Center for RESOURCE SOLUTIONS

Renewable Energy Policy Options for China: A Comparison of Renewable Portfolio Standards, Feed-in Tariffs, and Tendering Policies

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I. Introduction

The three most prominent policies in the US and Europe to stimulate the commercialization of renewable electricity projects are feed-in laws, tendering policies and renewable portfolio standards.

Feed-in laws have been the primary mechanism used historically to support renewable energy development in both Europe and the United States. The successes of feed-in laws have been numerous, and feed-in laws have many benefits relative to other forms of renewable energy policy. Renewable portfolio standards (RPS) and related mechanisms have become increasingly popular in the U.S. and internationally in the last several years. Many expect that RPS policies, which maximize competition among eligible renewable energy projects, will (over time) replace feed-in laws as the primary approach for spurring renewable energy development. Finally, tendering policies, such as the Non-Fossil-Fuel Obligation (NFFO) in the UK, have been used to spur new renewable development with mixed success in the US and the UK.

This paper briefly reviews experience with feed-in policies, tendering, and renewable portfolio standards, and compares the relative merits and disadvantages of each approach both generically and for application in China. This paper does not recommend one specific policy approach for China, but rather describes the pros and cons of multiple approaches for consideration in China.

II. Criteria for Analysis

The authors looked at several criteria for evaluating the success of each policy.

- ***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
- ***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
- ***Resource Diversity:*** ability of the policy to encourage diversity in renewable energy supply sources
- ***Political Viability:*** the viability of the policy in achieving necessary political support
- ***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
- ***Compatibility with the Electricity Industry and Regulatory Structure:*** compatibility of policy with the 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

- ***Integration:*** ability of the policy to integrate renewable energy into the larger electricity system and the reduce institutional barriers to renewable development
- ***Simplicity:*** the simplicity of policy design, administration and enforcement

No single renewable energy policy can meet the full range of these objectives. Accordingly, the aim of this paper is not to recommend one form of renewable energy policy over another. Rather, the objective is to compare the relative advantages of each policy based on these multiple objectives.

III. Feed-in Laws

A. Description

A feed-in law is a price-based policy that specifies the price to be paid for renewable energy. The amount of renewable energy actually obtained depends upon the types of renewable energy resources available in a particular region and their cost relative to the feed-in price. Feed-in laws offer renewable energy developers a guaranteed power sales price (the feed-in tariff), coupled with a purchase obligation (a guaranteed market) by electric utilities. Standardized interconnection requirements for renewable generators are also a common and important component of feed-in laws. The level and the duration of the price can vary, but typical implementation ensures that the price level and duration of the sales contract is sufficiently attractive to ensure renewable energy development. The guaranteed power sales price may also be amended periodically by regulators to reflect falling renewable energy costs or other market conditions. A number of past feed-in laws in Europe set the feed-in price as a percentage of retail electricity prices, however, these policies did not vary with falling renewable energy costs.[1]

B. Experience

Feed-in laws remain popular in certain European countries as an effective way to stimulate the expansion of the renewable energy sector. The beginnings of the growth in renewable energy supply, initiated in the United States (and California in particular) during the 1980s, can also be attributed largely to a feed-in law approach. The current Chinese tariff for wind-generated energy is a type of feed-in law.

Europe

Germany, Denmark, and Spain have all offered successful feed-in laws. Such feed-in laws provide generators stable and attractive prices for power sales, and provide standardized interconnection requirements. It is no coincidence that it is these countries in which the vast majority of renewable energy development has occurred. Other European nations also offer feed-in tariffs, including Austria, Belgium, Finland, Luxembourg, Portugal, and Sweden, but on less attractive terms (lower tariffs, shorter duration contracts, greater administrative complexity, etc.).

[1] The German feed-in law now requires technology-specific adjustments that are intended to track renewable energy costs.

