Energy Regulators (ACER) and the Council of European Energy Regulators (CEER) on “Renewables in the Wholesale Market” advocates for the “prohibition of priority dispatch to existing renewable energy source plants, so that all technologies compete fairly in the market to deliver the lowest possible cost to consumers” (CEER, 2017). Priority dispatch is yet to be fully prohibited but this quick government reversal should give pause to other jurisdictions seeking to implement priority

dispatch, especially in a power market in which consumers are especially sensitive to price change such as China.

### **CASE STUDY #3: CHINA**

**Key Takeaway:** Document analysis coupled with insights from interviews with subject-matter experts informed the following compilation of anticipated reforms in the policy evolution of the Chinese ETS and power market structure. On the C-ETS side, upcoming reforms to consider include the introduction of a mass-based cap and market expansion to include large, industrial end-users. On the power market side, the policy streams of most concern to ETS price pass-through are the development of tiered dispatch, floating price benchmarks, and regional electricity spot market pilots. This context is crucial for the subsequent policy recommendations.

#### **Anticipated ETS Reform**

##### ***Introduction of a Mass-Based Cap***

According to expert interviews, the transition to a mass-based cap is likely to be one of the first ETS reforms implemented with the rollout of subsequent policy documents to the 14<sup>th</sup> Five Year Plan. Such a policy move would replace the current intensity-based scheme with a cap-and-trade benchmark. Currently, the intensity-based system only incentivizes efficiency in power generation, which can send the unintended signal that it is more profitable for fossil-fuel generators to scale-up rather than transition away from coal. A mass-based cap has the potential to incentivize both efficiency of units and diversification of energy portfolios away from coal (given the feasibility of alternatives). This move would also send an important industry-wide signal because a cap on carbon emission in the system implies an imperative for decarbonization which is important because the power sector needs to peak and start a downward trajectory if China is to meet carbon neutrality goals (Slater, 2021).

Implementation of an absolute cap would align the C-ETS policy design closer with existing mechanisms in the K-ETS and EU-ETS. Additional research is needed to provide detail on what this transition would look like, how trading would be conducted in the interim, and what mechanism will be used to stabilize prices.

### ***Expansion to Steel, Cement, and Aluminum Sectors***

A specific timeline for the expansion of the C-ETS into the steel, cement, and aluminum sectors has not been identified. Expert interviews generally estimated 2-4 years until this expansion happens at the national ETS level, but the sample size is not large enough to make a direct assertion about the reliability of this timeframe. The argument for expansion into these three sectors is supported in document analysis as the seven pilot emissions trading schemes each covered direct emissions in these industries (icap, 2021a). Further, together these industries represent a significant minority of China's national carbon emissions, so the nation will need to incentivize decarbonization of these sectors to reach climate change commitments (Chen et al., 2017). Lastly, in October 2021, the Chinese government released notice that officials will formulate energy efficiency reference and benchmark levels for these sectors during 2021-2025 in support of peaking carbon emissions before 2030 (Argus, 2021). This announcement signals a definitive shift in the willingness of Chinese officials to clamp down on industry emissions.

### **Anticipated Power Sector Reform**

Since the release of Document No.9 in 2015, the Chinese government has advanced significant power sector reforms such as the market for ancillary services, the expansion of cross-regional mid- and long-term trading, and the adoption of surplus renewables trading. While each of these developments will be crucial to the liberalization of the Chinese power market, the policy streams most consequential for ETS price pass-through are the efforts to

implement tiered dispatching, the proposal for a floating price benchmark, and the scale-up of short-term electricity market pilots (hereafter “spot markets”). While each of these policy pathways are still early in development, the recent commitments signal that Chinese leaders are likely preparing for a future in which power market liberalization is the primary policy trajectory.

### ***Tiered Dispatch***

Chinese officials have released a new set of regulations for the tiered dispatch of the Chinese power market. In October 2021, the National Development Reform Commission (NDRC) released the “Implementation Opinions on Deregulating the Plans for Electricity Generation and Usage” (关于有序放开发用电计划的实施意见) which outlines a recommendation for a tiered power generation dispatch system (NDRC, 2021). The new regulation seeks to give priority generation to renewable energy. At face value, this policy suggests an acceleration in China’s pathway to diversification of the energy mix. However, according to expert interviews, similar policies advocating for tiered dispatch have been proposed in the past and failed to reach implementation due to significant resistance from industry (Lan, 2021). Further, the top tier of dispatch does not only include renewables, but also to low-emissions coal fired units (NDRC, 2021). Lastly, even in the face of these new dispatching ordinances, long-term coal contracts will continue to persist which guarantee quota for dispatch. As such, tiered dispatch should be front of mind for the design of new ETS mechanisms, but likely will not see impact in the short-term.

