WWS 402d: Energy for Sustainable Development

Professor Denise Mauzerall

Renewable Portfolio Standards, Feed-In Tariffs, and Tendering: Instituting Effective Mandated Market Policies in China

Sabina Sequeira

May 8, 2006

This paper represents my own work in accordance with University regulations.

Map of China

Source: CIA Maps and Publications, 2001.

Table of Contents

Executive Summary	3
Introduction	4
Criteria for Evaluating an MMS Policy	6
Discussion of MMS policies	7
Renewables Portfolio Standards	7
Feed-In Tariffs	12
Tendering	15
China’s Economic, Structural, and Geographic Climate for Renewables	16
Energy Policy in China	20
The Next Steps: China’s Progress in Deploying MMS Policies	23
Challenges	25
Recommendations	25
The Role of the CSD	27
Conclusion	28
Appendix	29
Acronyms	29
Works Cited	37

Executive Summary

China faces the challenge of accommodating the ever-growing energy demands, increased pollution, and rising greenhouse gas emissions. Renewable energy technologies represent a fundamental part of the strategy for tackling this challenge. However, high initial costs, investor uncertainty, and other market barriers prevent the expansion of renewable energy (RE) capacity in the free market. Consequently, mandated market share (MMS) systems, which create incentives for investment by establishing a purchase obligation for renewables somewhere along the production supply chain, have the potential to overcome these barriers and facilitate RE expansion. MMS systems, which aim primarily to reduce the costs of RE technologies through competition, economies of scale, and learning, have been implemented with success in the US and Europe, among other regions, and often take one of three different forms:

- Renewable Portfolio Standards, which create a purchase obligation for utilities and can offer a system of tradable renewable credits.
- Feed-in Tariffs, which allow the government to set the price of renewable energy.
- Tendering systems, which allow energy suppliers to competitively bid for RE obligations.

Lessons from an examination of these policies stress the importance of knowing market conditions to craft policy designs to take into account a lack of market competition, deadweight losses to producers and consumers, geographic RE resource capacities, and the potential for cost reduction. They also shed light on how these policies can be designed to have both flexibility for electric utilities and targeted support for different RE technologies.

This targeted support is important for the growth of both China's solar photovoltaic (PV) and wind industries, which are most easily exploitable in different geographic locations: solar PV in the southwest, and wind in the east. This difference, coupled with urban/rural regional differences, create a diverse set of market conditions among different provinces in China and the challenge of aligning potential rural energy supply with demand in the urban eastern coastal area.

Energy policy over the past two decades, set out in China's Five-Year Plans, have been characterized by a lack of concrete, specific targets and rules, as well as a lack of coordination between policy-making bodies.

To overcome the challenges touched upon above, the following recommendations are made in 3 categories, to the government of China, international institutions, NGOs, and the CSD:

- Policy design: promotion of a flexible decentralized hybrid system of the three MMS policies, with an emphasis placed on feed-in tariffs for rural areas lacking competition, tendering for areas suitable for large-scale RE development that might not otherwise gain competition, and RPS for urban areas.
- Administration and enforcement: the creation of a ministry of energy to coordinate local RE MMS policies with the national scheme, the extension of local energy centers to cover RE issues, a national tradable renewable credits system to lower administrative and compliance costs.
- Costs: Government outlays for costs of policy rather than direct funding of projects, spread of the cost burden across all parties involved, Government R&D investment in restructuring of transmission to dramatically increase effectiveness of MMS policies.

Role of the CSD: provision of research on purchase obligations, prices, and market conditions, encouragement of foreign investment, and of export industries.

Introduction

China's rates of economic growth have remained in the double digits for a large part of the past two decades, contributing to an ever-growing demand for energy as the country develops and its population grows (Martinot, 2001).[1] As the world's second largest producer of carbon emissions, China faces the prospect of becoming the world's largest emitter of greenhouse gases by 2020, hastening the serious negative global effects of climate change and producing serious health hazards for many of its urban residents in the form of pollution. Furthermore, China is projected to experience a large energy shortfall by 2050 under a business-as-usual scheme (Larson et al, 2003). Thus China faces the challenge of accommodating the energy demands that spring from population growth coupled with urbanization and development, all while fighting pollution and greenhouse gas emissions.

This challenge makes clear the need to rapidly replace carbon-based fuels with renewable energy technologies (RETs), which eliminate carbon emissions while deriving energy from inexhaustible sources such as the solar energy and the wind.[2] However, a significant challenge exists to the rapid expansion of renewable energy in China: RETs are characterized by high initial capital costs, compared to carbon-based sources of energy, resulting in low initial profit margins for producers. And although once established, many RE technologies such as wind farms provide low-cost, efficient energy, the demand around these areas, which might often be rural, would not keep up with the energy that could potentially be supplied. And in other areas where the demand is high, large-scale RE production may not be geographically feasible. Consequently, government

---

[1] For example, meeting the millennium development goals of halving poverty, reducing hunger, diseases, and mortality, fostering universal primary education, and working towards environmental sustainability all depend heavily on adequate access to energy services which often depend on the electrification of rural areas (van der Linden et al, 2003).

[2] The widespread development of renewable energy (RE) is essential as part of a combined strategy that includes increasing energy efficiency, changing how resources are used to produce energy, and investing and developing new technologies for energy production (Larson et al, 2003). This strategy is exemplified in Pacala, S. and R. Socolow. "Stabilization Wedges: Solving the Climate Problem for the Next 50 years with Current Technologies." *Science*. Aug 13, 2004. Vol. 305.

support is extremely important at the initial stages of the development of markets for renewable energy to provide means to overcome these barriers (van der Linden et al, 2003).

One strong measure a government can take to develop RE markets is through mandated market share (MMS) policies[3], which require that a certain quantity or proportion of a country's energy be generated from renewable energy sources by instituting a purchase obligation or creating strong incentives for renewable energy at some point along the energy supply chain (van der Linden et al, 2003). Mandated market shares for renewable energy can be created by instituting one of 3 policies, or a combination of them:

- Renewable Portfolio Standards, whereby the government requires that all electricity carriers produce a certain amount of renewable energy annually, or buy tradable credits for that amount of energy.
- Feed-in Tariffs allow the government to set the price of renewable energy and guarantee that all renewable energy produced will be purchased and fed to the grid at the specified price for a specific period of time.
- Tendering systems are a combination of the previous two policies, which allows energy suppliers to competitively bid for renewable energy obligations.

This paper will examine RPS policies, feed-in tariffs, and tendering policies, both in theory and in practice, to shed insight into how China might potentially implement MMS policies to combat climate change while meeting its energy demands through renewable energy production.[4] In order to evaluate these policies, criteria for mandated market systems will first be established, followed by a discussion of the advantages and disadvantages of RPS, feed-in tariff, and tendering with case studies on their implementation in the US and Europe. China's energy market and capacity for future growth will then be considered, with a specific emphasis placed on opportunities for wind and solar photovoltaic (PV) energy growth, followed by an evaluation of renewable energy policy in China to date. This paper will then explore the challenges particular to China in instituting a mandated market share system, and then offer suggestions to the Chinese

[3] This term will be used as it is defined in Van der linden, 2003 (paraphrased above).
[4] Renewable energy in this paper will refer to what is sometimes termed "new" renewable energy: wind, solar photovoltaic, solar thermal, geothermal, as well as small hydro (under 30GW).

government, NGOs, international institutions, and the UN Commission on Sustainable Development (CSD) on how to support the implementation of an effective MMS system in China.

Criteria for evaluating an MMS policy

The value and success of the three MMS policies will be evaluated according to the broad criteria shown in Figure 1, which are formed under three categories: Outcome criteria, which evaluate the overall impact of the policies; policy design criteria, which examine the elements of policy design that affect its success; and market criteria, which make clearer the market conditions under which these policies succeed (Wiser et al, 2005).[5] The MMS policies will also be evaluated in terms of three primary goals of MMS systems for China: to increase the production capacity of energy from renewable sources, drive down the price of renewable energy, and provide a viable alternative to coal-based energy production, creating methods for energy production that can compete effectively with fossil fuels (van der Linden et al, 2003).

Finally, one fundamental, underlying criterion must always be considered in the evaluation of different MMS systems: the cost of the policies themselves. Because these policies require revenue to cover incentives in the form of purchase obligations, above-market fixed prices, power purchase agreements, and administrative costs, the question of who will bear the burden of these costs is an important and politically significant one. Traditionally, the costs can be borne in four ways: incremental costs are passed on the nation's domestic energy consumer base in the form of a small KWh surcharge or tariff, electric utilities are forced to bear extra costs that are then passed on to consumers, the costs are covered by public funds provided by the government or donors, or they are paid for by a carbon tax on fossil fuel consumption (World Bank, 2006). Thus the issue of policy cost is related to debates on production and consumption distortions introduced by protectionist measures as well as those of political viability.

[5] Explicit three-way comparisons of the policies against the criteria in Figure 1 are made in Table A1 of the Appendix.

