Market-Based Mechanisms and Supporting Policies to Achieve Energy Efficiency, Energy Consumption, and Carbon Emissions Reduction Goals

The Regulatory Assistance Project[1]
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I. Introduction

This paper is intended to serve as a brief preliminary exploration of market-based mechanisms to achieve energy policy goals. These goals might include targets for energy consumption, energy efficiency or carbon emissions. We draw on international experience – including from Europe, the US and Australia – and sketch several illustrative options, framed in terms of policies for a hypothetical sub-national region that wants to limit overall energy consumption. We highlight issues relevant to Chinese provinces and municipalities – although the discussion will also be of interest for other parts of the world. Our aim is to identify key issues and identify areas where there may be demand for more in-depth discussion, analysis and recommendations. This paper is not intended to be a comprehensive overview; instead, it is meant to generate discussion on these topics. Later work will serve to fill in the gaps and provide more details regarding relevant international experience.

The international practices that we believe are most relevant may be categorized into two broad types of mechanisms:

- **Permit** schemes, which require consumers or grid companies to obtain a permit for each unit of energy (or emissions) used or sold. "Cap and trade" and "cap and invest" are varieties of permit schemes. For example, the EU Emissions Trading System (ETS) and the Regional Greenhouse Gas Initiative (RGGI) in the US both fall under this rubric.

- **Energy efficiency certificate** schemes, which obligate one or more entities (large firms or grid companies) to stay within a target level of energy consumption by reducing in-house energy consumption or energy sales or by buying certificates representing energy efficiency implemented by others. The Australian, Italian and French "white certificate" schemes are examples of this approach.

A key difference between a permit scheme and an energy efficiency certificate scheme is that a permit scheme uses prices to achieve energy efficiency, while an energy efficiency certificate scheme directly mobilizes energy efficiency investments.

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In practice, it is possible to design variations of both to satisfy local constraints and requirements. The options in this paper are intended to stimulate discussion and highlight issues that we believe are important.

Key Concepts

The options presented in this paper are based on the following key concepts.

Cap – A cap defines the maximum quantity of energy or emissions that can be consumed, emitted or sold within a jurisdiction (e.g., a country, province or municipality). The level of the cap is set by the jurisdictional authorities.

Obligation – A cap or target may be implemented by the appropriate jurisdictional authorities placing an obligation on one or more entities. The obligation requires that entity to consume or sell no more than a specified quantity of energy. The total of all obligations placed on entities in a jurisdiction equals the value of the jurisdictional cap or target.

Obligated party – An obligated party is an entity that is required to consume or sell no more than a specified quantity of energy. Obligated parties may be large firms and companies that are limited in how much energy they can consume or grid companies that are limited in how much energy they can sell. [2]

Permit – A permit allows an obligated party to consume or sell a specified quantity of energy (e.g., one kilowatt-hour).

Allocation – Permits are allocated to obligated parties by the appropriate jurisdictional authorities. Permits may be allocated free of charge or obligated parties may be required to pay for permits. Prices for permits may be set through an auction process.

Energy efficiency certificate – An energy efficiency certificate represents a specified and verified quantity of energy that has been saved through implementing energy efficiency measures. Certificates are created by accredited parties who implement energy efficiency measures. Energy efficiency certificates are also known as white certificates and white tags.

Secondary market – Obligated parties which own permits that are surplus to their needs may sell the surplus permits to other obligated parties through a secondary market. Entities which have created energy efficiency certificates by implementing energy efficiency measures may sell these certificates to obligated parties also through a secondary market.

[2] We use the term "grid company" in this paper because it is most relevant in the context of China. In some other countries, "energy utility" would be more appropriate.

Key Lessons from International Experience

Across policy designs, we see some common lessons from international experience:

1. **Market-based mechanisms must be carefully designed and managed to achieve a desired result.** Markets are like machines: they must be designed and built to do the job at hand. Once built, markets must be regularly maintained and managed. When necessary, they must be modified and improved: sometimes even well-built machines fail to operate as expected. International experience shows most schemes like the ones described in this paper have had to be modified numerous times to address unanticipated problems. If secondary market trading is adopted, an agency must be designated and authorized to watch its performance closely, manage it carefully, and, when necessary, adjust parameters and regulations to ensure effective operations.

