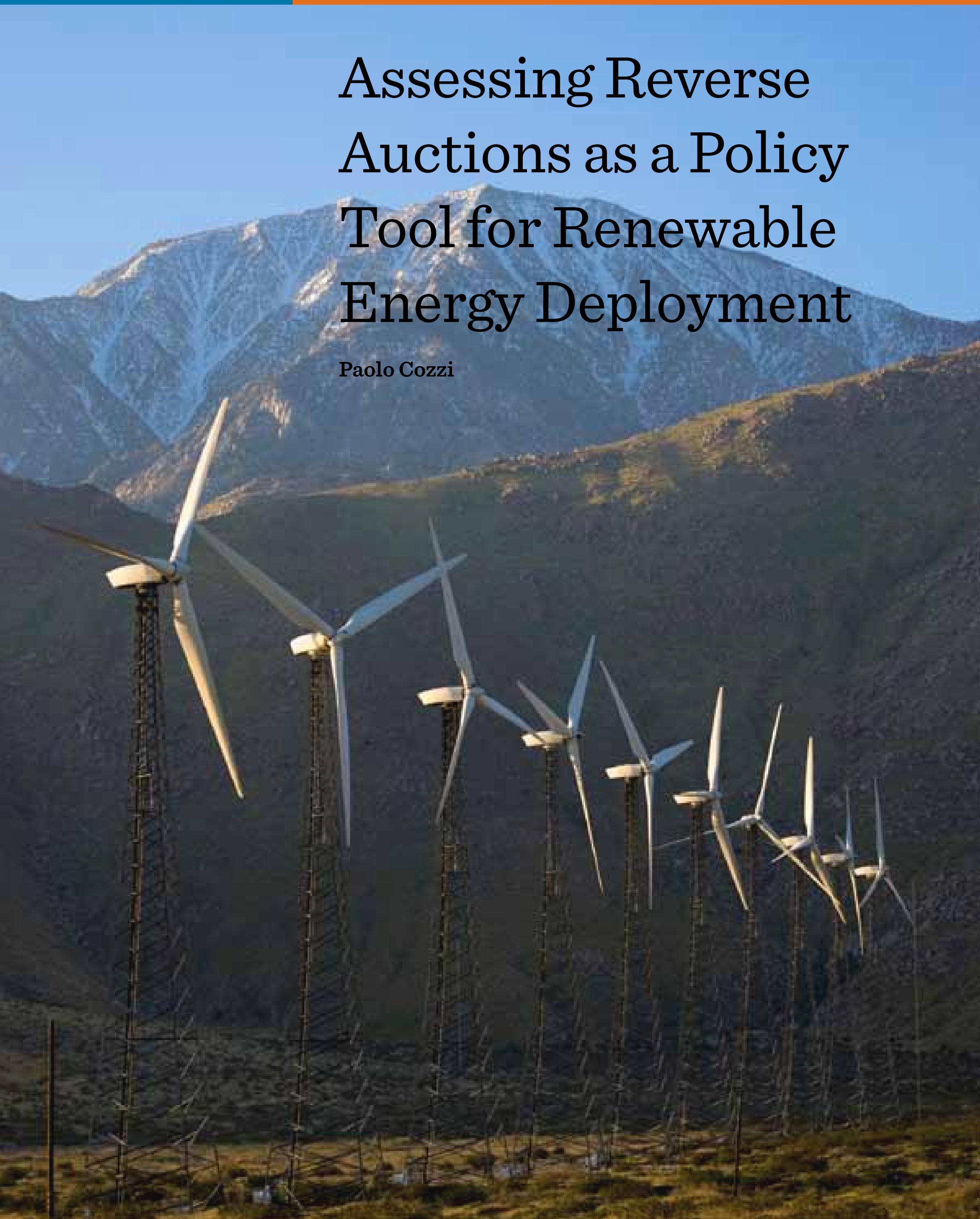
MAY 2012 | NUMBER 007

THE CENTER FOR INTERNATIONAL ENVIRONMENT & RESOURCE POLICY

ENERGY, CLIMATE, AND INNOVATION PROGRAM
THE FLETCHER SCHOOL
TUFTS UNIVERSITY

Assessing Reverse Auctions as a Policy Tool for Renewable Energy Deployment

Paolo Cozzi



Abstract

Several Countries have used reverse auctions to promote deployment of renewable energy. This combination of a competitive mechanism with a demand for renewable energy should reduce costs in achieving deployment goals. A comparison of British, Chinese, and Brazilian experiences with reverse auctions shows that reverse auctions can be used for renewable energy deployment at a low cost, but design elements need to be present to prevent underbidding and breach of contract.