Figure 1: MMS policy Evaluation Criteria

1. Outcome Criteria:

Cost Minimization: minimizing the cost of generation and maximizing the amount of competition in the renewable energy sector (to the extent this will contribute to minimizing costs)
Price Minimization: minimizing the price that is paid for renewables in the marketplace
Maintaining Targets for Renewable Energy: ability to establish and meet firm development targets for renewables
Local Industry and Manufacturing Development: ability of the policy to increase local renewable infrastructure and create a local renewable energy manufacturing industry that will have economic development and employment benefits
Resource Diversity: ability of the policy to encourage diversity in renewable energy supply sources
Market for Power from Renewable Facilities: the creation or maintenance of a sustainable market for purchases of renewable energy that supports the funding of new facilities
Full Compliance: all electric utilities are able to and chose to comply with the policy

2. Policy Design Criteria

Simplicity: the simplicity of policy design, administration and enforcement
Compatibility with the Electricity Industry and Regulatory Structure: compatibility of policy with increased competition being introduced into the electricity sector
Policy Stability: ability of the policy to create a durable renewable energy industry with access to reasonable financing
Competitive Parity: ability of the policy to spread the cost of renewable energy fairly and evenly across market participants
Complementation: ability of the policy to complement and be complemented by other incentive mechanisms created by the government for RE production
Credible and Effective Enforcement: Critical for renewable developers to be confident of their investment

3. Market Context Criteria

Integration: ability of the policy to integrate renewable energy into the larger electricity system and to reduce institutional barriers to renewable development
Political and Regulatory Support: Necessary to minimize uncertainty about the duration of the policy
Adequate and Accessible Developable Resource Potential: Policies must take into account geographic RE capacity, transmission costs, interconnection barriers and wholesale market rules to be effective
Presence of Long-Term, Credit-Worthy Power Purchasers: Crucial to the alignment of supply and demand of renewable energy within regions

Source: Wiser et al, 2002; Wiser et al, 2005.

Discussion of MMS Policies

Renewable Portfolio Standards

Description of the policy

Renewable Portfolio Standards allow the government to require that all electric utilities generate a stipulated quantity, proportion or capacity of renewable energy annually, often giving them the option to buy tradable credits for that amount of energy if they are unable to produce it themselves. An RPS policy can be designed to encourage the development of renewable energy technologies (RETs) beyond the one that is cheapest at present with ‘tiers’, in which a separate purchase obligation or standard exists for different RETs such as wind and solar photovoltaic, or through ‘credit multipliers, in which utilities receive more credit towards their purchase obligation by buying more expensive RE from less developed technologies.[6]

<u>Benefits</u>

The Renewable Portfolio Standard has a number of clear advantages that comes about as a function of its inherent structure (Wiser et al, 2005):

- It is a mechanism through which a specific quantity of renewable energy will be produced; it effectively sets target levels for RE development.
- RPS promotes off-grid supply because the generation cost of off-grid power from renewables is lowered through income from sale of tradable credits.
- It gives producers an incentive to produce RE in the most efficient manner possible since it does not set a specific cost, but rather gives them the flexibility to produce it in the manner they see fit.
- The policy creates a mechanism through which market competition can drive the cost of RE down.
- Certificate based trading lowers administrative and compliance costs, because it increases the ease with which electric utilities are able to comply with the policy.
- RPS offers the most equitable policy approach in that it does not favor specific bidders or developers.
- The policy has shown to be effective at the state level in the US (see below).

<u>Disadvantages</u>

Many of the disadvantages to be found in an RPS stem from the same qualities that provide strong advantages (Wiser et al, 2005):

- The price variability introduces profit uncertainty for investors.
- Success depends on how well the policy is designed; the optimal purchase obligation may be difficult to determine and must use parameters such as potential RE capacity in the country as well as projected consumer burden.
- RPS policies can be complicated and difficult to implement and enforce, especially if tiers or multipliers are introduced. The added complexity makes it more difficult and costly for the government to monitor whether electric utilities have complied properly with the policy.

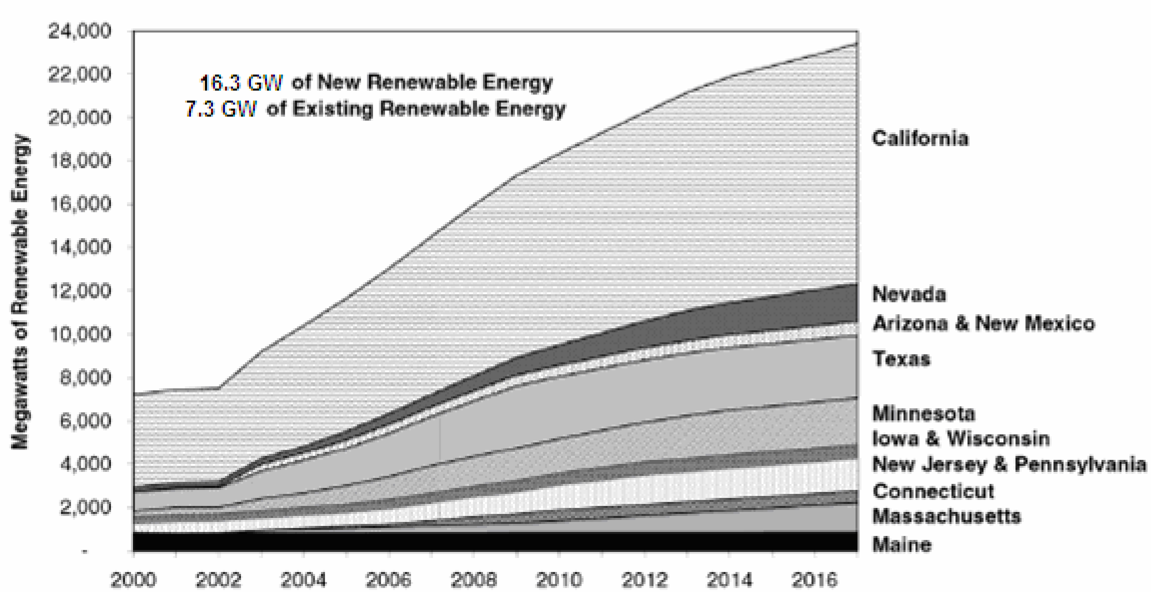
[6] Elements of the policy design are detailed more comprehensively in Figure A2 of the Appendix.

- Without tiers or multipliers, the policy may encourage the growth of just one type of renewable--whatever is the most cost-effective at the time.
- It can be less flexible in offering targeted support to specific groups, such as small utility carriers, than other policies, unless specific provisions are made for these groups.
- National RPS policies can have high administrative costs without local enforcement support.

Experience in the United States

The Renewable Portfolio Standard is the most popular MMS policy in the US, and has been instituted in the 21 states. A 2005 study by Global Energy Decisions estimates that current state RPS laws will require an additional 52 GW of renewable energy by 2020, more than double the existing U.S. renewables capacity (Martinot et al, 2005). Figure 2 illustrates a similar increase, in which the states depicted are projected to produce more than 16 GW of new renewable energy by 2017 under their various RPS policies. As the graph shows, the RPS policies of California and Texas in particular have had—and are projected to have—much more success than that of Maine and New Jersey, which has had moderate success. The RPS policies of these four states will thus be examined to explore what elements of the policies have led to strong successes or failures.

Figure 2: The Impact of State RPS Policies



Source: Wiser et al, 2005.

Texas

Texas has a relatively well-established state RPS policy, first enacted in December of 1999, which fulfills many of the outcome criteria listed in Figure 1. It contains a modest target of 2GW of additional renewables by 2009 (2.5% of total current state energy consumption), with steady incremental targets of .4 GW by 2003, .85 GW by 2005, 1.4 GW by 2007, and finally 2 GW by 2009, sustained through 2019. In 2001, it began the nation's first comprehensive certification program, administered by the Electric Reliability Council of Texas (ERCOT), to allow trading of renewable credits (RECs). The policy includes explicit penalties for non-compliance enforced by the Texas Public Utilities Commission, stipulating that electric utilities with up to a 5% deficit in RECs must make up the deficit in the next annual compliance period, and that those over 5% may pay $50/MWh of RE deficiency or pay 200% of the average market value of the credits deficient for that compliance period. Additional flexibility exists in the policy in that existing renewable generation is allowed to offset retail energy suppliers' new renewable purchase obligations (Wiser and Longniss, 2001; Wiser et al, 2005).

RPS compliance costs for electric utilities in Texas have appeared to be almost negligible because as of 2004, long-term wind power contracts averaged at 3 cents/KWh, which is equivalent to or below the cost of conventional power (REPP, 2004).[7] Furthermore, electric utilities have exhibited full compliance with the policy. These results provide strong evidence that the modest Texas RPS had visible success in promoting economies of scale for wind that have been driving the price/KWh of wind energy down (Wiser et al, 2005).

California

California has established an extremely aggressive, complex RPS policy in 2002 that has since been updated to be even more ambitious due to the initial success of the policy. Its targets now require additions of at least 2% each year (up from the initial goal of 1% yearly increases) to RE production, until a 20% target is met by 2010, with a goal of at least

[7] This is in part because of a 1.7 cent/KWh tax credit that is simultaneously being offered to Texan electric utilities.

33% by 2020 (DSIRE, 2006). The California Public Utilities Commission (CPUC) is in charge of overseeing and enforcing this growth and is in the midst of determining rules and specific but flexible compliance penalties that will apply to investor owned utilities (IOUs). The state has created the Renewable Resource Trust Fund, funded with a .2-.3 cents/KWh charge (a fraction of a cent) on all retail sales of electricity, which is being used as supplemental payments to eligible renewable energy resources to offset above-market costs of compliance with the policy (REPP, 2004A). The CPUC and the California state legislature have been carefully planning how to implement and enforce the policy in the simplest, most transparent manner possible (CEC, 2005). California shows how ambitious but carefully designed RPS can be used to drive remarkable growth in RE markets over a period of 10-20 years.