### ***Floating Prices***

In October 2019, the NDRC released “Guiding Opinions on Deepening the Reform of the On-grid Tariff Formation Mechanism for Coal-fired Power Generation” (国家发展和改革委员会

会关于深化燃煤发电上网电价形成机制改革的指导意见) (NDRC, 2019). This document introduces a market-based pricing mechanism into the coal-fired power generation benchmark to include both base price and “fluctuations” which change in accordance with market development. The benchmark fluctuation range is capped at 10 percent on either end. This is a significant policy development for the gradual liberalization of the Chinese power market.

### ***Spot Markets***

The regional spot market pilot effort is the primary mechanism of the Chinese government for revealing the actual value of electricity in the short-term market. The NDRC and National Energy Administration (NEA) have yet to release a definitive plan for the medium- and long-term spread and scale-up of current spot market design. However, the current trajectory of policy development and recent commitments to power market price reform goals suggest a continued effort to market spot market price formation and reflection.

Eight regional pilot spot markets were announced in 2017 with the release of “The General Office of the NDRC and General Department of the NEA Announcement on the Pilot Work for the Construction of Electricity Spot Markets” (国家发展改革委办公厅 国家能源局综合司关于开展电力现货市场建设试点工作的通知) (NDRC & NEA, 2017). The eight pilot markets – Guangdong, Mengxi, Zhejiang, Shanxi, Shandong, Fujian, Sichuan, and Gansu – started settlement trial operation by July 2020 (NDRC & NEA, 2020). Designed as a mechanism to increase the influence of market-based trends in electricity generation and pricing, the spot markets are not regulated by the on-grid price tariff or fair-dispatch system (Muller & Xiang, 2019). The spot markets utilize real-time electricity trading, formulate market clearing prices, and guide electricity production and consumption through flexible market price signals (NDRC & NEA, 2019).

The introduction and expansion of spot markets has significant implications for ETS development because the spot markets introduce price related signals into electricity generation and distribution. In combination with the ETS, these spot markets provide an outlet to pass-through carbon prices to consumers. Any policy design aimed at facilitating price pass-through within the Chinese ETS will need to account for the current reality of spot market trading. Policy analysis of documents from the NDRC and NEA affirm the commitment to spot market development in coming years. The 2020 “Notice on Further Doing a Good Job in Continuous Trial Settlement of Electricity Spot Market Pilots” makes such a commitment:

“三是强调了电力现货市场价格信号对电力生产、消费的引导作用。随着新能源发电快速发展，电力系统供需双侧的随机性和波动性不断增强。为了促进可再生能源消纳，充分调动电力系统中各类资源“削峰填谷”积极性，需要进一步完善电力现货市场价格形成机制，保证市场价格能切实反映系统实际供需情况，还原电力的商品属性。” (NDRC & NEA, 2020)

“The third pillar is to emphasize the guiding role of electricity spot market price signals for electricity production and consumption. With the rapid development of new energy power generation, the volatility on both sides of the power system's supply and demand continues to increase. In order to promote the consumption of renewable energy and fully mobilize various resources in the power system to ‘shake peaks and fill valleys,’ it is necessary to further improve the power spot market price formation mechanism to ensure that market prices can truly reflect the actual supply and demand of the system and restore the commodity attributes of electricity.” (NDRC & NEA, 2020)

This commitment to further developing the spot market price signal is substantiated by the release of the 2020 “Measures for Disclosure of Electricity Spot Market Information” which

establishes extensive guidelines to standardize the method of information disclosure and build-out a supervisory authority (NEA, 2020). Additionally, the announcement of the “14<sup>th</sup> Five-Year Plan for Economic and Social Development” includes a renewed dedication to power market reform (“Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035,” 2021). The document highlights the Government’s dedication to improving the price formation mechanism for energy use, specifically stating:

“深入推进山西国家资源型经济转型综合配套改革试验区建设和能源革命综合改革试点”

“We will promote in an in-depth manner the construction of a comprehensive reform pilot zone for the transformation of the national resource-based economy in Shanxi and a comprehensive reform pilot project for the energy revolution.” (“Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035,” 2021)

While subsequent policy documents from the NDRC and NEA detailing the development of this initiative have yet to be released, this statement clearly identifies a commitment to power market reform over the next five years. This sentiment is echoed in Articles XI, XII, XXXIX, and XXVIII (“Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035,” 2021).