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The Energy, Climate, and Innovation Program (ECI) gratefully acknowledges the support of the William and Flora Hewlett Foundation and BP International Limited.

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The Fletcher School at Tufts University was established in 1933 as the first graduate school of international affairs in the United States. The primary aim of The Fletcher School is to offer a broad program of professional education in international relations to a select group of graduate students committed to maintaining the stability and prosperity of a complex, challenging, and increasingly global society.

The Center for International Environment and Resource Policy (CIERP) was established in 1992 to support the growing demand for international environmental leaders. The Center provides an interdisciplinary approach to educate graduate students at The Fletcher School. The program integrates emerging science, engineering, and business concepts with more traditional subjects such as economics, international law and policy, negotiation, diplomacy, resource management, and governance systems.

The Energy, Climate, and Innovation Program (ECI) advances policy-relevant knowledge to address energy-related challenges and opportunities, especially pertaining to climate change. ECI focuses particularly on how energy-technology innovation can be better harnessed to improve human-well being, and the role of policy in the innovation process. Although ECI's outlook is global, we concentrate mainly on energy and climate policy within, and between, the United States and China. We also focus on how these countries influence the international negotiations on climate change, and the role of technology in the negotiations.

This report was printed using 100% wind-energy on a paper made of 100% post-consumer waste fiber.

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Acronymns

CDM	Clean Development Mechanism
CER	Certified Emissions Reduction
CO_2	Carbon Dioxide
DNC	Declared Net Capacity
DTI	Department of Trade and Industry (U.K.)
EPA	Environmental Protection Agency (U.S.)
FFL	Fossil Fuel Levy
GATT	Global Agreement on Tarrifs and Trade
GPA	Agreement on Government Procurement
GW	Gigawatt
H.R.	House of Representatives (U.S.)
LCR	Local Content Requirement
MMS	Mandatory Market Share
MW	Megawatt
MWh	Megawatt Hour
NDRC	National Development and Reform Commission (China)
NEA	National Energy Administration (China)
NFFO	Non-Fossil Fuel Obligation
NFPA	Non-Fossil Fuel Purchasing Agency
NREL	National Renewable Energy Laboratory (U.S.)
PPAs	Power Purchase Agreements
PROINFA	Programme of Incentives for Alternative Electricity Sources
PSP	Pool Selling Price
PTC	Production Trade Credit
R$	Brazilian Real (currency of Brazil)
REAP	Rural Energy for America Program
REC	Renewable Energy Companies
RES-E	Price of Electricity from Renewable Resources
RMB	Renminbi (currency of China)
RO	Renewables Obligation
RPS	Renewable Energy Portfolio Standard
TWh	Terawatt Hour
WTO	World Trade Organization

Section 1: Introduction

Among both developed and developing nations, few are those governments that do not at least make reference to the ideal of mass deployment of clean and renewable sources of energy. Some see renewable energy as a path to a low-carbon future to avoid climate change. Others may worry about price volatility and dependence on imported fossil fuels. Yet others see renewables as a business opportunity.

Regardless of the motivation, states have pursued several different policies for promoting the deployment of renewables. As such, a suite of options have become available to policymakers, including, but not limited to: production subsidies, feed-in tariffs and preferential pricing, command and control measures such as quota/portfolio standard approaches, land grants, and tax incentives. One of these policies is known as a "tender" or "reverse auction." While several different forms of reverse auction have been used, a reverse auction is a process by which an entity, generally the government, announces that it wants to purchase a certain amount of a product or service — in this case electricity from renewable sources — and solicits competitive bids so as to acquire it at the lowest cost — as regards renewables this is generally in dollars per Megawatt-hour (MWh). This is generally accompanied by a requirement to purchase the electricity, and the difference is often centrally subsidized. The use of reverse auctions is examined in this paper through case studies of experiences in the United Kingdom, China, and Brazil.