2. **Market-based mechanisms don't necessarily require secondary market trading of instruments.** Trading of certificates or permits between participants (i.e., secondary trading) is not a necessary component of a market-based mechanism. In some situations, there may be little or no scope for trading, such as when the obligation to meet the cap or target is placed on a single entity (e.g., a single grid company serving a province).

   In other situations, secondary trading may help to improve flexibility and efficiency. Secondary trading is particularly useful if permits are allocated to many individual energy consumers directly by the responsible authorities (instead of by auction). In this situation, the consumers are able to choose how many permits to buy according to how much it costs them to save energy. For example, consider the case where permits are allocated to 100 large consumers based on their historical energy use: it may be very costly for some consumers to reduce energy use and very inexpensive for others. In theory, allowing the trading of permits between these consumers helps achieve the overall reduction in energy use in a cost-effective way. Consumers with relatively costly energy savings potential can buy permits, while consumers with relatively low-cost potential can implement energy efficiency measures and sell surplus permits.[3]

   In energy efficiency certificate trading schemes, secondary trading of certificates can stimulate the development of an energy efficiency services industry. Where non-obligated parties are allowed to trade certificates, third parties such as ESCOs can carry out energy efficiency projects and sell the resulting certificates in the secondary market. This provides a funding source for energy efficiency activities.

3. **A clearly defined target or cap is critical.** A clearly defined cap, or target, on the

[3] In practice, company behavior is influenced by many factors and not all economically efficient trades will occur.

total volume of energy consumption or emissions will be needed to guide policy. Policymakers often end up adding features that undermine the cap or simply set the cap too high. If a scheme that includes secondary market trading is chosen, the level of the cap will be the most important factor determining the value of the tradable instrument and the incentive to engage in trading.

4. **Complementary policies supporting investment in energy efficiency are essential.** Relying on price signals alone to reduce energy use and deliver gains in energy efficiency is unrealistic. In theory, a properly implemented cap-and-trade program will, by itself, lead to success in meeting the cap. In other words, assuming that the cap is not violated, prices will rise until demand is reduced to the level of the cap.[4] In practice, however, this means prices may rise to very high levels. This is because the elasticity of electricity demand is low and because there are persistent barriers to consumer investment in energy efficiency measures.[5]

   The market-based mechanisms that have proven most successful are those that are combined with programs that invest directly in energy efficiency, which is an abundant and inexpensive resource. To achieve this, the first two options described below (i.e., the permit schemes) "recycle", or re-invest, revenue from permit sales into cost-effective efficiency programs. The energy efficiency certificate options described later achieve this same result in a different way, by requiring the obligated entities to invest in energy efficiency or buy efficiency certificates. The existing approaches to energy efficiency investment in China – such as construction of efficiency power plants (EPPs) – provide a strong foundation for efficiency investment and can readily be integrated into any new market-based mechanism.[6]

5. **Limiting the initial pilot programs to the power sector is a reasonable approach.** No government in the world has yet been successful in fully implementing a single comprehensive market-based mechanism that covers all sectors, fuels and end-users—although there is variation around the world in the breadth of schemes. Many governments have initially limited the focus to the power sector (or just a few sectors) in order to gain experience with implementation of market-based mechanisms and carefully monitor effects. As policies are fine-tuned, coverage can be broadened. Accordingly, we focus much of the following discussions on schemes limited to the power sector.

[4] Supply-side response is, in principle, also possible – but unlikely to be a factor for many Chinese provinces because of the geographically dispersed nature of generation.

[5] For example, see the IEA report "Mind the Gap" at http://www.iea.org/textbase/nppdf/free/2007/mind_the_gap.pdf

[6] An EPP is a virtual power plant consisting of a carefully selected bundle of energy efficiency investments that provide predictable load-carrying capacity, in much the same way that a conventional generating unit does.

The Situation in China

There are a number of conditions that are unique to China that should be considered in the design of any new market-based scheme:

- China does not have significant experience with secondary market trading schemes of the type discussed here, which require transparency and credible data to establish the currency of the traded instrument (i.e., permits or certificates). It may be best to start with market-based mechanisms that are not dependent upon secondary trading.

- China has very large energy utilities, known as grid companies. At least for the electric sector, this means if the obligation is placed only on the grid company, there will be little or no benefit of trading within a province (or municipality).