- Denmark's feed-in tariff for wind power has historically been set at 85% of retail electricity prices and – along with important companion policies including capital subsidies, tax incentives, low-cost financing, and R&D funding – has resulted in a sizable amount of wind power capacity and has made Denmark the largest industrial center for wind technology development and manufacturing in the world. In 1997, for example, Denmark held nearly 60% of worldwide wind power sales.

- From 1990 to 2000, the German electricity feed-in law has required that wind power, solar, hydropower, and biomass receive 90% of the residential retail price of electricity (from 9.5 cents/kWh in 1991 to 8.8 cents/kWh in 1999). More recently, the feed-in law has been updated with a new and more complex, but still attractive, pricing formula. Though the feed-in law has frequently been protested by electric utilities, and has seen revisions over the years, it has successfully launched the most sizable wind power market worldwide and Germany now represents one of the largest solar markets as well. A sizable wind and solar manufacturing base has also developed in the country.

- Spain has seen some of the most dramatic recent growth in installed wind power capacity, in large part as a result of an attractive feed-in tariff established in 1994. This policy has also helped establish a wind power equipment manufacturing industry in Spain to capture the sizable local market and for export.

United States

Fixed price feed-in laws are not a common or politically viable approach to renewable energy development in the US because policymakers increasingly prefer support mechanisms that stimulate competition and minimize cost. And yet, the birth of today's modern renewable energy industry can be traced to a form of feed-in law most prominently developed in California but also in place in Maine, New York, and other U.S. states in the early to mid 1980s.

Specifically, implementation of the Public Utilities Regulatory Policy Act (PURPA) in California and less so in other states was based upon standard long-term contracts and a mandatory fixed-price for some or all of the contract term. This created a market environment in the early to mid 1980s in which renewable energy developers could secure financing for projects because they could sell their output at attractive contract terms (the purchase price of the California contracts began at 4 cents/kWh and increased to 13 cents/kWh by the tenth year of the contracts[2]). As a result of these contracts, a sizable market and manufacturing capacity developed for wind, geothermal, biomass, small hydro and solar technologies in California. Even today, California remains one of the leaders in installed renewable energy capacity. Other states also brought significant renewable capacity into operation during this period. For example, over 45% of Maine's electricity supply comes from renewable energy sources, much of which were developed during the 1980s under PURPA contracts. The primary difference between the US/PURPA policy and the European feed-in laws is that the PURPA price was based on the wholesale cost of alternative power to the utility while the feed-in price has often been based on a percentage of the average retail electricity price.

[2] The fixed energy price was one component of a long-term (15 to 30 year) standard contract. The fixed energy price was only available for one-third of the contract life. The producer received the average market price for energy for the balance of the contract term.

C. Factors for Success

From the experience described above, a successful feed-in policy includes design features that eliminate risk for potential renewable investors. These include long-term contracts (15-20 years), guaranteed buyers (must-take or default contract terms), and a price that offers a reasonable rate of return for the producer. Other features of a well-designed feed-in policy are that it should be simple, allow a variety of renewable resource generation types of participate, have low administrative costs, and be flexible enough to capture market and cost efficiencies as they evolve. Finally, perhaps one of the most important factors for the success of a feed-in policy is that it is integrated into long-term planning with other policy options, such as favorable tax treatment, that create a stable environment for a renewable industry to thrive.

IV. Renewable Portfolio Standards

A. Description

Both feed-in laws and RPS are government-mandated policies designed to create a market for renewable energy. However, unlike the feed-in law, the RPS is a quantity-based policy that establishes a target quantity of renewable energy to be included in the electricity mix by a specific date. An RPS also specifies who is responsible for obtaining that renewable energy and specifies penalties for non-compliance. As currently implemented, RPS policies tend to be silent on price and leave that to be determined by the market.

Under an RPS, a country or state requires all utilities or retail suppliers to purchase a certain amount of renewable energy. Many design variations to an RPS are possible, and this policy may be used in conjunction with other policies such as a tendering auction, as in the UK NFFO, or a public benefits fund. The RPS is an increasingly popular form of support for renewable energy, with several developed nations considering phasing out their feed-in tariffs in favor of an RPS-based mechanism as they institute competitive market systems into the electricity sector.