1.1 THE LITERATURE

Much of the literature on renewable reverse auctions to date has focused on the United Kingdom's Non-Fossil Fuel Obligation (NFFO) (Mitchell 1995; Mitchell 2000; Mitchell and Connor 2004; Komor and Diebold Institute for Public Policy Studies 2004). In various articles Mitchell argues that the NFFO has led to a dawning of understanding about the issues renewable energy policy needs to address (Mitchell 1995), and that the NFFO has done a decent job of deployment and price reduction, though not of domestic market creation (Mitchell 2000). Mitchell's final assessment of the NFFO was less laudatory, commenting on how the policy has led to the consolidation of the industry within the hands of large developers (Mitchell and Connor 2004). On cost-effectiveness, the NFFO has been compared with Germany's Feed-in Tariff system. Mitchell has argued that the NFFO drove prices more than Germany's feed-in tariff (Mitchell 2000), whereas Butler and Neuhoff have argued that when resource differences are taken into account, the price paid in Germany is actually lower, as well as deployment being higher (Butler and Neuhoff 2008).

The Chinese Wind Concession Program fits into a greater tableau of Chinese wind promotion mechanisms. Raufer et al. describe the context for the adoption of the Wind

Concession Program (Raufer, Litong, and Shujuan 2003), relying heavily on Timothy Brennand's previous work, which encouraged the adoption of a wind concession approach (Brennand 2001). While the program has helped with large-scale wind deployment in China, Liu and Kokko identify underbidding and grid connection as problems (Liu and Kokko 2010). Lewis has argued that the program provided necessary support to wind energy development and created the demand necessary to promote local manufacturing, but needs more government involvement on the front end, more wind resource data, and more experimentation with what scale is optimal for concession projects in order to determine at what size economies of scale begin to make an impact on marginal costs (Lewis 2004).

Technology-specific auctions have only recently come into use in Brazil, and as a result it is not yet clear how the auction will perform in terms of deployment. Thus far, the results of the auctions are promising, prices have fallen, and arrangements for financing have attracted major wind component manufacturers to the country (GWEC 2011). Porrua et al. (2010) have found that the auctions have achieved low enough prices that they pave the way for direct competition between wind and other sources. This optimism notwithstanding, enforcement of pre-qualification and enforcement measures will be critical to ensuring the auction's success (Azuela and Barroso 2011).

1.2 AIMS

This paper attempts to identify the principal factors that influenced each country's decision to adopt a reverse auction and what factors led to its success or failure. It seeks to identify "success" and "failure" insofar as possible with regards to the goals of those implementing the policy. The principal areas examined are: effects on price, effects on deployment, interaction with other policies, and effects on the component manufacturing sector.

Comparing and contrasting studies that have been conducted on each of the cases, my goal is to find patterns that may assist in the conduct of future auctions, particularly as an option for deployment of renewables in the United States, as well as to generate a more uniform understanding of the pitfalls.

There was no initial intent in writing this paper to focus on wind energy. However, wind is one of the most mature and cheapest sources of renewable energy and as such has featured prominently in renewable tendering schemes. Thus much of the discussion within this paper will revolve around wind auctions, though some attention will be paid to other technologies that have been auctioned, such as landfill gas and hydroelectricity in the UK, or biomass in Brazil.

1.3 ROAD MAP

The next section of this paper focuses on the UK's Non-Fossil Fuel Obligation (NFFO). Starting in the beginning of the 1990s, the NFFO is the first example of a tendering system for renewable energy. The policy was a hybrid of the Thatcher government's desire for privatization in the electricity sector, a desire to support nuclear energy, and environmental concerns. Though the NFFO failed to achieve its deployment goals, it began the process of what has been reasonably successful expansion of renewables in the United Kingdom, provided a basis for comparison between a reverse auction and renewable energy portfolio standard (RPS) in the subsequent Renewables Obligation, and demonstrated the ability of a competitive auction mechanism to drive down prices.