- China has developed the EPP concept and has pilot programs underway in Guangdong, Hebei, Beijing, and other places. The EPP, as a vehicle for financing and capturing efficiency opportunities, can be integrated into a market-based approach as a very effective and practical first step toward reducing energy use and GHG emissions.

- China recently adopted a "Demand-side Management Rule" which requires the grid companies to reduce energy consumption through efficiency measures.[7] This new responsibility for the grid companies may also be a factor in the design and implementation of market-based approaches.

The remainder of this paper describes four illustrative options for a market-based mechanism in a sub-national region – based on our analysis of international experience. We frame the options in terms of achieving a cap or target on energy consumption – although most of the discussion is also relevant if the goal is to meet an emissions cap. In addition, we focus on cases where the energy utility (the grid company in China) is given an obligation; a number of existing schemes around the world have taken this approach. However, these options are presented only for the purpose of discussion; there are many different possibilities and variations, as well as details of implementation that we do not explore.

II. Permit Schemes

Permit schemes set a cap on the amount of energy that consumers can buy or the amount that grid companies can sell.

[7] The rule requires grid companies to achieve efficiency savings "of 0.3% in sales volume and 0.3% in maximum sales load compared with the previous year through self-action or purchasing service."

Permits with Secondary Market Trading: Cap-and-Trade

"Cap-and-trade" is one approach to implementing a permit scheme, although as we will explain below, it may be unnecessarily complicated. (The "simplified" scheme that we present in the next section may be more suitable.) Internationally, cap-and-trade schemes generally focus on emissions, not energy consumption or sales—but many of the issues and economic principles are the same. Variations of cap-and-trade schemes are in operation in the European Union, the United States, New Zealand and other countries.[8] It is important to note that each of these existing schemes has had significant problems that have required major modifications – and in many cases significant flaws remain.

The cap-and-trade scheme that we will describe here only covers the power sector. As noted above, we believe this limitation makes the most sense for a pilot program. (The option could be expanded to include other energy types). This scheme directly obligates only the grid company and large firms to buy permits, although all electricity consumption is covered. Setting up the scheme entails dealing with several constraints and requirements:

1. Policymakers set a cap on electricity consumption.

2. The total supply of permits (for example, one permit might represent one kWh) is limited by the cap. Large firms (i.e., those defined as obligated parties by the authorities) are required to acquire a permit in order to consume a unit of energy. Each grid company is required to acquire a permit in order to sell a unit to any small (i.e., non-obligated party) firm or residence.

3. The permits are sold by auction and revenues reinvested in energy efficiency.

4. Rules are put in place to address violations, reporting and verification, banking permits from one time period to another, credits for various types of actions, exemptions, and other concerns

In theory, a properly implemented cap-and-trade program will, by itself, lead to success in meeting the cap. In other words, prices will rise until demand is reduced sufficiently.[9]

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[8] In the US, a cap-and-trade for SO_2 was authorized by the Clean Air Act of 1990 and first launched in 1995; a cap-and-trade for NO_X first launched in 1999; and a mandatory cap-and-trade for CO_2 emissions has been in effect since January 1, 2009 in the northeastern United States. For more information, see: US Environmental Protection Agency, Acid Rain Program, http://www.epa.gov/airmarkets/progsregs/arp/basic.html; US Environmental Protection Agency, NO_X Budget Program, http://www.epa.gov/airmarkt/progsregs/nox/index.html; Regional Greenhouse Gas Initiative, background information available in Key Documents, at http://www.rggi.org/states.

[9] As noted above, supply-side response is unlikely to be a factor unless the region in question is large (spanning multiple provinces).

However, as mentioned earlier, relying on prices alone is a risky and costly option. Instead, we recommend the cap-and-trade scheme be linked with increased investment in energy efficiency to avoid driving prices too high and to ensure the cap is met cost-effectively. To achieve this, policymakers could link the revenue producing aspect of a cap-and-trade scheme to direct investment in energy efficiency, such as the EPP pilots already in operation in China.