B. Experience

RPS policies are being considered and implemented throughout the world, from Sweden, Italy, and the U.K., to the United States, Japan, and Australia. Although the RPS policies in these countries are relatively new, early evidence shows that the design of the RPS is critical; A well-designed RPS can be extremely effective at bringing new renewables on-line, while a poorly designed RPS can have little or no effect on new renewable development. So far, there is an RPS policy in 12 U.S. states, Australia, and the U.K. (though the UK experience is so limited that it is not covered below).

United States

Twelve U.S. states have now adopted an RPS. What is evident from experience in Maine, Texas, Arizona, and Wisconsin is that the design is critical to the success of the policy. Where designed appropriately, as in Texas, an RPS can create a large and vibrant market for renewable energy

and integrate renewable energy supply into the overall competitive electricity system. An RPS can provide support for the least-cost eligible renewable energy sources and ensure the maximum degree of competition among renewable generators. Overall diversity among renewable energy sources will be limited, because of the intense competition between project developers. This competition will tend to favor the most experienced industry participants, including foreign companies.

One additional successful feature of the Texas RPS that is worth noting here is the use of a certificate based tracking system that greatly reduces the administrative costs of implementing the policy, spreads the costs of the program equitably among market participants, and has the ancillary benefit of helping to bring buyers and sellers together.

Australia

Australia enacted an RPS in 2000 that specifies a target of 9,500GWh of new renewable generation by 2010 with interim targets increasing each year. A wide range of renewables may be used to meet the targets and a certificate trading system has been established to facilitate compliance with the target. Suppliers easily met the 2001 target as existing and new supply exceeded the target level. It is still uncertain whether or not suppliers will be able to meet the target in future years. Although it is still early, the Australian RPS appears to have many of the necessary components of a successful RPS. Enforcement of the renewable targets and the market price of the renewable certificates relative to the penalty price are likely to determine whether or not the policy is effective at bringing more renewables on-line.

C. Factors for Success

From the limited experience to date, there are several design factors that seem to dictate the success of an RPS in spurring new renewable development. Some of the key factors present in a successful RPS include appropriate target levels, renewable targets that are long lasting and increase over time, strong and effective enforcement with appropriate penalty levels, and output-based generation targets. It is also important to have credit-worthy buyers in place to allow long-term contracts and renewable energy financing. If credit-worthy buyers are not in place, the presence of merchant renewables and/or low-cost renewables, combined with sufficient lead-time and buyers with long-term obligations, can help overcome this problem. Finally, the creation of a certificate-based trading platform to assist liable parties in finding eligible renewable generation helps lower the administrative costs of compliance and helps parties meet their compliance targets.

V. Tendering Policies

A. Description

For the purpose of this paper, we define a tendering policy as one that uses government-overseen competitive processes to meet a planning target with long-term power purchase agreements with renewable generators. Tendering policies are a variation of feed-in laws and renewable portfolio standards, the key difference being that the price and the eligible projects are selected through a competitive bidding process. Like feed-in laws, tendering policies guarantee to purchase the output of a qualifying renewable energy facility at a specified price for a specified period of time. The difference between these two policies is how the price is set, and which renewable

energy generators can participate. While the feed-in laws set a price and guarantee to purchase the renewable energy output from any eligible facility at that price, a tendering policy uses competitive bidding to select projects that offer the best price. These projects are then awarded power purchase agreements for their output. Through the competitive bidding process, renewable developers submit proposals to build new renewable generation facilities and indicate the price they would accept for their output. The lowest priced renewable energy projects are then selected with a guarantee to purchase all the output from these projects. As with feed-in laws, this guaranteed power purchase agreement helps reduce investor risk and helps the project secure financing. Also like the feed-in law, the amount of power acquired may depend upon the prices bid (i.e., the cheaper the bid prices, the more that can be purchased). However, this strategy can also be combined with a mandatory quantity and with a ceiling on acceptable bid prices.