Given these recent and ongoing commitments to spot market advancement, it will be necessary for an ETS price pass-through mechanism to be designed to exist in harmony with carbon price signals being increasingly reflected in spot market electricity prices.

## **Long-term Power Market Trajectory**

While the recent and projected path of Chinese power market reform seems to suggest a trend towards power market liberalization, the long-term future of the Chinese power market is not decidedly clear. There are three general potential trajectories for the Chinese power market in the long-run:

1. Continued commitment to power market liberalization. Competitive market forces play an increasingly large role in determining energy dispatch. Pass-through of carbon prices is realized beyond regional pilot spot markets. China advances in liberalization stages to introduction of competition in wholesale and retail markets, incentive regulation of transmission and distribution networks, establishment of an independent regulator, and privatization.
2. National efforts to deregulate power dispatch and pricing are stalled and spot markets remain the only center for competitive price pass-through. There is minimal pass-through of the carbon price to consumers.
3. Power market liberalization efforts in China are abandoned. Electricity prices are guaranteed through regulated on-grid tariffs and operating hours are distributed using the fair-dispatch system.

Any design mechanism geared towards the pass-through of price-related signals in the Chinese ETS should be able to accommodate any of these three long-term trajectories.

## POLICY RECOMMENDATIONS

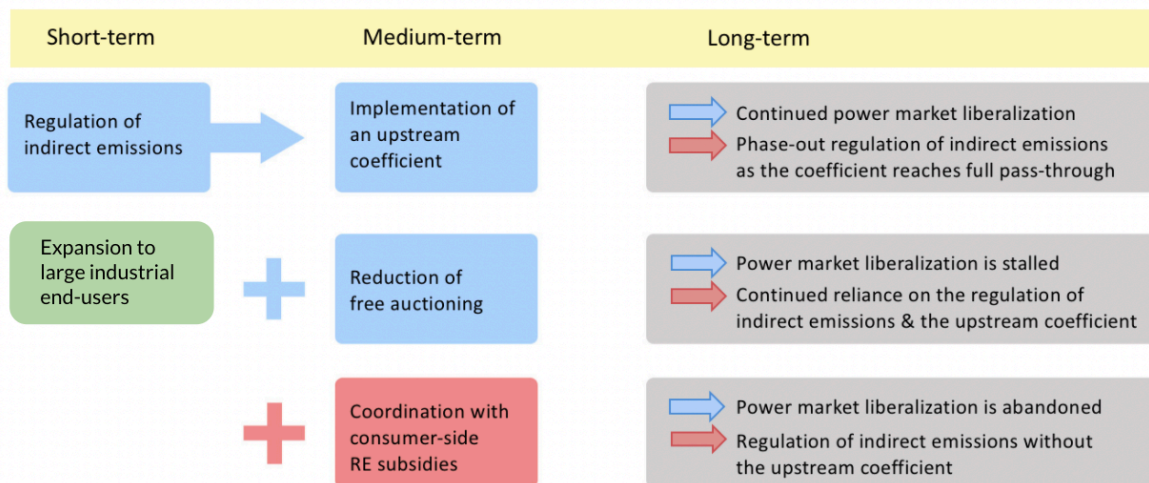
### Regulation of Indirect Emissions

The Chinese Government should implement the regulation of indirect emissions in the next trading cycle of the C-ETS. This policy intervention is supported by evidence from the Korea Case Study and interviews with C-ETS subject-matter experts.

#### Key reasoning:

1. Regulation of indirect emissions is an elegant strategy given the current structure of the Chinese power market in which carbon price pass-through is not fully achieved.
2. The regulation of indirect emissions is a flexible policy intervention and can be adapted to fit shifting ETS design and power sector context to prevent double counting.
3. Indirect emissions can be coordinated with subsidies to prevent a sudden increase in the transfer of burden to small consumers.