Section three focuses on China's Wind Power Concession Program. This program was adopted in 2003, when growth was occurring in China's renewable energy sector, but the country sought to pursue larger-scale deployment. The Concession approach represents one of greater government involvement, as what are being auctioned are the rights to develop a particular, government-chosen, site. The Wind Concession Program was an important part of a suite of interconnected policies, which have led to China's advancement in deployment of wind, to the point where it now has the largest installed wind capacity in the world.

The fourth section examines how Brazil, under its New Model for energy, has utilized electricity auctions to promote non-hydro renewable resources, with a focus on the country's first wind-only auction. Brazil has an abundance of renewable energy resources, particularly hydroelectric, wind, and biomass. Following the energy shortage crises that afflicted the country 2001-2, an attempt was made to expand capacity and diversify the energy portfolio, as well as to ensure that distribution companies had contracts to cover all of their load requirements. As a result of these reforms Power Purchase Agreements (PPAs) came to be offered through public auctions. In 2008 and 2009, the government began to organize auctions specifically for renewables in an attempt to diversify its hydroelectric-heavy electricity portfolio.

The fifth and sixth sections conclude this paper. In the fifth section, I examine similarities and differences between the approaches of the different auctions, and aim to pull out useful lessons on the design of a reverse auction system. In the sixth section I look at the United States, and analyze a reverse auction for Renewable Electricity that was included in a 2011 energy bill. I conclude that the auction in the U.S. House of Representatives bill number 909 (H.R. 909) has many of the attributes that an effective reverse auction should, but that its apparent focus on existing power plants will likely make it ineffective, should it gain passage.

Section 2: Britain's Non-Fossil Fuel Obligation

2.1 POLITICAL CLIMATE

At the end of the 1980s, the political climate in England surrounding renewables and environmental issues differed significantly from that of today. A central theme was the use of nuclear energy. On the one hand nuclear energy was seen as a fossil fuel alternative, the use of which lessened the threat of acid rain, then seen as one of the principal dangers of fossil fuel emissions.

On the other hand, the use of nuclear power presented both security and environmental concerns to critics. The explosion and subsequent fallout at the Chernobyl reactor worsened these fears. Worry about nuclear energy even led the environmental group Friends of the Earth to ally with the International Coal Development Institute for a time in 1988 to oppose the nuclear lobby in the UK, even teaming up to host a conference titled Clean Coal, Challenges and Technologies for the 21st Century (Ryan T 1988). Though the group is still opposed to nuclear, the idea of Friends of the Earth promoting coal's use as an alternative today seems outlandish. In recent years Friends of the Earth has frequently pushed against the expansion of coal use in the UK and abroad (Friends of the Earth 2010). Global warming was a known issue in the late 1980s, though as part of a slate of environmental issues facing the world, and more poorly understood than it is today. In a speech in 1988 to the Royal Society, Margaret Thatcher identified the greenhouse effect, the ozone hole, and acid rain as the three main dangers to the health of the planet (Wood 1988). Though Thatcher was given kudos from members of the environmental community for moderating her free-market ideology with a commitment to government action to preserve the environment, very little was still known about climate change. Indeed, the Intergovernmental Panel on Climate Change was formed in 1988, the same year that Thatcher gave her famous speech to the Royal Society. The panel's first assessment report would not come out until 1990.

Similarly, renewables looked much less viable in the late 1980s than they do today. In 1988 the UK was on the verge of siting its first wind farm (Matthews 1988). In contrast, today the UK boasts 309 wind projects with 3,415 turbines and a capacity of 5,751 MW (RenewableUK 2010). Many within the Thatcher administration supported the continued use of nuclear power, even though it was at a comparative disadvantage with coal. However, the administration was also committed to the establishment of a free market for electricity. The Electricity Act can be seen as attempting to satisfy several of these goals at once.

The Electricity Act was a hybrid. Thatcher had publicly endorsed the idea of public action on climate change, and thus it was environmental. There was also an impetus to privatize the electricity industry. This was partly ideological — privatization was a central part of Thatcher's platform. It was also practical — new regulations would require the government to make a large investment to clean up generating infrastructure, so it was easier to privatize them. Ultimately, it was decided to privatize part of the system, retaining the nuclear industry under government control, since they did not make for an attractive investment without government assistance (Mitchell 2000).