The U.K. Non-Fossil Fuel Obligation (NFFO) is the most widely cited example of a tendering policy. The U.K. NFFO also used a public benefits fund (a fossil fuel levy) as the funding mechanism to pay for the *incremental* cost of renewable energy generation.

B. Experience

United Kingdom

Through the NFFO, the U.K. government placed five successive competitive orders for renewable energy between 1990 and 1999. The orders were designed to bring 1500 MW of new renewable capacity on-line, roughly equal to 3% of the total U.K. electricity supply. The NFFO required the twelve restructured regional electric companies to buy all power from selected NFFO projects. After the first round of orders, the policy was modified to award contracts on a competitive basis within specific technology bands. Thus, wind projects would compete against other wind projects but not against biomass. The projects that could generate at the lowest price per kilowatt-hour were awarded the contracts. The separation of different bands allowed a measure of resource diversity within the policy. The Department of Trade and Industry (DTI) oversaw the bidding process and decided upon the mix of technologies in each NFFO order.

California

Once a strong renewable energy industry was established in California and supply/demand were more in balance, California instituted a type of tendering policy attached to its Biennial Resource Planning Update process (BRPU) in 1992. Once the state planning process determined the amount of new power needed and what the monopoly utilities would otherwise build/spend to meet this demand, the State put out a solicitation for power from renewable energy and cogeneration facilities that could bid a price equal to or lower than the utility's indicated costs. The solicitation awarded contracts to 1400 MW of winning bidders representing a variety of renewable and cogeneration technologies all bidding significantly below the projected utility costs. Unfortunately, movement in the restructuring area resulted in these projects being cancelled before they could be constructed.

C. Factors for Success

The key success of tendering policies is the ability to reduce costs over time for renewable energy development. In the UK example, the DTI selected the lowest price projects in each technology band, which resulted in stiff competition. This was successful in driving down the per-kWh price of renewable electricity bid within each technology band. For example, the average price of large wind dropped from around 18 cents/kWh to 4.5 cents/kWh over five years. In the last year of the NFFO, large wind and landfill gas were price competitive with the average power pool purchase price. In both the UK and US examples (CA/BRPU), the policy was tied to a resource planning process. Strong support for a resource planning and portfolio management process will strengthen the likely success of this policy approach.

The U.K. NFFO had a number of other successful characteristics. It incorporated flexible legislation, such that the NFFO offer could be modified each year to rectify problems and to ensure that goals were achieved (e.g. sewage gas was excluded after NFFO-2 and energy crop gasification included in NFFO-4). The NFFO has proven to be a relatively efficient way of giving out a large number of contracts, considering there was almost no renewable energy activity in the UK prior to 1990. Over five years, the NFFO program brought on-line around 823 MW of new renewable capacity.

There were also some important weaknesses in the NFFO, however. First, the intense price competition among renewable energy suppliers favored large, incumbent renewable energy developers and suppliers who, through their size and experience, were able to reduce costs and thus bid lower prices. However, this did little to create a domestic infrastructure of renewable energy manufacturers as have the feed-in laws in Denmark, Spain, and Germany. The lack of a domestic renewable manufacturing industry is an important impediment to capturing the economic development benefits that renewable energy might provide. Moreover, the existence of a healthy renewable energy industry, usually made up of multiple independent power producers, is an important prerequisite to competitive bidding and to other successful renewable policies, such as an RPS.

Second, it is evident that a large amount of the renewable projects that won various tenders will not be developed. For example, although 95% of the projects that received NFFO-1 contracts have been commissioned, only 37%, 47%, 19% and 5% of the tenders received from NFFO-2 through NFFO-5, respectively, have been commissioned. The small number of large players may have resulted in gaming of the bid prices, allowing companies to bid very low prices to block out other competitors without having to actually build and operate the facility. In addition, there has been reluctance between local planning and siting agencies to allow new power project development that stalled many projects.