**Figure 2. Recommended Policy Package**



## **Short-term Application of Indirect Emissions Regulation**

### ***Indirect Emissions and C-ETS Expansion***

The main constraint on the regulation of indirect emissions in the short run is the timing of the expansion of the C-ETS to include large industrial end-users. As stated in the Chinese case study, expert interviews indicate that the expansion of the C-ETS to large industrial end-users is anticipated to be included in upcoming policy evolutions of the C-ETS as the government will need to decarbonize these sectors to reach 2030 and 2060 carbon emission goals. However, the specific timing is yet to be revealed by the MEE. The regulation of indirect emissions is contingent on this expansion, so the design of the regulation will need to be closely coordinated with expansion efforts.

### ***Power Market Coordination***

In the immediate future, indirect emissions will be operating in a market with minimal price pass-through and, thus, will provide an elegant solution to passing through carbon costs to end users without double counting from upstream effects. As it stands, the Chinese efforts to liberalize the power market are primarily encompassed by efforts to implement tiered dispatching, floating benchmarks, and spot market pilots. Each of these efforts suggest a long-term commitment to liberalization, but are limited in pass-through capability in the short-term. Thus, the design for the regulation of indirect emissions will need to be cognizant of changing circumstances in power market liberalization, but should not encounter significant threats to double counting in the short-term.

### ***Political Challenges***

The regulation of indirect emissions will likely be challenged by industrial interests as it will be viewed as an additional cost to production. While this will be a large hurdle in the

passage of such policy, the ability to point to the precedent for this regulation in Chinese ETS pilots will serve as leverage. Further, the regulation of indirect emissions should be viewed relatively favorably by the Chinese government as a way to facilitate price pass-through as it will not directly impose a carbon price on the retail price of electricity for household consumers. Directly increasing the retail electricity price for individual consumers would likely bring about immediate opposition. Instead, this strategy will indirectly affect the household economy (Oh et al., 2015). Lastly, the expansion of the C-ETS to the steel, cement, and aluminum sectors provides an opportunity for a policy window to introduce the regulation of indirect emissions. Coupling these two policies will likely streamline passage.

### ***Policy Design***

As in Korea, indirect emissions should be levied on large consumers who meet the threshold for direct emissions regulation. In the Chinese ETS this threshold is currently set to include entities with annual emissions of 26,000 tCO<sub>2</sub> in any year over the period from 2013 to 2019 (icap, 2021b). This threshold may need to be adjusted when incorporating the expansion to industrial sectors. In comparison, the Beijing pilot ETS – which covered both direct and indirect emissions for energy and industrial sectors – set the participation threshold at 10,000 tCO<sub>2</sub>/year (icap, 2021a). The Korean and Chinese ETS designs diverge with the specifics for the allocation of indirect carbon credits. The K-ETS utilizes a mass-based cap on carbon emissions but the C-ETS is an intensity-based scheme. Thus, the Chinese national ETS will need to draw lessons from the design of indirect emission allocation in the pilot schemes.

## **Medium-term Application of Indirect Emissions Regulation**

### ***Introduction of an Upstream Coefficient***

As efforts to liberalize the Chinese power market continue to advance, carbon prices will be passed-through to retail electricity prices at an increasingly high rate. This pass-through via competitive market pricing will create a scenario of double counting in which large industrial consumers will internalize the cost of carbon both in their electricity bill and through the regulation of indirect emissions. Thus, the regulation of indirect emissions will slowly become redundant, as seen in the Korea case study. In order to be a viable medium- and long-term policy strategy, the allocation of indirect emissions will need to be able to react to changing conditions in electricity market reform. One way to approach this design is to introduce a coefficient to the equation defining the allocation of indirect emissions that measures how much of the carbon price is included in the electricity price and, consequentially, reduces the surrender obligations for indirect emissions. In effect, this coefficient will adjust indirect emissions coverage downstream to account for any pass-through that occurs upstream.

There is limited available information about the potential implications of the introduction of such a coefficient. However, expert interviewees working in Korea suggested the primary designers of the K-ETS are currently studying the feasibility of such a tool. The timeline for this research is not finalized, but Chinese policy designers should be able to point to Korea for research on the adaptation of this policy in the short- to medium-range (Kim, 2021; Yoo, 2021).