Maine

Maine nominally set out in 2000 what appeared to be an aggressive standard, requiring that 30% of energy consumed in Maine be generated from renewable sources. However, because both existing and new renewable generation are eligible to meet the targets, the resource types eligible to meet compliance are particularly broad, including fossil-fuelled cogeneration, large hydropower, and biomass, and RE resources need not be located in state. Maine's RPS, though currently the highest in the country, is unlikely to spur the growth of additional RE production capacity in Maine as projected in Figure 2 (Wiser et al, 2005; REPP, 2004B).

New Jersey

New Jersey has avoided the problem that Maine has faced in defining acceptable RE too broadly by creating two-tiered RPS with two distinct classes. Class I includes wind, solar, geothermal, fuel cells, ocean power, landfill gas, and specific biomass technologies, while Class II includes some types of hydropower and municipal solid waste facilities. As of 2003, the purchase obligation Class I technologies started at 0.5%

in 2001 and would increase to 4% by 2012; the purchase obligation for Class II resources would stay constant at 2.5% through 2012 (Wiser et al, 2005). In April of 2006, the New Jersey Board of Public Utilities followed California's lead, and increased the state's Class I standard to 20% by 2021, with 2.12% generated from solar PV sources, resulting in the production of more than 1.5 GW of PV power in New Jersey by this date (DSIRE, 2006A). This revision shows how RPS policies have been used to spur targeted growth of specific RE technologies such as solar PV.

Feed-In Tariffs

Description of the policy

Also called a pricing system, this policy obligates electric utilities to let renewable energy plants connect to the grid, and requires that the utilities purchase all electricity that they produce at or above a set minimum price, which is above the market price for energy and is guaranteed typically for a lengthy period of time so that renewable energy producers can be sure of gaining a small profit margin (Sawin, 2004).

Benefits

- The fixed price (usually for 15 to 20 years) allows for more investor certainty.
- The price also stimulates investment, since it is guaranteed to sell at above the market price.
- Different types of renewable energy (ie. Wind, solar photovoltaic, or geothermal) can have different fixed prices depending on their current costs to ensure a profit for producers and create strong financial incentives for investment across technologies.[8]
- This policy can be combined with a standard or purchase obligation (similar to that of an RPS) to create a second mechanism that ensures RE produced is fed to the grid.[9]
- Can be designed in a simple manner and has low administrative costs (Wingate, 2003).
- Needs less of a competitive environment than RPS and tendering policies to be successful.

Disadvantages

- Does not encourage a specific quantity of RE production or set targets unless combined with a standard (which can be done with powerful results).

[8] Economies of scale and learning could then facilitate the transition to free market conditions once the tariff expires.
[9] This system would place the burden of higher costs on electric utilities fulfilling their purchase obligations, which could be lessoned by subsidies from a public benefits fund that derives revenue from a small, flat tax on all retail electricity.

- Fixed price may engender inefficiency, and result in the overcompensation of market actors.
- The costs to electric utilities in paying the tariff may often be high—however, caps can be placed on the total amount each utility is required to pay.
- Determining effective prices is a complex and difficult task (Teri, 2006).

Experience

US

The renewable energy industry in California saw considerable growth in the 1980s due to the 1978 Public Utilities Regulatory Policy Act (PURPA) which was essentially a feed-in tariff, coupling long-term contracts with a mandatory fixed price. Today, California remains one of the leading states in installed energy capacity as a result of its strong start in the 1980s. California's interpretation of the act along with favorable tax incentives resulted in the production of 12 GW of renewable energy in the US in the 1980s (Wiser, 2002; Martinot et al, 2005A). Thus feed-in tariffs played a large role in the strategic creation of RE markets in the US. However, through the 1990s, the repeal of federal and state incentives, a long period of electric power sector restructuring, and changes in market conditions such as a drop in natural gas prices caused very little growth in RE capacity. Nevertheless, PURPA highlights the usefulness of feed-in tariffs in developing small RE markets still in their very initial stages. Currently, several states still implement PURPA as a feed-in tariff for small projects; examples of this can be found in Idaho, Minnesota, and Oregon (Martinot et al, 2005A).

Europe

Germany, Denmark, and Spain have instituted effective, successful feed-in tariff systems, and have the three most successful renewable energy programs in Europe. The three countries have been able to implement attractive pricing formulas and have seen extensive wind power growth:

In Germany, though feed-in laws have frequently been protested in the electric utility industry, it has had strong results—Germany has one of the largest wind and solar markets in the world, with wide-scale manufacturing bases for both technologies. Initiated in 1990, the feed-in law required that wind power, solar, hydropower, and biomass receive 90% of the residential retail price of electricity until 2000 (from 9.5 cents/kWh in 1991 to 8.8 cents/kWh in 1999) (Wiser et al, 2002). The regulatory authority set the tariffs every year based on the value of the average utility revenue per kWh sold, which stimulated wind growth in particular. The result of the tariff was that installed capacity expanded substantially from 1.1 GW in 1995 to 6.1 GW in 2000 (Sijm, 2002). However, the tariff was funded ultimately from the revenues of utilities rather than taxes, distorting competition between utilities. It also left the tariffs variable since they were based on utility revenues; when the electricity prices dropped, so did the tariffs (ECN, 2003). Germany's feed-in tariff shows not only how the policy can bring about strong positive results in RE capacity development, but also highlights the risk of market distortions with the implementation of a tariff attractive to RE investors.

Denmark's feed-in laws have been cited as particularly successful due to complementary policies implemented along with them that include specific capital subsidies, tax incentives, low-cost financing opportunities, and R&D funding. Between 1990 and 2000, wind capacity in Denmark grew by 21 percent per year on average to about 2.3 GW in 2000 (Sijm, 2002).In 1997, Denmark produced almost 60% of worldwide wind power sales (though it has now been overtaken in absolute terms of installed wind capacity by Germany and Spain), providing evidence that feed-in tariffs can be notably strengthened by well-designed tax and subsidy incentives (Wiser et al, 2002).

Spain's feed-in tariff, established in 1994, has resulted in dramatic recent wind power growth with the establishment of several of the largest wind farms in the world, each over .1GW/KWh in capacity, and the development of a sizeable wind-power equipment manufacturing industry, which has lowered investment costs due to economies of scale and learning (Junginger et al, 2005).[10] Between 1995 and 2000, installed (onshore) wind capacity in Spain almost doubled every year, expanding from .114 GW in 1995 to more than 2.8 GW in 2000 (Sijm, 2002).Green power producers operating under the system can choose between a fixed price and a premium on top of the market price of traditional energy, and make agreements regarding grid connection for a minimum of five years (ECN, 2003A). These design elements of the tariff allows those under the tariff more choice and gives the policy flexibility in capturing market trends, and thus spurs additional investment.

Tendering

Description of the Policy

Tendering systems use government-supervised competitive processes to meet planned targets by making long-term power purchase agreements with renewable energy generators. Tendering policies are similar in some respects to feed-in laws and renewable portfolio standards; in that both the price and targets are set, but here the price and the RE projects eligible for government support at the specified price are chosen through a competitive bidding process, in which bidders submit project proposals with the price they are able to offer (Wiser et al, 2002).

Benefits

- The guaranteed power purchase agreement reduces investor risk and uncertainty.
- Separation of competitive bidding between technologies allows diversity in the industry to emerge.
- Allows government to easily target the development of specific technologies.

Disadvantages[11]

- The amount of power acquired may depend on the prices bid. This can potentially be avoided if a mandatory quantity to be produced and a ceiling on the maximum price is set.
- May or may not reduce RE costs over time, depending on the quality of proposals and the level of competition.
- The intense price competition common to this method favors large RE developers with more size and experience (so they could reduce their bidding costs), making market entry for small developers who don’t have government support much more difficult.

[10] 12% of installed capacity is in wind farms is below .015GW, 40% is in wind farms between .015 and .025GW, and 48% of installed capacity is in wind farms over .025GW in capacity. Several parks exist with around and above a .100GW installed capacity (Junginger et al, 2005).

[11] Inferred from Wiser et al, 2002.

- Large companies may not find it necessary to develop a domestic infrastructure manufacturing industry since they can import equipment more easily.
- Multiple bidders and a competitive industry is necessary for policy to work.

<u>Experience in the U.K.</u>

A large, successful tendering process has taken place in the U.K. with its Non-Fossil Fuel Obligation (NFFO), which has placed five successive competitive bid orders for renewable energy between 1990 and 1999, which aimed to bring 1.5 GW of new renewable capacity to the grid (roughly 3% of the total U.K. electricity supply). Twelve regional electric companies were required to buy all power from these NFFO projects. The policy awards contracts on a competitive basis within specific technology types (so wind projects compete against other wind projects), accepting projects that projected to generate RE at the lowest price/KWh among each technology type. This process proved to be highly successful in reducing the price of wind. For example, the average price for large wind energy dropped from around 18 cents/kWh to 4.5 cents/kWh over five years. However, a substantial number of the RE projects that won bids under the NFFO have never been developed, due to the inherent design of the policy, where some degree of speculative bidding by renewable energy developers takes place as groups may understate the price they are capable of offering as they jockey for contracts (Wiser et al, 2002). Thus while the NFFO example shows that tendering can dramatically reduce costs over a short period of time, precautions must be taken in policy design to ensure a realistic bidding process.