VI. Comparing the Policies

Tendering policies, feed-in laws and RPS-based mechanisms can effectively spur the development of the renewable energy sector, if designed properly. In this section we compare the policies based on the policy objectives identified earlier. Table 1 summarizes our conclusions.

A. Cost and Price Minimization

A key objective of a renewable energy policy, especially as competition is introduced in the electricity sector as a whole, is to minimize the incremental cost and therefore the price of renewable supply, thereby assuring the benefits of renewable energy at least cost. Renewable energy cost reductions result from: (a) efficiencies in the scale of manufacturing – increased manufacturing output and thus a lower cost per unit; (b) industry infrastructure development – development of supporting businesses and venders of various materials/renewable technology components thereby reducing actual project costs; (c) project development experience that builds human capacity to design and operate renewable facilities more efficiently and/or (d) the opportunity for multiple project development (e.g. through a wind or geothermal resource concession) that will allow incorporation of the cost reduction features in (a), (b), and (c).

For a variety of reasons, most involving the corporate culture of utility companies, these cost minimizing features have generally been developed by independent power producers (IPP) rather than traditional electric utility companies. If a state or country has not developed its own IPP industry, any attempt to lower prices (through competitive bidding, etc) is likely to fail or will bring IPPs from other countries or regions who have cost reduction experience, and thus a competitive advantage through their ability to underbid local, less-experienced project developers.

Because a feed-in law usually stimulates the development of a local renewable industry as well as generating a large number of projects, this experience can have an effective cost reduction effect for local development. However, unless carefully constructed, it will not reduce market prices because the specific feed-in tariff is often fixed. Fixed feed-in tariffs therefore do not generally ensure least cost development. They are generally unable to react flexibly and quickly to renewable energy cost reductions and the cost reductions are not made transparent in a fixed-price market. If the power sales price is modified frequently to reflect presumed declining costs in renewable energy supply, a lower cost program may result, but there may be added administrative costs to doing this and the uncertainty could jeopardize project financing. Even then, one cannot expect the same degree of competition and cost minimization as under an RPS or tendering approach. Moreover, once established, it may be difficult politically to reduce the tariff level to reflect renewable energy cost reductions.

RPS and tendering policies can create wholesale price competition among renewable energy suppliers, provided that there are several suppliers bidding on any particular contract. Though these policies do not inherently lower costs of production, they can create the volume that allows renewable energy generators to lower costs through economies of scale, and they can help local renewable developers gain project development experience that helps to lower costs. However, the volume of projects and speed of infrastructure development/cost reductions will be dependent upon the initial level of industry development at the time the policy is implemented and a program design (for tendering strategies) that includes effective penalties for speculative and non-cost based bids.

B. Maintaining Targets for Renewable Energy and Costs of Achieving the Targets

An RPS creates specific supply targets and, if designed properly with appropriate penalties for non-compliance and enforcement, can be very effective at achieving those targets. Since the target is specified in advance, effective enforcement should lead to achievement of the target but, as experience shows thus far, the costs of meeting the RPS targets are less assured. A penalty for non-compliance should be set at or above the cost of compliance. So if the penalty cost is equal to or more than the cost of building new renewable energy facilities, and any penalty fees collected are used to fund new renewable energy facilities, the renewable energy target should be met.

Feed-in laws are dependent on the level of the fixed price to determine the amount of new renewable capacity that will actually be brought on-line. If the feed-in tariff is highly attractive compared to renewable energy costs, substantial amounts of renewable energy might be developed. However, the level of the fixed price must be carefully set to ensure the costs of the overall policy do not exceed the benefits. If the feed-in tariff is not attractive, however, little development might occur.

Under tendering policies, since the developer bids the price, policy makers can more easily control costs of the program. However, as seen under the U.K. NFFO, there is no guarantee that the contracts awarded will be built or that targets will be met unless the program is carefully designed to avoid speculative bids.