### ***Reduction of Free Auctioning***

As demonstrated in the Korean case study, the high prevalence of free auctioning diminishes the effectiveness of carbon price pass-through from indirect emissions regulation. While this could theoretically be addressed in the short-term implementation of indirect

emissions policy, historical trends in ETS design and implementation point to the necessity of phasing-in auctioning. Across all three case studies, complete auctioning of direct and indirect emissions has not been implemented in the short-term. In the EU-ETS, for example, 100 percent auctioning in the power sector was not implemented until phase four of operation, 15 years after the initial launch of the ETS (icap, 2021c). The Chinese ETS should prioritize the gradual introduction of auctioning into allocation design in the medium- and long-range in order to optimize the effectiveness of the regulation of indirect emissions in passing-through the cost of carbon. This policy will likely need to be introduced on a per-industry basis, as was done in the EU-ETS, in order to avoid political pushback.

### ***Policy Coordination with Consumer-Side Subsidies***

The regulation of indirect emissions will pass-through the carbon price to large industrial end-users which, in turn, will increase downstream prices for households. In theory, a Western-centric view should not find issue with this reaction to the introduction of competitive market pricing forces. However, the social and political environment in China is not conducive to such price increases (Boute, 2017). In order to mitigate the financial burden on small consumers, subsidies for energy efficiency adaptation should be coordinated with the implementation of indirect emissions. These subsidies should be targeted at households, apartment complexes, and other buildings of all sizes. The focus on built infrastructure holds a dual purpose (1), to minimize the regressive nature of the regulation of indirect emissions by subsidizing energy efficiency for consumers, and (2), to encourage energy efficiency measures in the building sector as the built environment accounts for 30-40% of China's carbon emissions (Lin & Liu, 2015).

Consumer-side subsidies should be designed to promote investment in energy efficiency measures in new construction and retrofits in existing buildings. There is precedent for the

political, social, and financial feasibility of such a subsidy program in China. In 2009, the Chinese government launched the *Promoting Energy Efficiency Appliance for the Benefit of the People Program* and in 2012 State Council committed 26.5 billion RMB (\$4.26 billion) to invest in this program (Yu, 2013). The initiative provided subsidies to consumers for the purchase of energy-efficient appliances. Further, in May 2020 the NDRC released “Implementation Options on Building a Better Development Environment to Support Healthy Development of Private-Enterprises in the Energy Saving and Environmental Protection Sector” (NDRC, 2020). This document provides tax incentives for energy conservation projects and energy management contracts, thus demonstrating a clear commitment to energy efficiency in national politics.

As for timeline, these subsidies would ideally be implemented in the short-term but, realistically, they can be delayed until medium-range adoption. It is essential that these policies occur in conjunction with the phase-in of auctioning for direct and indirect emissions credits as this auctioning will accelerate the downstream effects of the carbon price.

### **Long-term Application of Indirect Emissions Regulation**

The long-term application of the regulation of indirect emissions is highly dependent on the trajectory of power market reforms. As stated above, the regulation of indirect emissions was chosen as the recommended policy tool because it is flexible across changing power market conditions. The following three scenarios demonstrate the capacity for the proposed regulation to shift according to power market dynamics. It is important to note that, given the effectiveness of the ETS, consumer-side subsidies will eventually be phased out across all three scenarios as renewable energy becomes more cost-effective and transition costs subside.

### *Three scenarios*

1. Continued commitment to power market liberalization. Competitive market forces play an increasingly large role in determining energy dispatch. Pass-through of carbon prices is realized beyond regional pilot spot markets. China advances in liberalization stages to introduction of competition in wholesale and retail markets, incentive regulation of transmission and distribution networks, establishment of an independent regulator, and privatization. → In this scenario, the regulation of indirect emissions will be phased-out completely in the long-run. The coefficient tool will measure increasingly high rates of pass-through of the cost of carbon in electricity pricing and the regulation of indirect emissions will become obsolete.
2. National efforts to deregulate power dispatch and pricing are stalled so spot markets remain the only center for competitive price pass-through. There is minimal pass-through of the carbon price to consumers. → In this scenario, the regulation of indirect emissions remains the primary tool for price realization and the coefficient continues to measure upstream price pass-through.
3. Power market liberalization efforts in China are abandoned. Power prices are guaranteed through regulated on-grid tariffs and operating hours are distributed using the fair-dispatch system. → In this scenario, indirect emissions remain regulated. The use of the upstream coefficient will no longer be necessary as there will be no upstream price realization due to a complete lack of competitive market forces in power market pricing, dispatch, and transmission decisions.