2.2 THE NFFO PROCESS

As well as dividing up and privatizing much of the state utility apparatus (the nuclear industry, unattractive to shareholders, remained in public hands), the Electricity Act took two important steps for renewable energy. First, it established the Fossil Fuel Levy, which would provide the funding mechanism for the NFFO. Second, it gave the Secretary of State the authority to require the Regional Electricity Companies to purchase a certain amount of electricity from renewable sources.

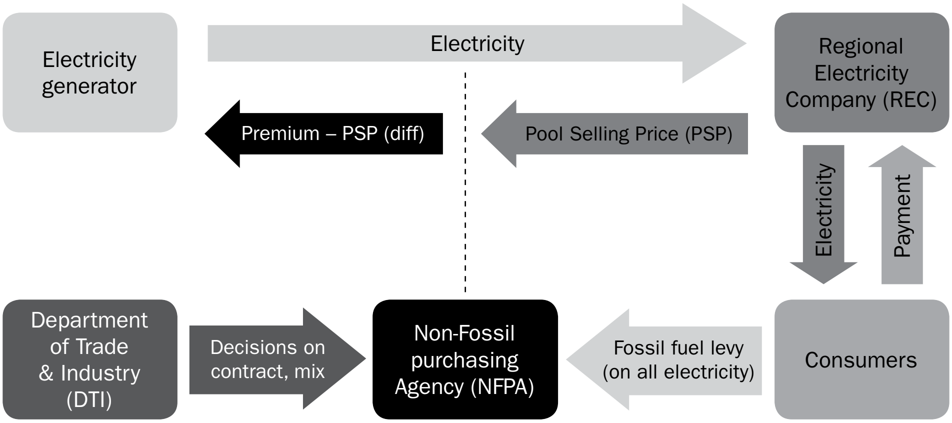
The NFFO consisted of a series of five orders by the Secretary of State calling for bids for PPAs. These "orders" were a series of auctions for non-fossil sources of electricity. After the first Non-fossil Fuel Order (NFFO) occurred in 1990, essentially for the purpose of subsidizing nuclear, auctions occurred in 1991, 1994, 1997 and 1998. The legislation required all public electricity suppliers, and later all Renewable Energy Companies (RECs) to purchase all non-fossil generation offered to them through these auctions (Mitchell 1995). Auctions occurred on a specific date within specific technology bands, meaning that wind projects would compete against other wind projects but not against solar or landfill gas, for example. Once bids were solicited, they were compared with others within their technology band and the lowest-priced bids won.

While initially no capacity target was set for the NFFO, with NFFO-1, one was set of 600 MW DNC.[1] NFFO-2 raised this to 1000 MW DNC, and NFFO-3 called for 1500 MW DNC — approximately 3% of the electricity supply at the time. When the Labour party came to power in 1997, it increased the goal to renewables generating 10% of electricity by 2010 (Mitchell and Connor 2004).

A diagram of the subsidization process can be seen in Figure 1. Though required to buy the electricity, the RECs only had to purchase it at the market price, or more specifically, the average Pool Selling Price (PSP). The Non-Fossil Purchasing Agency (NFPA) would reimburse the REC the difference between the premium price — established in the contract awarded as a result of the auction — and the PSP. For example, if a contract for on-shore wind was awarded, at 3p/kWh, and the average monthly pool selling price were 1.4p/kWh, the NFPA, a wholly owned entity of the Regional Electricity Companies, would reimburse the 1.6p/kWh difference to the utility.

[1] Declared Net Capacity — the equivalent capacity of a base load plant that would produce an equivalent amount of power

Figure 1: The NFFO Process



Source: Visualization of information from (Mitchell 2000)

This difference between the contracted price and the PSP was paid by the NFPA out of the funds that came from the Fossil Fuel Levy (FFL), a tax on all electricity (not, as the name would imply, only on electricity from fossil sources). This amount was originally set at 10%, but by the end of the NFFO had dropped to 1% (Komor 2004). The Department of Trade and Industry (DTI) determined how much it was willing to spend on each technology band, allocating the revenue from the FFL. Later on, following the 1997 Comprehensive Spending Review, the cost of the NFFO was transferred to DTI, such that in case of cost overruns the Department was required to make up the shortfall from its own budget (Mitchell 2000). While such a process was non-bureaucratic in that the mix of technologies was at the discretion of DTI, the department was constrained by the total size of the levy, determined by the treasury.