C. Resource Diversity

Another important policy objective is to encourage a diversity of renewable energy supply sources. Particularly at the beginning of renewable energy resource development, it is frequently valuable to see what types of renewable energy technologies will be developed and at what cost by the market rather than to speculate what policy experts *think* will be developed within a particular price range. To some degree, this objective conflicts with the desire for cost minimization. RPS and tendering policies can encourage diversity by establishing separate technology purchase bands or tiers. Without these tiers, resource diversity is likely to be limited to the least expensive renewable resources. However, such approaches do have significant administrative drawbacks.

Feed-in tariffs appear to provide an easier mechanism of assuring diversity. First, setting a fixed renewable electricity sales price ensures that any form of renewable supply that can be generated at or lower than the feed-in tariff will be developed. This occurred in California, where PURPA contracts brought on-line sizable amounts of wind, geothermal, biomass, and small hydro capacity in a wide variety of applications not previously envisioned. Then, as the costs of some technologies go down, feed-in tariff prices can be reduced for that technology but left at the higher level for higher cost renewable energy technologies, as in some European nations, ensuring resource diversity while achieving some economic efficiency. In California as renewable energy costs fell, the state implemented a tendering process to procure the next order of renewable power while achieving greater economic efficiency. However, there was not as great resource diversity in the winning renewable resource bidders as there had been through the fixed-price contract strategy.

D. Market for Power

All three of these policies are designed to develop a market for the sale of renewable energy that will support the financing of new facilities. A market for renewable power will exist if there is government enforcement of the renewable mandate, the energy price is greater than energy costs, there is a guaranteed power purchase agreement with minimal transaction costs, and fair and reasonable interconnection is available. Whether a government mandated renewable energy market is sustainable, however, is a more complex question.

The market will be economically sustainable as long as all of the criteria mentioned above are met, and the price exceeds the costs. The market will be technically sustainable as long as there are additional renewable resources available for development at a cost less than the price that the government or its citizens are willing to pay. RPS programs have the advantage of being able to use renewable energy certificates to support new development in other geographic areas if cost-effective resources in the immediate area are exhausted.

The political sustainability of the market is the most complicated sustainability issue. The political sustainability depends upon the 'perceived' costs and benefits of the policy, the underlying economic health of the electricity sector, the stability of government policies in general, public support for renewables, and the relative political influence of developers of competing technologies not included in the mandated policy. Finally, if the financial community perceives that political support is not sustainable, that the policies are likely to change or are not being enforced, they may be reluctant to finance new renewable energy projects and market sustainability will dissolve.

E. Political Viability

The political viability of a policy will necessarily depend on the particular circumstances at hand, but there are several factors that influence political viability, such as cost to implement the policy, success in other markets and the perceived compatibility with current political philosophy. All three of the policies discussed have had successes and failures, largely dependent on the design of the policy and the market circumstances. The US and several European countries today are moving away from tendering and feed-in tariffs in favor of RPS and similar purchasing obligations that are viewed as maximizing the efficiencies of the marketplace and that may be more compatible with current political philosophy. Moreover, both the US and Europe have relatively mature markets, thanks in part, to tendering and feed-in tariffs of the past that helped to establish the renewable generation industry. Because China already has a rudimentary feed-in law for wind power, making modifications to the wind power pricing regulations already in existence may entail relatively lower political risks.

A second factor influencing political viability is the cost to implement the policy or to achieve goals. Feed-in tariffs and RPS policies generally have lower administrative costs than tendering policies, largely because with the latter, there are ongoing costs to the government of adjusting the policy, overseeing each offer, raising the money to pay for the incremental costs of renewables and administering the funds. Usually, the funds for tendering policies are paid through a tax or fee on electricity. The addition of new taxes and fees can be politically sensitive and can reduce the political viability of tendering policies. RPS and feed-in laws also have costs,

except in these two cases, the incremental costs of the renewable generation is a direct part of the electricity rates, which may be more politically viable from the government's perspective.

In terms of the ability of each policy to bring renewable energy on-line at the least cost, RPS is generally considered most effective, followed by tendering and feed-in policies.