## CONCLUSION

The launch of the Chinese emissions trading scheme in July 2021 signaled a fundamental shift in the international fight against climate change. As the largest greenhouse gas emitter in the world, this commitment has reinvigorated discussions of an international trade in carbon, emboldened environmental advocates, and called to action other global powerhouses to set a national carbon price. In the coming years, the global community will be watching to see if the Chinese ETS meets its dual goals of (1), incentivizing the reduction of carbon emissions in energy production, and (2) incentivizing behavior change in consumers to prioritize energy efficiency and shift to low-carbon alternatives. As discussed, the likelihood of meeting this second goal is minimal. Government regulation in the Chinese power market prevents significant pass-through of carbon costs from energy producers to consumers. In order to encourage consumer-side emissions reduction, Chinese policymakers will need to make an intentional effort in the next evolution of ETS design to facilitate this pass-through.

The Korea case study examined the potential pathways to facilitate carbon price pass-through within a regulated power market structure. The European Union case study explored the policy pathway towards continued power market liberalization and the potential implications of this transition on price realization in an emissions trading scheme. Finally, the China case study projected upcoming reforms and design shifts in the Chinese ETS and power market to provide context for the coordination of policy recommendations. Together, these three case studies advance a new understanding of the intersection between power market structure and emissions trading price signaling and inform a policy approach for Chinese officials.

The findings of this research demonstrate that the most effective pathway forward for the Chinese emissions trading scheme will not be a prescriptive set of policy reforms, but a package

of new tools to allow the ETS to optimize efficiency while adapting to shifting power market practices. Any new design iterations to the C-ETS will need to be highly flexible across a variety of possible long-term power market trajectories. While recent policy adaptations in the Chinese power market suggest a trend towards long-term power market liberalization, evidence from the European Union case study suggest that Chinese reforms are still in earliest stages of deregulation and the future path cannot be defined absolutely.

Evidence from the Korean case study provides a cautionary example of static ETS design. In Korea, the initial design of the K-ETS utilized the regulation of indirect emissions to pass-through carbon costs by circumventing power market regulations. However, upcoming reforms to utilize environmental dispatch in the Korean power market will require the rollback of indirect emissions regulation to avoid double counting, thereby forcing Korean ETS designers to substantially reorganize original ETS structure. Chinese officials should heed this lesson and introduce an upstream coefficient alongside the regulation of indirect emissions to maximize the flexibility of this policy tool.

The structure of administrative authority in Chinese government serves as an additional justification for flexible ETS design. In 2018, Chinese officials unveiled the creation of a new government department, the Ministry of Ecology and Environment (MEE). This department absorbed the climate portfolio from existing departments including the following functions: climate change and emissions reduction, water pollution regulation, watershed protection, agricultural pollution control, marine conservation, and environmental protection in project development (Jing, 2018). Therefore, in 2018 the MEE took over control of the Chinese ETS development and execution from the National Development and Reform Commission (NDRC). While this administrative shift certainly streamlined China's environmental governance, it also

has significant implications for the prioritization of the ETS in national policymaking. The NDRC is one of the highest-ranking departments in China's cabinet structure and has strong affiliations with the National Energy Administration (NEA) which manages China's power sector (Jing, 2018). Therefore, with this restructuring the ETS has effectively ceded both general government and power market influence. Without direct responsibility for ETS functioning, the NDRC and NEA have minimal incentive to prioritize ETS success in power market reform decisions. Therefore, implementation of the aforementioned policy recommendations will be contingent on flexibility measures in order to best coordinate across agencies.

A last piece of important context for conceptualizing the findings of this study is the summer of 2021 power shortages in China. Throughout the 2020 calendar year, thermal coal prices in China increased by more than 40% to around 777 yuan per metric ton (\$119.53) by December 2020 (Cheng, 2021). China's post-pandemic economic recovery and summer peak season put further pressure on these prices and, by June, power restrictions and rationing rules were put in place. There have been numerous proposals as to how to return coal prices to reasonable levels in the wake of the energy crisis and included among them are both calls for accelerated liberalization and a return to a more de-liberalized power market (Davidson, 2021). Already uncertain, the path forward for the Chinese power market has been further obscured by these events.