China's Economic, Structural, and Geographic Climate for Renewables

Energy Use and Environmental Impacts

Trends in China's growth show that it would have much to gain from the strategic implementation of MMS policies to rapidly advance the development of renewable energy in China. Most of China's growth is occurring on its Eastern coastal areas, which is where highly concentrated energy demand lies. As of 2000, this region contains 13.6% of China's land area and 38.8% of China's population, but 63.2% of the total GDP of the country (Fan et al, 2005).

Pollution has become a significant problem, as production is heavily coal-based. In 1999, for example, coal production and consumption accounted for 60.3% and 69.0% of total energy production and consumption for China (Fan et al, 2005). The result is that this region emits 69375 X $10^8 m^3$ of industrial gas emissions waste (50.3% of the country's total emissions) and 683 X 10^4t sulfur dioxide emissions (42.3% of the country's total of this pollutant) (Fan et al, 2005). Although 97% of the population does have access to electricity, the area outside the eastern coastal region contains rural villages unconnected to the grid with 30 million Chinese residents still without electricity (NREL, 2004).

Potential Capacity for Renewables

The potential for the expansion of China's renewable energy capacity is significant (See Figure 3). However, though demand is concentrated in the Eastern Coastal areas, much of the potential wind and solar PV supply is spread over regions with low energy demand. As Figures 4 and 5 show, Wind energy is in fact concentrated on the eastern half of China, with significant opportunities for offshore production, whereas solar PV potential is concentrated in the western half of China, with an abundance of solar energy available in the southwest region where Tibet is located. Though the total technically exploitable capacity of onshore wind is 253 GW, and onshore potential capacity is as much as 750 GW, and the exploitable capacity of solar PV, if China covered 1% of its land area with solar panels, is approximately 240 GW, the areas with a significant potential capacity of RE are not necessarily those with the greatest energy demands (Zhengming et al, 2000; Yixin et al, 1999).[12] For example, the provinces of Inner Mongolia and

[12] The solar PV estimate, an extremely rough figure, was derived from figures cited in Yixin et al, 1999. The paper states that annual solar insolation (incoming solar radiation) is $50*10^{18}$KJ, which is roughly equal to 170 Btce (billion tons coal equivalent). This figure (170 Btce/year) was converted to GW using conversion tables published in Mutiga, 2001 and IEA, 2006 through the following process: 170 Btce/year x 1year/365 days x 1 day/24 h x 10^9 tce/1 Btce x 29.3 GJ/1 tce x 10^9 J/1 GJ x 1TJ/ 10^{12} J x 1 GWh/3.6 TJ = 157,946 GW. Solar PV panels were assumed to have a 15% level of efficiency, as per NREL, 2006, meaning that about 23,691GW would be exploitable from solar insolation to China. Because estimates as to the surface area of land that China could use for PV purposes and the intensity of incoming solar radiation is unavailable, an estimate of energy derived PV panels peppered across 1% of China's total land area (~100,000 km^2 as per CIA, 2006) yields 240 GW. This number might potentially be

Xinjiang have substantive potential capacities for PV and wind, but these areas have little energy demand in comparison to the eastern coastal areas, presenting a considerable challenge for China align to demand and potential supply (Zhengming et al, 2000).

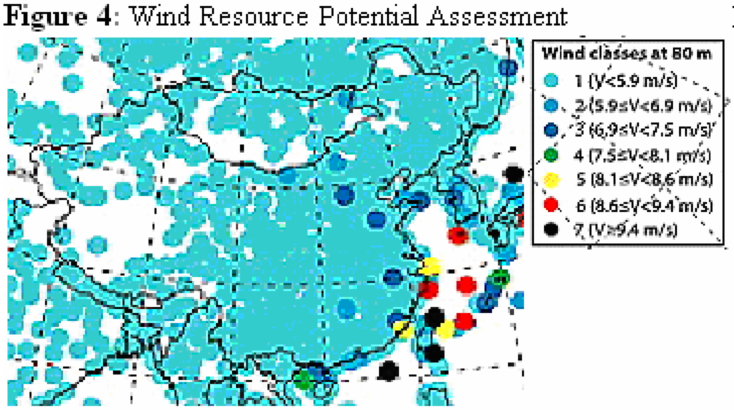
Figure 3: *Overview of technically exploitable potential and currently installed capacity of renewable energy for power generation in China in 2002*

Renewable energy source	Technically exploitable potential	Installed capacity [MW]
Grid connected RE power production		
Bagasse fired power generation	21.2 mln. ton bagasse	807
Wind energy	253 GW*	440
Large and small hydropower	265 GW	90,200
Geothermal	5.8 GW	30
Tidal energy	110 GW	5.9
Decentralised RE power production		
Solar PV		43
Wind Energy		25
Mini-hydro (< 10kW)	80 GW	154

Sources: Iberdrola technology study; 'Renewable Energy Development in China: The potential and the challenges: Zhang Zhengmin et al

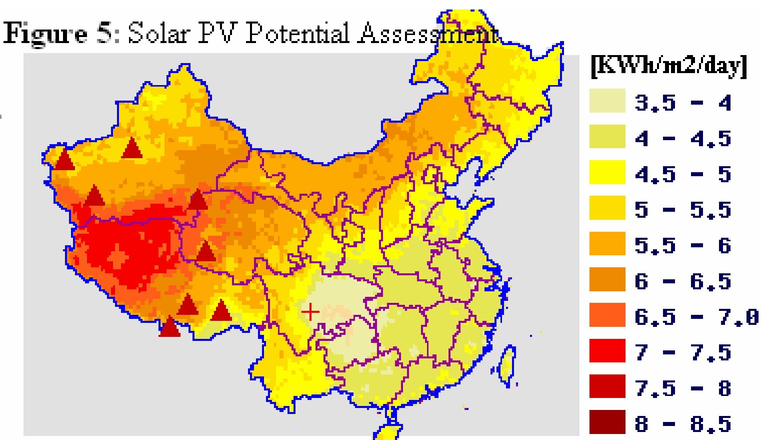
* Based on an evaluation of winds at 10 metres above ground.

Figure 4: Wind Resource Potential Assessment



Source: Archer et al, 2005.

Figure 5: Solar PV Potential Assessment



Source: SWERA, 2006.

Markets and the Development of Renewables

The successful implementation of MMS policies in RE in China not only depend on considerations of geographic resource capacities, but also the different stages of market development of the different technologies, outlined in Figure 6. For example, as of 2000, solar water heating in China was moving into Phase V while large-scale wind generation was in Phase II. Furthermore, a technology may not have fully completed all parts of a phase before starting

significantly higher if PV panels were concentrated in China's western regions with higher levels of incoming solar radiation.

developing aspects of subsequent phases. However, attempting to force a shift in phases without the presence of an adequate foundation in the other phases creates a high risk for the failure of MMS and other policies. For example, if a new RE technology was forcibly moved into a competitive market situation to reduce the price of the technology before sufficient infrastructure, such as a domestic manufacturing base able to produce the technology, existed, price reductions would be unlikely to occur (Zhengming et al, 2000).[13]

Figure 6: Typical Renewable Energy Developmental Phases

Phase I. Research, Development and Demonstration of New Technologies
- Resource Assessment
- Technology Development and Demonstration

Phase II. Wholesale Market Development
- Establishment of stable wholesale market rules and processes
- Establishment of companies willing and able to undertake resource development (usually IPPs)
- Establishment of manufacturing facilities
- Development of a financing framework

Phase III. Cost Reduction
- Project experience (multiple projects by individual companies)
- Increased manufacturing volume
- Development of related infrastructure and service companies to support the technology
- Standardized product

Phase IV. Price Reduction
- Assured volume/long-term opportunities
- Competitive market

Phase V. Retail Market Development
- Clear market rules
- Four or more individual companies
- Public education/information

Source: Zhengming et al, 2000.

[13] The development of each industry is visible to an extent through an examination of its installed capacity. Table 4-1 of the Appendix examines details on the installed capacity of wind and solar PV technologies in the context of other renewables.

In recent years, the development of wind and solar PV have taken significant strides, both are in the process of moving from Phase III to Phase IV, developing increased manufacturing volume and related infrastructure for both technologies. While wind energy in China has been making headlines due to projections for substantive short-term increases in installed wind capacity, the solar photovoltaic manufacturing industry in China has swelled, expanding to produce all components necessary for solar photovoltaic cells, including polysilicon feedstock, wafers, cell, and module production. China's module capacity of .45 GW is projected to rise to 1.2 GW, its solar cell-making capacity from .2 GW to 1.2 GW, and its wafer capacity from .1 GW to .8 GW by 2008 (Pichel, 2006).

The Price of Renewables

Wind energy in China currently is priced at between 7.6 to 10 cents/KWh and solar at around 42 cents/KWh (Liu, 2005; Asia Pulse, 2005). However, as Larson et al have shown, there is promise that renewables costs will decline for China as the development of RE technologies increase. Larson et al's Markal model makes a strong case, using a broad range of economic and political factors, that "even when significant limitations on carbon emissions were stipulated, the model calculated that an advanced energy technology strategy using our technology-cost assumptions would not incur a higher cumulative (1995–2050) total discounted energy system cost than the business-as-usual strategy" (Larson et al, 2003). Thus there exists a cost-based argument to be made for policy market drivers in China, in addition to the environmental and energy demand factors discussed.