The best international example of this approach is the Regional Greenhouse Gas Initiative (RGGI) in the northeastern US. The ten states participating in the RGGI program agreed to auction a majority of the emissions allowances (i.e., permits to emit), as opposed to distributing them to emitters for free, as was previously done in the Acid Rain and NO_X Budget programs and the first phase of the European Union Emission Trading Scheme. By auctioning the allowances, the states generated revenue to invest in energy efficiency and other greenhouse gas mitigation measures. The states independently decided to auction between 60-100% of the allowances, and use an average of 74% of the revenue generated from the auction sales for energy efficiency and clean energy activities. The majority of reductions in greenhouse gas emissions resulting from the program were expected to result from these direct investments.[10]

As long as permits are auctioned, then secondary trading adds very little to the policy design. Secondary market trading is useful if the permits are initially misallocated (for example, given for free to favored firms regardless of their energy profile or willingness to pay). In the case of misallocation, trading helps to remedy the error by allowing the free movement of the permits through a secondary market. But if well-designed periodic (e.g., monthly or quarterly) auctions are used to distribute the permits from the outset, then secondary markets will be largely redundant. This is because a primary auction performs much the same function as a secondary market does: it takes account of the supply of permits (i.e., the amount fixed by the cap) and the demand for permits (i.e., the demand by regulated entities). It then determines the price at which these two are equal and channels the permits to the entities that can use them most effectively.

A Simplified Permit Scheme, Without Secondary Market Trading

The issues with the first option identified above suggest that a market-based scheme limited to the electric sector without secondary trading might be a practical option for pilot implementation.

The following approach could be applied to all electricity end-users:

1. Policymakers set a cap on electricity consumption. The total supply of permits (for

[10] See The Regulatory Assistance Project, "The Regional Greenhouse Gas Initiative in the Northeastern United States: Auctioning Emissions Allowance," December 2008, available at http://raponline.org/docs/RAP_RGGIAuctioningEmissionsAllowances_2008_12_05.pdf.

example, one permit might represent one kWh) is limited by the cap.

2. Instead of an initial auction (or free allocation), government administrators sell the permits directly to end-users by attaching a permit to each kWh. When a consumer buys a kWh, the consumer cannot avoid buying a corresponding permit. To simplify administration, grid companies are mandated to collect the permit fee and remit it to the responsible entity.

3. The price of the permits is set by the government administrator. The administrator reviews electricity consumption trends and short-term forecasts, and monitors the market regularly, periodically adjusting the price of the permits (perhaps once per month) with the goal of constraining demand to the overall cap. The price of permits could be the same for all kilowatt-hours and all customers, or it could vary for different customer classes, seasons, or time-of-use. In the case of residential consumers, different blocks of consumption could have certificates with different prices.

4. The revenue collected from the sale of the permits is invested in energy efficiency (e.g., EPPs).

5. Rules are put in place to address exemptions (what types of customers might not be required to purchase permits), credits for various types of actions, and other provisions to address particular conditions or concerns.

III. Energy Efficiency Certificate Schemes

The following two options feature energy efficiency certificates instead of permits. Under these schemes, policymakers set energy consumption or sales target for the jurisdiction and place individual obligations on designated firms and/or grid companies. If a firm or grid company exceeds the target set in its obligation, then it must purchase certificates equivalent to the excess amount. Each certificate represents a specific and verified amount of energy savings, achieved through energy efficiency measures. Accredited parties create certificates by implementing energy efficiency measures.

The options discussed below are similar to the schemes currently operating in three Australian states (New South Wales, Victoria and South Australia), several US states, Italy, France and the UK. India is also in the process of launching an energy efficiency certificate scheme. There is substantial variation across these international examples. In particular, coverage varies in each of these cases, from a focus on electricity in Australia, to all energy consumption in Italy. Some allow for secondary trading of certificates and some do not.

Energy Efficiency Certificates: Electricity-Only and Without Secondary Trading

Implementing an electricity-focused program should be relatively simple. Under this option:

1. Policymakers give each grid company an annual cap for energy sales.

2. If sales threaten to go above the cap for the year, the grid companies either achieves energy reductions through direct investment in end-use efficiency or are required to buy certificates representing verified energy savings.

3. Certificates may be created by any party who registers and is accredited by the administrator of the program to implement energy efficiency measures. The administrator must review all applications to undertake energy efficiency projects—although there is scope for streamlining approval for typical energy efficiency measures. For example, the energy savings achieved by implementing typical measures could be set (or "deemed") in advance. Energy efficiency certificate schemes in Australia and some US states use this "deemed savings" approach.

4. The authorities must decide what types of energy efficiency projects may be counted toward compliance, which agents may be accredited, and how to do measurement and verification. As mentioned above, in several Chinese provinces, EPP pilots already provide much of this framework.