Given these conditions, it is essential that the Chinese ETS is designed to adapt to fluctuating power market regulations. The policy package proposed in this study is informed by case study analysis from Korea and the European Union, expert interviews, and analysis of past, current, and upcoming reform efforts in China. However, the recommendations are still impacted by limitations. First, the limited scope of the case study analysis – only observing two jurisdictions

beyond China – constrained available reform options to those elicited from these cases. Second, the small sample size of interview subjects prevents general conclusions from that section of the data about patterns, lessons, and recommendations. Lastly, accessing and analyzing literature and official documents from Korea and China relied on translation.

Future work in this area should be focused on economic modeling of the implementation of indirect emissions to facilitate price pass-through in the Chinese national ETS. Specifically, it would be greatly beneficial to simulate the implementation of the upstream coefficient in the market to measure and control pass-through rates.

Ultimately, whether or not the Chinese ETS will be a pillar policy of China's decarbonization strategy is yet to be determined. Future investment in the ETS is highly contingent on early performance, international calls to action, and top-down pressure from high ranking Chinese government officials. However, closely coordinating ETS design with power market reform to optimize mutual efficiency will help to substantiate the necessity of the ETS as a central policy in China's decarbonization efforts.

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## APPENDICES

### Appendix A – Hierarchical Coding Framework

Coding for document analysis	Coding for interview analysis
<p>Case</p> <ul style="list-style-type: none"> <li>• China</li> <li>• Korea</li> <li>• European Union</li> </ul> <p>Type</p> <ul style="list-style-type: none"> <li>• Government document</li> <li>• Study</li> <li>• Report</li> <li>• Press</li> <li>• White paper</li> <li>• Other</li> </ul> <p>Relevance</p> <ul style="list-style-type: none"> <li>• Emissions trading scheme</li> <li>• Power market development</li> </ul> <p>Mentions</p> <ul style="list-style-type: none"> <li>• ETS weakness</li> <li>• ETS strength</li> <li>• Power market weakness</li> <li>• Power market strength</li> <li>• Previous legislation</li> <li>• Upcoming legislation</li> </ul> <p>Policy suggestions – ETS</p> <ul style="list-style-type: none"> <li>• Indirect emissions</li> <li>• Absolute cap</li> <li>• Expansion to industry</li> <li>• Single benchmark</li> <li>• Limited free allocation</li> <li>• Other</li> </ul> <p>Policy suggestions – power market</p> <ul style="list-style-type: none"> <li>• Liberalization</li> <li>• Increased regulation</li> <li>• Spot markets</li> <li>• Tiered dispatch</li> <li>• Environmental dispatch</li> <li>• Floating benchmark</li> <li>• Renewable performance standards</li> <li>• Consumer-side subsidies</li> <li>• Other</li> </ul>	<p>Case</p> <ul style="list-style-type: none"> <li>• China</li> <li>• Korea</li> <li>• European Union</li> </ul> <p>Mentions</p> <ul style="list-style-type: none"> <li>• ETS weakness</li> <li>• ETS strength</li> <li>• Power market weakness</li> <li>• Power market strength</li> <li>• Previous legislation</li> <li>• Upcoming legislation</li> </ul> <p>Policy suggestions – ETS</p> <ul style="list-style-type: none"> <li>• Indirect emissions</li> <li>• Absolute cap</li> <li>• Expansion to industry</li> <li>• Single benchmark</li> <li>• Limited free allocation</li> <li>• Other</li> </ul> <p>Policy suggestions – power market</p> <ul style="list-style-type: none"> <li>• Liberalization</li> <li>• Increased regulation</li> <li>• Spot markets</li> <li>• Tiered dispatch</li> <li>• Environmental dispatch</li> <li>• Floating benchmark</li> <li>• Renewable performance standards</li> <li>• Consumer-side subsidies</li> <li>• Other</li> </ul>

## Appendix B – List of Interviewees

Name	Title	Region of Interest	Date of Interview (EST)
Xiujie Tan	Institute for International Studies, Wuhan University	China	September 23rd, 2021
Huw Slater	ICF Beijing	China	September 28th, 2021
Seung Jick Yoo	International Service, Sookmyung Women's University	Republic of Korea	September 29th, 2021
Zhenxuan Wang	PhD Candidate NSOE	China	September 30th, 2021
Joojin Kim	Managing Director, Solutions for Our Climate	Republic of Korea	September 30th, 2021
Will Acworth	Head of Secretariat at the International Carbon Action Partnership (ICAP)	European Union	October 5th, 2021
Anatole Boute	Faculty of Law, Chinese University of Hong Kong	European Union	October 5th, 2021
Cyril Cassisa	Climate & Energy Analyst, International Energy Association	China	October 25th, 2021
Lan Wu	PhD Candidate, Chinese University of Hong Kong	China	October 25th, 2021

## Appendix C – Semi-Structured Interview Guide: China

Hello (NAME),

Good (MORNING/EVENING). Thank you so much for your willingness to speak with me today!