National Energy Policies in China

Classifications

China's energy policies can be placed in 3 classifications (Yao, 2005): The first level consists of those policies that provide general direction and guidance. Second level policies set

Figure 7: A Timeline of Energy Policy in China According to Classification

First Level	
1983	Suggestions to Reinforce the Development of Rural Energy
1992	China Agenda 21
1992	Ten Strategies on China's Environment and Development
1995	State Science and Technology Commission (SSTC) Blue Paper No. 4: China Energy Technology Policy
1995	Outline on New and Renewable Energy Development in China, State Planning Commission (SPC), SSTC, State Economic and Trade Commission (SETC)
1995	Electric Power Law
1996	Guidelines for the Ninth Five-Year Plan and 2010: Long-Term Objectives on Economic and Social Development of China
1996	State Energy Technology Policy
1997	Energy Saving Law
2003	Renewable Energy Promotion Law
Second Level	
1994	Brightness Program and Ride the Wind Program, formulated by SPC
1995	New and Renewable Energy Development Projects in Priority (1996-2010) China, by SSTC, State Power Corporation, and SETC
1996	Ninth Five-Year Plan and 2010 Plan of Energy Conservation and New Energy Development by the State Power Corporation
1996	Ninth Five-Year Plan of Industrialization of New and Renewable Energy by SETC
1998	Incentive Policies for Renewable Energy Technology Localization by State Development and Planning Commission (SDPC) and Ministry of Science & Technology (MOST)
2001	Tenth Five-Year Plan for New and Renewable Energy Commercialization Development by SETC
2003	Rural Energy Development Plan to 2020 for Western Areas
Third Level	
1997	Circular of the Communication and Energy Department of SPC on Issuing the Provisional Regulations on the Management of New Energy Capital Construction Project
1999	Circular of MOST and SDPC on Further Supporting the Development of Renewable Energy
2001	Adjustment of Value-Added Tax for Some Resource Comprehensive Utilization Products by Ministry of Finance (MOF) and State Tax Administration
2001	Electricity Facility Construction in Non-Electrification Townships in Western Provinces of China or Township Electrification Program by SDPC and MOF

objectives and form development plans. Third level policies create specific rules, incentives, and "managerial guidelines", such as non-compliance penalties.

General Energy Policy: the Five Year Plans

Government policy in China first shifted toward environmental concerns in 1978, and then, beginning in the 1980s, the Sixth, Seventh, Eighth, Ninth, Tenth, and Eleventh Five-Year Plans have shown a growing attentiveness to energy concerns (Yao, 2005; NREL, 2004):

The Sixth Five-Year Plan (1981-1985) put the equivalent of 10% of energy supply investment into energy conservation projects. This policy continued in the Seventh Five Year Plan, though the percentage was reduced to 8%. The Ninth Five-Year Plan (1996-2000) took important steps from this point, implementing Agenda 21[14], and allowing the National Environment Protection Agency (NEPA) to set up a long-term "Green Project

[14] After the 1992 Rio de Janeiro UN Summit on Global Environment and Development, China issued its "Agenda 21", which expressed that 'priority should be given to the development of renewable energy in the state energy development strategy, and to encourage energy-saving, energy efficiency and developing renewable energy should become the fundamental state policy'" (Yao, et al., 2005).

Plan" (Yao, 2005).

The Tenth Five-Year Plan (2001-2005) made renewable a specific priority, introducing a Tenth Five-Year Plan for Sustainable Development, as well as a Tenth Five-Year Plan for Renewable Energy Commercialization Development. The plan stipulates that "the production capacity of solar energy, wind energy, and geothermal energy should be increased" (NREL, 2004A). However, the plan offers general objectives for the most part, making loose recommendations for the development of MMS policies for RE development, including tendering programs, and a national RPS or feed-in tariff.

The Eleventh Five-Year Plan (2006-2010) will support the implementation of the Renewable Energy Law (effective January 1, 2006), the most direct step China has taken towards the development of the RE industry. Under the direction of China's Center for Renewable Energy Development (CRED), the law aims to meet short term energy needs with long-term clean energy objectives, offering specific incentives to spur growth by guaranteeing grid access to renewable energy producers while spreading its cost across the industry, primarily through purchase obligations (IFC, 2006). In addition, the Renewable Energy Law announced a goal of producing 60 GW, or 10% of its power supply, with renewables by 2020 (Jing, 2005), a goal which was increased to 15% in March 2006 (China Daily, 2005).[15] The law requires that utilities purchase 100% of the output generated from eligible renewable energy facilities, designates the NDRC as the regulatory body responsible for implementation of the law, and provides a national fund and tax incentives to foster development, including a 50% tax break for investment in solar, wind, and biomass energy (Jing, 2005; EF China, 2005). The Renewable Energy Law marks a shift in energy policy toward the use of policy to spur the growth of dynamic market of renewables for China.

[15] This goal was hailed as a strong indication that a National RPS would follow for China, but at present the 15% is a goal without a set purchase obligation for electric utilities.

Policy Trends

As the discussion of the Five-Year Plans have shown, a great deal of China's national energy policy is broad and overarching, often lacking quantitative targets with specific enforcement rules, as well as clear and transparent operational rules (Fan et al, 2005). Figure 7 provides an overview of the policies China has enacted since the 1980s, according to classification. Between 1997 and 2001, however, four national level-three energy policies with more specific, concrete regulations were passed, illuminating the trend that China has been picking up the pace on national efforts to meet future energy demands.[16]

Evidence exists that the gap between overarching energy policies and clear implementation are present as a result of a lack of coordination between policy-making and regulatory bodies. Throughout the 1990s, energy policy was developed by the State Planning Commissions, the State Economic and Trade Commission, the State Science and Technology Commissions, the Ministry of Finance, and the State Environmental Protection Agency, among others. In 2003, the government took a major step in creating the NDRC to replace the state commissions (Andrews-Speed, 2004). In May 2005, it further corrected the problem by establishing the National Energy Leading Group (NELG) to coordinate energy policy. However, many experts have recommended that a department of energy be created on the ministry level of the government to further develop coordination (Andrews-Speed, 2004).

The Next Steps: China's Progress in Deploying MMS Policies

The Wind Concession program

In 2002, China created the Wind Power Concession program under the NDRC, which called on international and domestic investors to develop .1 GW wind farms on potential wind sites. Winning bidders' proposals were approved for the development of the sites, given a power

[16] Table 12-1 of the Appendix catalogues the various incentives that province has in place for the development of renewables.

purchase agreement (PPA) for the first 30,000 hours of the projects' operations, assured grid interconnection, financial support for extension of the grid and roads, and other tax, subsidy, and loan support. These measures are used to create a low-risk investment environment for wind farm developers. In October 2003, two bids were accepted. However, these winning bid prices were excessively low, dipping below long-run marginal costs for the projects. As a result, the developers chosen have not been able to obtain financing, and the projects have yet to go forward. A second round of bidding brought forth even fewer proposals (World Bank, 2006). In eight of the concession rounds that have taken place since 2003, seven of them have been won by state-owned power companies, at prices around 5 cents/KWh, which may have been too low for private and foreign companies unwilling to incur losses to compete (Liu, 2006). Another concern is the potential burden on consumers-- In 1998, five wind farm projects with PPAs funded by the World Bank and Global Environment Facility under the China Renewable Energy Development Project (CREDP) ran into difficulties when the surrounding regional grids could not support the spread of the higher price across the grid (Raufer, 2002). However, though the tendering system has been a source of concern, if adjusted to better reflect private developer and consumer concerns according to market conditions, it could be the source of the rapid establishment of numerous large-scale wind farms for China, though these adjustments are extremely difficult to make in light of the difficulty in assessing market factors in nascent industries.

A National Feed-in Tariff?

The November 2005 draft of the Renewable Energy Law indicated that the Chinese government would pass a feed-in tariff for wind power fed to the grid, specifying that this measure would take into account the "nominal tariff of local desulfurized coal-fired power plants" and add subsidy of (US) 2.8 cents/KWh, funded through a small (less than .1 cent/KWh) tax on domestic energy consumers. However, the final version of the regulation, approved at the end of March 2006, does not include this language, leaving the Wind Concession program as the primary market driver policy of wind development, a policy which, as mentioned above, many developers have deemed too risky to provide an incentive to enter the market, as remarkably low price proposals are needed to win bids (Liu, 2006).

Challenges

The Chinese government, at present, has stepped away from a national feed-in tariff, has not yet had consistent success with the wind concession approach, and may not, on the whole, have markets sufficiently developed for a national RPS. What would be the best, most efficient and cost-effective way for China to proceed? In any national MMS policy it puts forward, it will need to consider several challenging factors about its market conditions: the discrepancy between potential supply and demand across provinces and urban and rural regions, and the deadweight losses to consumers and producers, and the different developmental stages of particular RE technologies. To do so, it must carefully weigh the elements of policy design to determine which set of policies will achieve the most success, taking an integrated approach to fulfill the three main branches of policy criteria set out in Figure 1. Thus, an MMS system must explicitly address issues of price, availability of capital, manufacturing and service capabilities, institutional arrangements, and lack of competition (Raufer et al, 2002). Because of the difficulty of demonstrating and quantifying the impacts of these systems beyond case-study experience, their theoretical qualities will be compared to the situation in China, supported by various case studies, to sketch out how China should create an optimal MMS system (Thiruchelvam et al, 2003).

Recommendations

Because developing an effective mandated market system for renewable energy in China can be encouraged and facilitated by a wide rage of groups and actors, policy recommendations will be made to the government of China, NGOs, and international institutions, with an emphasis made towards the UN CSD.