F. Local Industry and Manufacturing Development

Because tendering provides strong and continuous incentives for cost minimization, absent additional policies or an already established renewable industry, it can be difficult for such policies to increase local renewable energy supply infrastructure in order to gain the local economic development and employment benefits of renewable energy. With a continuous incentive to reduce costs, as under the U.K. NFFO, established equipment suppliers and developers are likely to dominate the market, at least initially. Therefore it is important to already have local suppliers established so they can compete. By contrast, a feed-in tariff creates incentives for local economic and industry development is part of the policy effects, as demonstrated by experience in Germany, Denmark, Spain and the U.S. In a nascent market, a feed-in tariff can minimize contracting, development, financing and interconnection hassles. Such ease of market entry is especially important at the initial stages of renewable industry development for less well-financed and smaller players in the renewable energy business.

The ability of an RPS to spur local generation is largely dependent on the design of the RPS. For example, the RPS could be designed, as some US states have done, so that the renewable targets must be met with in-state generation. Absent such requirements, however, the RPS will encourage the least-cost generation. With regards to manufacturing of renewable energy equipment and components, the RPS is likely to favor the most established companies that can manufacture parts and components at the least cost.

G. Compatibility with Electricity Industry and Regulatory Structure

An RPS is highly compatible with both regulated and competitive electricity markets; whereas feed-in laws are more appropriate in a regulated setting where absolute competitive parity is not required. Under a competitive electricity market, feed-in laws are only competitively neutral if applied to regulated elements of the industry or if a cost recovery and sharing mechanism is developed. Concerns over the compatibility of feed-in tariffs with electricity liberalization has led several European nations to consider abandoning or phasing out such systems over time in favor of an RPS. On the other hand, a fully implemented RPS requires a strong and effective administration and enforcement mechanism to validate trades in renewable energy credits and enforce compliance. Without such an advanced administrative mechanism, a fully implemented RPS cannot function appropriately. Feed-in tariffs do not require as complex and sophisticated administration.

Tendering is usually associated with restructured wholesale markets and can be a good policy to help establish a renewable generation base in newly restructured wholesale markets. Tendering can also be used in conjunction with an RPS to help subsidize new renewable energy generation to satisfy the RPS and can also be used in a conventional monopoly market. The primary issue for tendering is infrastructure development.

H. Policy Stability

Ensuring a stable policy environment is essential for the development of a durable renewable energy industry with access to reasonable financing. Feed-in tariffs and tendering policies provide a high-level of short-term regulatory security to potential renewable energy investors because they guarantee a fixed return on investment. This is an important advantage of feed-in laws and tendering over RPS-based mechanisms, and is the source of the success of these policies. However, this security can only be maintained if the feed-in tariff or the tendering contract remains fixed for some reasonable amount of time (10 years at a minimum), and is not modified by the regulatory authority. Modifications, which are essential if cost reduction is ultimately a goal, can compromise investor certainty if they are applied retroactively or not designed well.

Initially, RPS-based mechanisms provide more regulatory and market uncertainty as renewable energy developers are not promised a particular price. However, if renewable energy purchase targets are established well in advance and if investors view these targets as credible, an RPS can provide an adequate amount of policy stability to ensure low-cost renewable energy development. In addition, the government can set a price floor for tradable credits, thereby helping to add economic and financial stability to the market.

I. Competitive Parity

Especially as competition in electricity markets increases, a desire to maintain competitive parity and not unfairly shift the cost of public policy on certain market participants increases. A fully implemented RPS is competitively neutral. When designed well, all utilities and retail suppliers are required to meet the same renewable energy purchase requirement. With tradable renewable energy certificates, the incremental cost of the policy can be spread fairly across the implementing jurisdiction. This is one of several reasons that the RPS has become a popular element of reformed electricity markets.