As I outlined in my email, I am in the midst of researching my honors thesis about the pass-through of price-related signals in the Chinese emissions trading scheme. I will be conducting comparative case study analysis with the European Union and the Republic of Korea to elicit policy recommendations. In order to better conceptualize the political and technical feasibility of these recommendations, I am speaking with experts on ETS design and/or power market dynamics from China, Korea, and the European Union.

Please know that you can always choose to skip a question or ask for clarification at any time.

Do you have any questions before I begin the recording?

If it is okay to start, I will begin the recording by saying your name and then we will begin the interview. This recording will only be accessible to me.

I am starting the recorder...

Okay, I am here with (NAME) on (DATE)

**Question 1:** How important is the issue of carbon cost pass-through in the Chinese ETS?

**PROBE:** How reactionary should C-ETS design be to shifts in the Chinese power market?

**Question 2:** In your professional opinion, what do you think is the best C-ETS design option to facilitate the pass-through of carbon costs to large, industrial end-users?

**PROBE:** What are the political and technical challenges to this intervention?

**PROBE:** How would this mechanism interact with the gradual market reform we are seeing in the spot markets?

**Question 3:** What do you predict to happen in the near future of Chinese power market reform?

**PROBE:** How are the spot market pilots faring?

**Question 4:** Some scholars have acknowledged the importance of transitioning to an absolute cap for the ETS. How feasible is this in the near future?

**Question 5:** Are there aspects of the European Union ETS or the Republic of Korea's ETS that you think would be applicable to the Chinese context?

**Question 6:** Could you comment on the overall performance of the ETS within these first few months of operation? How do you think it is going?

## **Appendix D Semi-Structured Interview Guide: Korea**

[SAME INTRODUCTION AS CHINESE INTERVIEW GUIDE AS SEEN IN APPENDIX A]

**Question 1:** How effective is the pass-through of carbon cost – imposed by the K-ETS – from producers of electricity to end consumers in the Korean power market?

**Question 2:** What tool is the primary driver of this pass-through?

PROBE: How does the Korean power market drive this pass-through?

PROBE: How does the K-ETS drive this pass-through?

**Question 3:** What design tools, if any, exist in the K-ETS to facilitate the pass-through of carbon costs to end consumers?

**Question 4:** Switching gears to the Korean power market, how would you classify the current stage of power market liberalization in Korea?

PROBE: What have been some of the largest hurdles to power market liberalization?

**Question 5:** What has been the stakeholder response to power market liberalization?

PROBE: Industry, government, and citizens?

**Question 6:** In your professional opinion, what do you see as the biggest benefits and challenges for transplanting the Korean ETS model to China?

PROBE: How feasible do you see this and on what timeline?

## **Appendix E Semi-Structured Interview Guide: European Union**

[SAME INTRODUCTION AS CHINESE INTERVIEW GUIDE AS SEEN IN APPENDIX A]

**Question 1:** How effective is the pass-through of carbon cost – imposed by the EU-ETS – from producers of electricity to end consumers in the European Union power market?

**Question 2:** What tool is the primary driver of this pass-through?

PROBE: How does the European Union power market drive this pass-through?

PROBE: How does the EU-ETS drive this pass-through?

**Question 3:** What design tools, if any, exist in the EU-ETS to facilitate the pass-through of carbon costs to end consumers?

**Question 4:** Switching gears to the EU power market, how would you classify the current stage of power market liberalization in the EU?

PROBE: What have been some of the largest hurdles to power market liberalization?

**Question 5:** What has been the stakeholder response to power market liberalization?

PROBE: Industry, government, and citizens?

**Question 6:** In your professional opinion, what do you see as the biggest benefits and challenges for transplanting the EU model of power market liberalization to China?

PROBE: How feasible do you see this and on what timeline?