Policy Design

A joint effort between China, NGOs, international institutions, and the CSD to implement a strong decentralized MMS with the following characteristics would have many advantages:

As the analysis of MMS policies have indicated, a homogenous mandated market system (such as a national RPS policy) appears disadvantageous because of its lack of flexibility toward the unique market conditions in each region of China. Implementing a policy flexible towards the needs of specific regions and cities has clear advantages for the government of China.

Because of the lack of competition in rural areas, feed-in tariffs appear to be the best initial policy for these areas for at least the next 10 years. This will reduce investor uncertainty and increase investment, and will also support community-based development more than the other policies. As competition and development increase in these regions, the province-level governments of China can move to RPS policies. The MMS policies for rural regions will benefit from working to first develop capacity in underdeveloped regions at a reasonable price, and then work to drive this price down.

In high-capacity sites in rural areas, primarily in the Western region, China, energy-affiliated NGOs, and the CSD will find it beneficial to encourage investment from the eastern coastal area and abroad, in order to garner enough competition so that a competitive bidding process can be undertaken with efficient results that will make sure that these areas are made productive (Fan et al, 2005). However, proposals accepted must be evaluated carefully and determined to be realistic in terms of the bid price.

In urban areas, the province-level governments of these areas would find clear advantages in implementing ambitious RPS policies locally. In the presence of sufficient market competition and capital, the RPS provides a market atmosphere through which installed renewable capacity can rapidly expand and evolve under the forces of competition that spurs innovation. China would gain from setting strong but realistic purchase obligations for utility carriers in these areas and undertake measures to garner political support for these policies so they are not made too mild and thus useless (Fan et al, 2005).

The government of China and the CSD would also benefit from encouraging the development of renewable energy technology for export, and supporting the growth of the solar manufacturing industry. This will potentially allow Chinese companies to engage in economies of scale that would reduce material costs over time, helping the progress of the growth of renewable energy both at home and abroad.

MMS policies would gain from strategic supplements of other financial incentives as in the case of Denmark, especially because renewables must also compete against many hidden subsidies for conventional fuels (Martinot et al, 2002). For example, these incentives may come in the form of low import duties on renewables components. China has been doing well to bolster investment in renewable energy with tax breaks at this point in time.

Administration and Enforcement

Though homogenous MMS policies do not have the flexibility to best support RE growth in China, policy coordination to ensure policy complementation across provinces is essential.

Thus, China would have much to gain from the establishment of a ministry of energy that coordinates and clearly defines the roles of the various agencies as national or province-based regulatory bodies in implementing and enforcing specific MMS policies.

Transparency, information flows, and coordination must be excellent so that evolving market conditions are known to make accurate policy adjustments. The Ministry of Agriculture has established over 1700 rural energy offices at county, district, and township levels that provide a variety of services, which include information, subsidies, and technical support. These centers could be asked to track RE development and the impact of local policies, reporting this information to the ministry of energy, if created. The responsibilities of these already-established centers could also potentially be extended to administer specific enforcement rules and noncompliance penalties for MMS policies tailored to fit the areas they serve (Martinot et al, 2002).

A national RPS has been cited to have high administrative costs and difficulty of enforcement. However, because the presence of a tradable renewable credits system greatly lowers these costs, the urban RPS systems would benefit from a complementary national tradable renewable credits system by which urban electric utilities can purchase tradable credits from rural or off-grid areas. This will also help electrify off-grid regions and address some of the disparity between potential renewable energy supply and demand across the country.

Costs

China has reported that it hopes to spend $1.84 billion by 2020 on renewable energy projects and costs (Jing, 2005). This fund could effectively be made to support a carefully designed MMS system, rather than directly fund projects, and might potentially see more real returns to this approach. By strategically using MMS policies to engage the private sector, far more investment will flow into RE development than government funded RE projects alone.

Because the burden of an MMS policy as a protectionist measure can be substantial, care can be taken to spread the burden over all parties who benefit (even indirectly) from the implementation of the MMS. Thus the government of China can use a combination of policies to cover the incremental cost of its MMS: through a very small (less than .1 cent/KWh) surcharge on electricity consumed, a government or donor-based public fund, and a small carbon tax. Though the latter will be politically unfavorable, the change can be seen as a reduction in carbon subsidies rather than a carbon tax.

Finally, China, and donors in the form of NGO's and international institutions, would benefit immeasurably from making a large investment from money allocated to RE development causes to restructure China's transmission systems, funding R&D measures to close the regional gap between potential supply and demand. Removal of this gap provides perhaps the only route for China to fully exploit its wealth of RE resources and fully reap the benefits of a high installed capacity of RE.

The Role of the CSD

The CSD is in an important position to provide invaluable assistance to China in its development of MMS systems. It might potentially help to bring foreign investment to

Chinese RE projects, especially those located in rural regions or other areas lacking in competition. The CSD can also encourage expansion of renewables and development of a domestic RE equipment manufacturing industry in an environmentally friendly manner by promoting RET exports from China. It can make sure, in addition, that donor programs, which are often cost less to consumers, do not upset market competition (Martinot et al, 2002). Finally, the CSD can work closely with China to study its energy markets to effectively determine optimal purchase obligations and prices to design policies given current levels of RET development that will find the same level of success as those in Germany, Denmark, Spain, and parts of the US. Determining the nature of market conditions for nascent industries can be extremely difficult, thus the CSD (and international organizations) could provide valuable help in the form of research to China in this area.

Conclusion

Weidou et al (2004) have stated that “On balance, the strength conferred by the sheer scale of the internal market and forecasted demand for China’s energy products outweighs the very real challenges of distance and terrain.” The effective implementation of well-structured MMS systems have the enormous potential to play a critical role in the process of RE development across distance and terrain in China. Used effectively, these policies will offer real support towards efforts to slow the pace of global climate change for many years to come, and make reaching the MDGs and other sustainable development goals possible for China.

Appendix

Acronyms

CEC	California Energy Commission
CPUC	California Public Utilities Commission
CRED	Center for Renewable Development
CREDP	Center for Renewable Development Project
CSD	Commission on Sustainable Development
ERCOT	Electric Reliability Council of Texas
GDP	Gross Domestic Product
GW	Gigawatt
KWh	Kilowatt Hour
IOU	Investor Owned Utilities
NDRC	National Development and Reform System
NELG	National Energy Leading Group
NEPA	National Environment Protection Agency
NGO	Non-Governmental Organization
NFFO	Non-Fossil Fuel Obligation
PPA	Power Purchase Agreement
PURPA	Public Utilities Regulatory Policy Act
PV	Photovoltaic
RE	Renewable Energy
RET	Renewable Energy Technology
RPS	Renewable Portfolio Standard
MMS	Mandated Market Share System
UN CSD	United Nations Commission on Sustainable Development

Table A1: Comparing the Policies

Table 1. Comparing the Policies

Policy Objective	RPS	Feed-in	Tendering
Incentives for cost and price minimization	Policy creates incentives for generators to lower RE prices in order to compete for contracts; does not inherently reduce costs of generation except those related to technology learning and efficiencies of scale	Few inherent incentives to minimize market prices for renewable energy, though there are likely to be project cost reductions related to technology learning and manufacturing volume	Policy creates significant competitive pressures for price minimization that will be linked to cost minimization where there is sufficient competition, technology learning and manufacturing volume
Ability to maintain targets for renewable energy	Purchase obligation can be effective at meeting RE targets provided RPS is well-designed	Ability of feed-in tariff to help government meet RE targets is variable depending on host of factors	Ability of tendering policy to help government meet RE targets is variable depending on host of factors
Assurance of resource diversity	Diversity possible with bands and tiers, but has administrative drawbacks	Can successfully stimulate a more diverse set of resources by setting one price that many technologies can meet or setting a separate price for each technology band.	Diversity possible with bands, but as with targets, policy does not guarantee that projects will be built
Sustainable market for power	All three policies build markets for RE power – RPS may be more technically & politically sustainable.	Can be vulnerable to political 'tinkering' and if viewed as 'subsidy' makes it less economically and politically sustainable	Tends to be tied to a resource planning process that can make it more politically vulnerable if planning out of favor
Political viability	Depends on circumstances – unclear in China	Depends on circumstances – unclear in China	Depends on circumstances – unclear in China
Local industry development	Needs companion policies to ensure local development	Feed-in tariffs can create local manufacturing and development infrastructure benefits	Will favor least cost generation over local industry development; benefits established industry
Compatibility with electricity industry and regulatory structure	RPS is compatible with industry and regulatory structure in China, though appropriate phase-in and enforcement are important.	Compatible with existing regulatory and industry structure but current tariff structure needs fixing to work	Tendering is compatible with industry and regulatory structure in China and can be used by utilities in conjunction with an RPS.
Policy stability	Provides less certainty than feed-in tariffs, must be carefully designed	Provides high degree of certainty and stability	Can provide high degree of certainty and stability, but only if well designed
Competitive parity	Creates competitive parity as the same standard applies to utilities and developers equally	Parity achieved only if cost sharing mechanisms are established that spread the costs broadly	Policy favors established market players over new market entrants and can allow market manipulation by existing companies
Integration of renewable energy supplies	Creates incentives for full integration and barrier reduction	Fewer incentives than under RPS to reduce institutional barriers	Neutral- doesn't help reduce institutional barriers
Simplicity	More challenging policy to design and administer, and more complex contractual and development process for generators as compared to feed-in	Most simple design, administration, enforcement, contractual, and development simplicity	More complex than feed-in laws, because requires the development of a system to raise money for the incremental costs of RE.