Feed-in tariffs and tendering, on the other hand, hold the potential to discriminate among market players. With feed-in tariffs, utilities located in renewable resource rich areas will bear the brunt of the cost impacts of the policy, as renewable generators located in those areas receive above-market tariffs. This has been one of the key sources of criticism in Germany, where certain distribution utilities have been disadvantaged due to their proximity to high wind regions. Cost sharing mechanisms can be designed to spread these costs more broadly – as has been accomplished in Germany – but only with an increase in the complexity of the policy. With tendering, the policy favors established businesses and allows companies to keep potential competitors out of the market by bidding low on projects, regardless of whether or not the company has any intention to actually build the renewable energy project. This problem can also be mitigated through careful program design and stiff penalties for missing benchmarks.

J. Integration

Another important objective of renewable energy policy is to ensure that renewable generation is integrated fully into the overall electricity industry, systematically reducing or eliminating institutional barriers to its development.

Under any of these three policies, if there is no incentive for the utility to reduce the institutional barriers to the development of renewable energy, barriers will remain. In fact, there may be an incentive to raise institutional barriers to thwart renewable energy development and thereby lower the cost burden of paying the feed-in tariff, for example, or to show the government that the policy just won't work as could be the case with an RPS-based policy.

A credit trading system under an RPS where renewable resources may be located in regions different from the primary load centers allows for better integration of economic development, environmental, and resource development goals. However, there is often serious opposition by local utilities and governments to send their development money to other regions. In China, a fully implemented RPS policy would integrate the Western Strategy with other economic development, population migration, environmental and resource development goals but will require careful design to avoid local opposition in non-western provinces.

Tendering policies are generally neutral on this evaluation criteria, though it also does not provide any incentives for utilities to reduce the institutional barriers to the development of renewable energy unless that is part of the program design.

K. Simplicity

The design, administration, and enforcement of feed-in tariffs are relatively simple, and significant experience exists in other nations from which to garner useful experience.
The RPS is a much younger concept. While experience in the design and administration of an RPS is increasing rapidly throughout the world, there are only a few successful examples that have more than one year's experience, making the design, administration, and enforcement task a more difficult one for countries now developing an RPS. From a contractual and transaction cost perspective, fixed feed-in tariffs with standardized interconnection requirements, contract terms, and conditions can also simplify negotiations and speed the development and contracting process for renewable generators relative to an RPS strategy.

Tendering policies can be relatively simple in design, but are usually accompanied by a separate system to collect monies to pay for the incremental costs of the renewable energy. In addition, tendering policies need to be regularly reviewed and modified to ensure that they are achieving goals. Overall, tendering and RPS strategies are more complex to implement than feed-in tariffs.

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.

VII. Implications and Conclusions

As is evident from this analysis, there are advantages and disadvantages to each of the renewable energy support policies discussed in this paper. It is not our intent to suggest an "ideal" policy for China. Whether the weight of the evidence suggests one policy over the other depends on the primacy of different possible policy objectives and the political context within which the decisions are being made.

- RPS-based mechanisms may hold the best hope for price minimization, allow for the development and maintenance of specific renewable energy targets, and may be more compatible with future electric industry structures.
- Feed-in laws are simpler to administer and enforce, may better ensure resource diversity and local industry infrastructure development, can set the stage for price reductions by nurturing cost reductions, and may be more compatible with the current industry and regulatory structure in China.
- Tendering policies can be an effective compliment to an RPS as it can help to establish a renewable generation base that can support the RPS. The primary issue with a state supported tendering policy in China is the political will to levy a tax or fee to collect the money to pay the incremental cost of the renewable generation. The design and implementation mechanisms of a tendering policy can be developed in parallel with or after other policy initiatives have been established such as a public benefits fund or RPS.

A final consideration is timing. A feed-in tariff can help develop renewable energy infrastructure more rapidly than either of the other two policies. A tendering strategy is useful for reducing prices but may require an established industry to achieve this economic efficiency goal. An RPS policy can possibly build the industry but experience is limited and suggests it will take more time with an RPS than with a feed-in law if market development is in its infancy. Because it will take time to implement RPS and tendering policies in China, and because a rudimentary feed-in tariff for wind is already established, one attractive approach would be to rely on a feed-in tariff policy for some time as other policies are researched and developed.