The DTI was required to bring down costs per contract per order, creating another constraint. This led to a restriction in technology bands in later rounds of the NFFO, such that technologies such as energy crops or offshore wind were not allowed in NFFO 5, as they might have put DTI over budget (Mitchell 2000).

The contracts varied from order to order. While the contracts for NFFO 1 and NFFO 2 were set to expire in 1998 and be incorporated into the competitive electricity system, NFFO 3, 4, 5 had contracts for a maximum of 15 years of index-linked premium prices. NFFO 3 had a 4-year development period, while NFFO 4 and NFFO 5 had a 5-year development period. While the contract was still valid after this period, payments would stop after a period equal to the development period + the contract length (NFFO 3, 4, 5 – 19 or 20 years) (Mitchell 2000).

Table 1: NFFO Technologies

Technology	NFFO1	NFFO2	NFFO3	NFFO4	NFFO5
Wind	✓[a]	✓	✓	✓	✓
Wind sub-bands	–	✓	✓	✓	✓
Hydro	✓	✓	✓	✓	✓
Landfill gas	✓	✓	✓	✓	✓
Sewer gas	✓	✓	–	–	–
M&IW[b]	✓	✓	✓	–	–
M&IW[c]	–	–	–	✓	✓
M&IW/CHP[d]	–	–	–	✓	✓
Biomass[e]	✓	✓	–	–	–
Biomass[f]	✓	✓	✓	✓	–
Wet Farm Wastes[g]	–	–	–	✓	–

a Eligible.

b Municipal and industrial waste with mass burn technology.

c Municipal and industrial waste with fluidized bed technology.

d Municipal and industrial waste with combined heat and power.

e Steam generation.

f Gasification.

g Anaerobic digestion.

Source: Mitchell (2000)

2.3 THE DEATH OF THE NFFO AND THE ADOPTION OF THE RENEWABLES OBLIGATION

In 1997, a new Labour government took office and undertook a series of policy reviews. By 1998, a Utilities Bill team had been set up within the Department of Trade and Industry with the focus of altering the basis of utility regulation (Mitchell and Connor 2004). Though the bill was initially intended to address electricity, gas, and water, in the end electricity was the only utility affected, through the imposition of a Renewables Option.

Of the ways that the Utility Bill's changes affected renewables, the most critical to the NFFO system was that it separated the Regional Electricity Companies into distribution and supply companies. As such, it eliminated the legal basis of the NFFO (Mitchell and Connor 2004). The Utility Bill also created a policy to continue the promotion of the renewables following the elimination of the NFFO. In developing a successor policy to the NFFO, the government sought to improve on what it saw as the policy's defects:

- The inability to deliver sufficient deployment — in later orders only a fraction of the contracted capacity had come online.
- The isolation of generators from the marketplace through must-take contracts for utilities.
- The fact that the NFFO "picked winners."

The Utilities Act thus replaced the NFFO with the Renewables Obligation (RO). The RO was a quota or Renewable Energy Portfolio Standard (RPS) system whereby utilities were required to purchase a certain increasing percentage of electricity (not capacity) from renewables. They would then have to provide Ofgem, the utility regulator, with Renewable Obligation certificates to prove that they had met their obligation. These certificates could be purchased directly from a generator or purchased in the market. The system also included a buyout provision of 3p/kWh, which went into a pool to be redistributed to those utilities that did participate (Mitchell, 2004). The mechanism was technology non-specific, such that different technologies competed against each other.

Mitchell makes two main points about the Renewables Obligation. First, it did not bring down the price of electricity from renewable sources (RES-E), at least not in the early years. A breakdown of the value of renewable energy into its component parts (i.e. renewable energy credit, electricity cost, levy exemption certificate, recycled premium) showed electricity from renewables to carry a value of approximately 6-7p/kWh. This was higher than the cost of renewables at the end of the NFFO, and was roughly the same as the price guaranteed by the German government through its feed-in tariff system, with more risk for generators (Mitchell, 2004).