Source: Wiser et al, 2005.

Figure A2: RPS Design Elements

Structure, Size, and Application of the RPS

- Percentage purchase obligation targets over time
- Start date for purchase obligations
- Duration of purchase obligations
- Structure (e.g., single % requirement, or multiple % requirements for each technology group)
- Renewable resource diversity requirements or incentives
- Application to electric utilities – who must meet the obligations

Eligibility

- Resource type eligibility
- Allow imports, or just in-state facilities
- Eligibility of existing renewable generation
- Definition of new/incremental generation
- Eligibility of customer-sited renewable facilities

Administration

- Regulatory oversight body(ies)
- Verifying compliance – RECs or contract-path
- Certification of eligible generators
- Compliance filing requirements
- Enforcement mechanisms (i.e., penalties)
- Existence of cost caps
- Compliance flexibility mechanisms
- Contracting standards for regulated electric utilities
- Cost recovery for regulated electric utilities

Interactions Between the RPS and Other Policies

- Interactions with other renewable energy policies
- Linkages with emissions credits policies

Source: Wiser et al, 2005.

Table 4-1 Chinese Renewable Energy Resource and Development Potential

Variety	Recoverable Resource	Developed amount in 2000	Undeveloped resource
Small-scale hydropower	1.Small-scale hydropower under 25MW is 75GW, generable electricity is 240TWh, equivalent to 87.1Mtce 2.Micro-scale hydropower under 0.1-10kW is 80GW,g generable electricity is 125TWh, equivalent to 45.3Mtce Subtotal: 132.4Mtce	Installed capacity of small-scale hydropower is 24.8GW, taking up 33% of recoverable resource; installed capacity of micro-hydropower is 167.7MW, taking up 0.2% of recoverable resource, generated power is 261.9GWh;subtotal is 29.1Mtce, development rate is 22%	Small-scale hydropower: 50.2GW; micro-scale hydropower is 79.8GW Subtotal: 103.3Mtce
Solar energy	Two thirds of land has sufficient solar energy, annual radiate amount is over $6GJ/m^2$.	Water heater, passive solar house, solar oven, and photovoltaic battery. Total: 3.84Mtce	Development potential is huge

Continued on next page.

Wind power	Wind resource above 10m height is 253GW; offshore wind resource is 750GW; wind resource above 50m height is 1000GW; Total: 2000GW, 4700TWh, equivalent to 1706.1Mtce	Installed capacity of interconnection wind generator is 344MW, generated power is 930GWh; small and micro-scale wind generator is 17MW, generated power 35GWh. Developed rate is 0.018%	Developed amount is small and undeveloped amount is more than 2000GW, equivalent to 1700Mtce
Biomass	Resource is about 700Mtce, crop and straw is 120Mtce, fuel wood 90Mtce, livestock and birds feces, the waste and organic waster water are 390Mtce. With agricultural development, improvement of living condition, and implementation of large-scale project of returning land for farming to forestry, resources of straw, fuel wood, faces, waste and energy crop will increase, and will reach 900-1000Mtce in 2020.	Biomass through traditional measures is 219.1Mtce (straw and fuel wood), accounting for 104.3% of total resource (excessive consumption); biomass through new technology is 3.3Mtce, accounting for 0.8%	With the development of new technology, biomass through traditional measures will decrease. the potential of biomass through new technology is large, and can reach over 800Mtce in 2020.
Geothermal energy	Recoverable geothermal energy resource is 3158Mtce/a, geothermal energy spots are over 2900	Generation and heat use of geothermal energy are 0.65Mtce	Development potential is huge
Ocean energy	Recoverable resource is abundant and over 48.58GW, tidal energy is 21.79GW, wave energy is 12.85GW, tidal flow energy is 13.94GW	7 small-scale tidal energy generation stations with 6MW; 1 tidal flood energy generation station with 5MW, total is 11MW	Development potential is huge

Source: Zhenmin et al, 2005.

Table 12.1: Incentives for Wind/Solar Energy Development

	Inner Mongolia
Current Status	14.5 MW of large wind power generators, 18.5 MW of small wind power generation; household photovoltaic (PV) systems dominated by 10 –20Wp.
Subsidy policies	Rmb 25 million to users in 1986-90; Rmb 200 for each 100W wind power generator purchased or each 16W PV unit from financial budget. Annual subsidies of Rmb 300,000 for R&D activities; Working capital provided by local authorities for establishment of extension station in 56 counties.
Taxation policies	3% VAT surtax on wind power generation; income tax relief for 2 years; 10.69-14.43 Yuan for VAT surtax on PV units of 16Wp –21.6Wp.

Continued on next page.

Pricing policies	Tariff calculated on repayment of principal and interest. 713Yuan/MWh including VAT in 1995 and 609 Yuan/MWh not including VAT; the difference is shared by grid and subscribers with 200 Yuan/MWh by grid and rest by subscribers in the form of subsidies 2.5 Yuan/kWh.
Loan policies	Rmb 400 million for wind power by State Economic and Trade Commission; Danish Government loans for wind power generation.
Other	Land use policies: Land tax collected on the land actually occupied;5 year income tax holiday for occupying arable land;10 year land tax holiday for occupying the unused land.
	Xinjiang
Current Status	16.7MW of large wind power generation; 8000 household PV systems dominated by 10-20Wp.
Subsidy policies	50-200 Yuan for PV unit and small wind power generation unit purchased; 1 million Yuan for R&D; Working capital for extension stations; 300 Yuan subsidies for PV users.
Taxation policies	2 year tax holidays, 3 year tax relief and 5 year 15% income tax for foreign invested or joint venture with an operational life for 10 years. VAT holiday for products export. Monthly collected VAT and surtax at 17% and 10% respectively. Seasonal collected income tax at 15-33%; Import tariff and VAT at 12% and 17% respectively, with duty free for international donation.
Pricing policies	Tariff calculated on repayment of principal and interest. 698 Yuan/ MWh including VAT in 1995. The regular grid tariff is 118 Yuan/MWh in the area; The difference is shared by grid and subscribers. The added 2 cents/kWh with 0.5 cent for difference with rest borne by grid.
	Gansu
Current Status	5000 household PV units mainly of 20Wp
Subsidy Policies	300 Yuan for each PV unit purchased; Subsidies for R&D; Support for extension station
Taxation policies	Policies similar to that of Xinjiang in taxation on PV system with only exception for monthly collected value added tax on non-donated PV system.
Loan policies	Guarantee by local government for household PV system to secure a loan with interest rate at 3%. The subsidies came from additional tariff by 3 Yuan/MWh and 20% interest subsidized from financial budget.
	Qinghai
Current	15000 household village PV station of 23 kW

Continued on next page.

Status	
Subsidy policies	300 Yuan for each PV unit purchased; Rmb 500,000 for R&D; Working capital for extension stations
Pricing policies	Addition tariff 2 Yuan/MWh, with some of the revenues used to finance installation PV system
	Northeast Grid
Current Status	6 MW of wind generation
Taxation policies	6% VAT on wind generation. No tax relief for high power tariff (900Yuan/MWh) in Henshan, Liaonin. 6% for Donggang, Liaonin (100Yuan/MWh).
Pricing policies	Tariff calculated on repayment of principal and interest
Loan policies	Discount loans for wind power
Other	Land use fee paid on the area actually occupied by wind power generation with preferential treatment as foreign invested businesses
	Gaungdong
Current Status	11.7MW of wind power generation
Taxation policies	VAT collected at 20 Yuan/MWh and 15% for income tax
Pricing policies	Tariff calculated on repayment of principal and interest; Grid tariff 770Yuan/MWh with difference shared by subscribers
	Zhejiang
Current Status	1MW of wind power generation
Pricing policies	Tariff calculated on repayment of principal and interest;

Data sources: Draft Final Report on Financial Policies Promoting China's Renewable Energy Development by World Bank and China.

Source: Zhengming et al, 2000.

Works Cited

Andrews-Speed, C.P. “Energy Policy and Regulation in the People’s Republic of China.” Kluwer Law International, April 2004.

Anil R. Cabraal, Xiaodong Wang, Grayson Heffner, and Yabei Zhang. “Renewable Energy Toolkit Needs Assessment.” World Bank, 2005. <http://wbln0018.worldbank.org/esmap/site.nsf/files/077-05+Final_to_Printshop.pdf/$FILE/077-05+Final_to_Printshop.pdf>.

“Annual Report of the Expert Group on Technology Transfer.” United Nations Framework Convention on Climate Change, November 28, 2005. <http://unfccc.int/resource/docs/2005/sbsta/eng/inf10.pdf>.

Archer et al. “Evaluation of Global Wind Power.” *Journal of Geophysical Research*, 2005. Vol. 110. <http://www.agu.org/journals/jd/jd0512/2004JD005462/>.

Asia Pulse. “China to Develop Renewable Energy in West.” Asia Times Online, April 21, 2005. < http://www.atimes.com/atimes/China/GD21Ad02.html>.

Bergmann, Ariel, Nick Hanley, and Robert Wright. “Valuing the Attributes of Renewable Energy Investments.” *Energy policy*, 2006. Vol. 34.

California Energy Commission (CEC). “Integrated Energy Policy Report.” 2005. <http://www.energy.ca.gov/2005publications/CEC-100-2005-007/CEC-100-2005-007-CMF.PDF>.