5. Rules are put in place to address violations, reporting and verification, certificate status across compliance periods, credits for various types of actions, exemptions, and other provisions to address particular conditions or concerns.

In China, because the typical province is served by only one grid company, secondary trading yields little benefit (in terms of flexibility and economic efficiency), but potentially introduces a burden on the administrator (in terms of monitoring and regulating markets). Trading of energy efficiency certificates is a feature of the schemes in Australia, Italy, and France, but not the UK – and it need not be an essential aspect in the case of a Chinese province.

Overall, this option is very similar to requiring the grid company to invest in EPPs in order to meet an energy efficiency savings target. As mentioned above, the National Development and Reform Commission recently issued a "DSM rule" that gives grid companies just such a target; and it may be possible to design an energy efficiency certificate scheme to dovetail with the rule.

One problem with energy efficiency certificate schemes is that they have tended, in practice, to omit relatively small and atypical energy savings opportunities, due to the

transaction costs associated with accreditation, reporting, monitoring, and verification. In the residential sector, they have also been criticized for neglecting the "whole house approach" in favor of specific measures. Indeed, in the countries mentioned above, energy efficiency certificate schemes have tended to produce an emphasis on a narrow range of measures. For example, in the initial phases of the New South Wales scheme, a dominant business model emerged in which a small handful of firms discounted or gave away low cost efficient appliances (particularly compact fluorescent lamps and low-flow showerheads) in order to acquire (and then sell) certificates.[11] In Italy, energy efficiency measures which have a comparatively longer payback period have been overlooked in favor of those with shorter term benefits. Consequently much of the focus has been on low cost measures while insulation of buildings, for example, has been largely overlooked.[12]

For these reasons, it would be worth considering integrating energy efficiency certificates closely with EPPs.[13] For example, the scheme could be set up to promote a business model where accredited agents build EPPs (in order to create certificates). This could be done by allowing entire EPPs to be approved as a whole, thus lowering transaction costs.

Energy Efficiency Certificates with Broader Coverage and Trading

Energy efficiency certificates could also be applied to a broader segment of the economy, which may introduce a greater role for secondary market trading to ensure cost-effectiveness across sectors. In this option:

1. Policymakers decide just how broad they want the scheme to be. The scheme could apply to all energy sectors (as is technically the case in Italy), although this would be challenging to implement.

2. The administrator sets caps for not just the grid companies, but for firms in other "covered" sectors, as well. (France, Italy and some Australian states have placed obligations on gas distribution companies as well as the electricity utilities.)

3. As above, firms with caps must compensate for excess consumption by achieving energy efficiency savings from internal measures or by purchasing energy efficiency

[11] See David J. Crossley, "Tradeable energy efficiency certificates in Australia," Energy Efficiency (2008) 1:267–281.
[12] The Regulatory Assistance Project, "A Comparison of Energy Efficiency Programs in Existing Homes in Eleven Countries," February 2010, pp 71- 77, available at http://www.raponline.org/docs/RAP_Hamilton_ComparisonOfEEProgrammesForExistingHomesInElevenCountries_2010_02_19.pdf.
[13] For similar reasons, authorities in New South Wales considered options to "bundle" energy efficiency measures. See Crossley, "Tradeable energy efficiency certificates in Australia."

certificates. Agents could be accredited to build EPPs and thus earn certificates to sell on the market or to specific clients.

4. Because this option involves more than just one regulated entity, a secondary market may be more useful.

5. Rules are put in place to address violations, reporting and verification, compliance periods, credits for various types of actions, exemptions, and other provisions to address particular conditions or concerns.

IV. Conclusions

This paper discusses two types of market-based mechanisms: permit schemes and energy efficiency certificate schemes. Broadly speaking, permit schemes use prices to achieve energy efficiency, while certificate schemes directly mobilize energy efficiency investments. In the case of permit schemes, we recommend revenues generated from the sale or auction of permits should be dedicated or "recycled" back into energy efficiency measures. In certificate schemes, investment in energy efficiency measures is built into the scheme. However, certificate schemes require a strong capacity for conducting energy assessments and measurement and verification of energy savings.

The illustrative options in this paper take account of important lessons from international experience and are also informed by China's conditions. In particular, they all avoid relying on price signals alone to achieve investments in energy efficiency.