China’s Agenda 21. White paper on China’s Population, Environment and development in the 21st Century,1992. <http://www.acca21.org.cn/indexe5.htm>.

China Daily. “Greenpeace Hails China’s Energy Law.” March 3, 2005. <http://www.chinadaily.com.cn/english/doc/2005-03/03/content_421154.htm>.

Central Intelligence Agency (CIA). “Country Map: China.” CIA Maps & Publications, 2001. <http://www.cia.gov/cia/publications/mapspub/36.shtml>.

Central Intelligence Agency (CIA). “China.” CIA World Factbook, 2006. <http://www.cia.gov/cia/publications/factbook/geos/ch.html>.

Cleaner Production Promotion Law; 2003. <http://www.chinacp.com/>.

Craig Hansen and Vince Van Son. “Rewewable Energy Certificates: An Attractive Means for Corporate Customers to Purchase Renewable Energy.” *World Resource Institute*, September 2003. <http://pdf.wri.org/gpmdg_corporate_5.pdf>.

Database of State Incentives for Renewable Energy (DSIRE). “California Incentives for Renewable Energy: Renewable Portfolio Standards.” January, 2006. <http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=CA25R&state=CA&CurrentPageID=1>.

Database of State Incentives for Renewable Energy (DSIRE). “New Jersey Incentives for Renewable Energy: Renewable Portfolio Standards.” April, 2006. <http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=NJ05R&state=NJ&CurrentPageID=1>.

Energy Research Center of the Netherlands (ECN). “Renewable Electricity Fact Sheet Germany.” 2003. <http://www.renewable-energy-policy.info/relec/germany/policy/feed-in.html>.

Fan et al. “Renewables Portfolio Standard and Regional Energy Structure Optimization in China.” Energy Policy, 2005. Vol. 33. pp. 279-287.

Fengqi, Zhou. “Renewable Energy in China: Status, Goals, and Policy Recommendations.” China Energy Laws and Regulation Workshop & The China Sustainable Energy Program Sixth Senior Policy Advisory Council Meeting. National People’s Congress, 2003. <http://www.efchina.org/documents/Briefing_book_031114_EN.pdf>.

International Energy Association (IEA). “Unit Converter.” IEA Energy Statistics, 2006. <http://www.afrepren.org/datahandbook/pdfs/conver.pdf>.

Jiménez, Viviana. “World Sales of Solar Jump 32 Percent.” Earth Policy Institute. 2005. <http://www.earth-policy.org/Indicators/2005/indicator12.htm>.

Jing, Fu. “Renewable Energy Gets Huge Outlay.” China Daily, November 11, 2005. <http://www.chinadaily.com.cn/english/doc/2005-11/08/content_492254.htm>.

Larson, et al. “Future Implications of China’s Energy-Technology Choices.” Energy Policy, 2003. Vol. 31. pp. 1189-1204.

Liu, Yingling. “Behind the Chilly Air: Impacts of China’s New Wind Pricing Regulation.” Worldwatch Institute. March 30, 2006. <http://www.worldwatch.org/features/chinawatch/stories/20060330-1>.

Martinot et al. “Renewable Energy Markets in Developing Countries.” Annu. Rev. Energy Environ. 2002.

Martinot, Eric. “World Bank Energy Projects in China: Influences on Environmental Protection.” *Energy Policy*, 2001. Vol. 29. pp. 581-594. <http://www.martinot.info/Martinot_EP29-8.pdf>. Cited in: Yao, et al. “Energy Policy and Standard for Built Environment in China.” *Renewable Energy*, 2005. Vol. 30. pp. 1973-1988.

Martinot et al. “Renewable Energy Policies and Markets in the United States.” Center for Resource Solutions, 2005A. <http://www.efchina.org/documents/RE_Policies&Markets_US.pdf>.

Martinot et al. Renewable Energy Policy Network. “Renewables 2005: Global Status Report.” Washington, D.C.: Worldwatch Institute. 2005B.

Mutiga, Amos, M. “Energy Data Conversions.” African Energy Policy Research Network, 2001. <http://www.afrepren.org/datahandbook/pdfs/conver.pdf>.

National Renewable Energy Laboratory (NREL). “Photovoltaics.” January, 2006. <http://www.nrel.gov/learning/re_photovoltaics.html>.

National Renewable Energy Laboratory (NREL), “Renewable Energy in China.” 2005. < http://www.nrel.gov/international/china/pdfs/35786_policy.pdf>

National Renewable Energy Laboratory (NREL). “Renewable Energy in China: Township Electrification Program.” April, 2004. <http://www.nrel.gov/docs/fy04osti/35788.pdf>.

National Renewable Energy Laboratory (NREL). “China’s Plan for Renewable Energy.” Renewable Energy in China, April 2004. <http://www.nrel.gov/docs/fy04osti/35787.pdf>.

“National Renewable Energy Law.” The People’s Republic of China, 2005. <http://china.lbl.gov/publications/re-law-english.pdf>.

Pacala, S. and R. Socolow. “Stabilization Wedges: Solving the Climate Problem for the Next 50 years with Current Technologies.” Science, Aug 13, 2004. Vol. 305.

Painuly, J. “Barriers to Renewable Energy Penetration: A Framework for Analysis.” Renewable Energy, 2001. Vol. 24. pp. 73-89.

Pichel, Jesse. “China’s Solar Push More Than Just Low-Cost?” Renewable Energy Access, March 27, 2006. <http://www.renewableenergyaccess.com/rea/news/story?id=44457>.

“Program Updates April 2005.” *China Clippings*. The China Sustainable Energy Program. Issue 17. April 2005. <http://www.efchina.org/documents/CSEP_Update_Apr_05.pdf>

Rader, Nancy and Scott Hempling. “The Renewables Porfolio Standard: A Practical Guide.” National Association of Regulatory Utility Commissioners, February 2001.

Raufer et al. “Wind Resource Concession Approach in China.” IEEE Power Engineering Review, September, 2002.

Renewable Energy Policy Project (REPP). “RPS Texas: Renewable Portfolio Standards—State Summary.” July, 2004. < http://www.crest.org/articles/static/1/Texas_RPS.html>.

Renewable Energy Policy Project (REPP). “RPS California: Renewable Portfolio Standards—State Summary.” July, 2004A. <http://www.crest.org/articles/static/1/California_RPS.html>.

Renewable Energy Policy Project (REPP). “RPS Maine: Renewable Portfolio Standards—State Summary.” July, 2004B. < http://www.crest.org/articles/static/1/Maine_RPS.html>.

Sijm, J.P.M. “The Performance of Feed-In Tariffs to Promote Renewable Electricity Generation in European Countries.” Energy Research Center of the Netherlands (ECN), 2002. <http://www.ecn.nl/docs/library/report/2002/c02083.pdf>.

Sinton, et al. “Evaluation of China’s Energy Strategy Options.” The China Sustainable Energy Program, 2005. <http://china.lbl.gov/publications/nesp.pdf>.

TERI. “Renewables and Regulatory Issues.” The Energy and Resources Institute, February 2006.

Van der Linden, N.H., J.C. Junfeng, D. Keyun, J.W. Martens, K.V. Ramani, W. Sicheng, W. Shutian, C. van der Tak. “Analysis of the Feasibility of Inclusion of Decentralized Renewable Electricity Systems into A Mandated Market Share Mechanism in China”. ECN, October 2003.

Weidou et al. “Energy for Sustainable Development in China.” Energy Policy, 2004. Vol. 32. pp. 1225-1229.

Wiser, Ryan, Jan Hamrin, and Meridith Wingate. “Renewable Energy Policy Options for China: A Comparison of Renewables Portfolio Standards, Feed-In Tariffs, and Tendering Policies. Center for Resource Solutions, June 2002.

Wiser, Ryan and Ole Langniss. “The Renewables Portfolio Standard in Texas: an Early Assessment.” Lawrence Berkeley National Laboratory, November 2001. <http://eetd.lbl.gov/ea/EMS/reports/49107.pdf>.

Wiser, Ryan, Kevin Porter, and Robert Grace. “Evaluating Experience with Renewable Portfolio Standards in the United States.” Mitigation and Adaptation Strategies for Global Change, 2005. Vol. 10. pp. 237-263.

World Summit on Sustainable Development. “Facts About…Energy.” Johannesburg, South Africa. Aug 26-Sep 4, 2002.

Yixin, Dai et al. “Technical Innovation of the Chinese Photovoltaic Industry.” Center for the Integrated Study of the Human Dimensions of Global Change, 1999. <http://www.andrew.cmu.edu/user/kf0f/Solar_PV_Report_8-99.pdf>.

Zhang, Z., Li, J., & Wan, Y. (1998). "Comparison of Renewable Energy Policies of China and the United States."

Zhengming, et al. “Renewable Energy Development in China: The Potential and the Challenges.” The Center for Resource Solutions, 2000. <http://www.efchina.org/documents/China_RE_Report_EN.pdf>.

Zhenmin, et al. “China National Energy Strategy and Policy 2020.” *Renewable Energy Strategy and Policy*. The Development Research Center of the State Council of the People’s Republic of China, 2005. <http://www.efchina.org/documents/8_Renewable_energy.pdf>.

Zhipeng, Liang. “Targets and suggested policy framework for Renewable Energy Development in China.” *China’s National Energy Strategy and Reform*. China Development Forum, 2003. <http://www.efchina.org/documents/Briefing_book_031115_EN.pdf>.