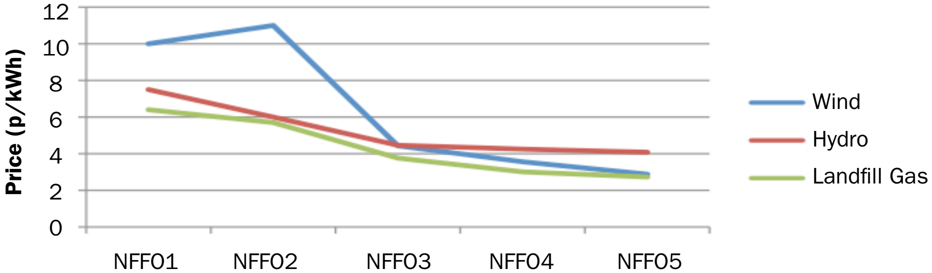
Second, the Renewables Obligation significantly changed the structure of the market on the side of the generators. One of the concerns mentioned above was that the NFFO, though a competitive process, isolated generators from the market through its use of must-take contracts for utilities. Typical contracts under the NFFO lasted 15 years. In contrast, while contracts under the RO varied based on the price offered for electricity, suppliers (utilities) were more wary of getting into long-term contracts if they believed that the price would come down in the meantime (Mitchell and Connor 2004), a reasonable bet given learning curve expectations.

The generators also found themselves taking on significantly more risk under the RO. In some ways this was the purpose, in that the RO was intended to be more of a market mechanism in order to expose renewables producers to market pressures.

2.4 ANALYZING THE NFFO

2.4.1 THE NFFO, PRICES AND DEPLOYMENT

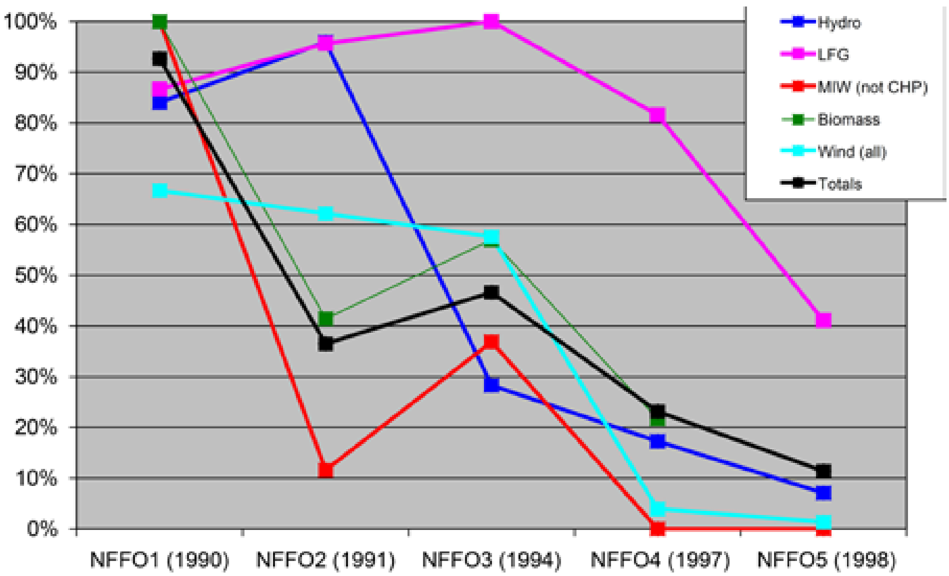
Figure 2: Falling NFFO Contract Prices



Source: Mitchell (2000)

As has been noted by Mitchell and others, and can be seen in Figure 2, Falling NFFO Contract Prices, prices of electricity from renewables dropped significantly during the NFFO. This was particularly the case for onshore wind. Wind dropped from 10p/kWh in the first round to 2.88 p/kWh in NFFO 5. Although prices were dropping all over for wind during this period, the fact that the UK government was contracting for wind at half what other countries were paying with feed-in tariffs indicates an accomplishment in bringing the cost down (Komor and Diebold Institute for Public Policy Studies 2004). Less dramatic but similar trends occurred within hydroelectric and landfill gas, two other significant technologies.

Figure 3: Overall Completion Rates for NFFO Contracts in 2003



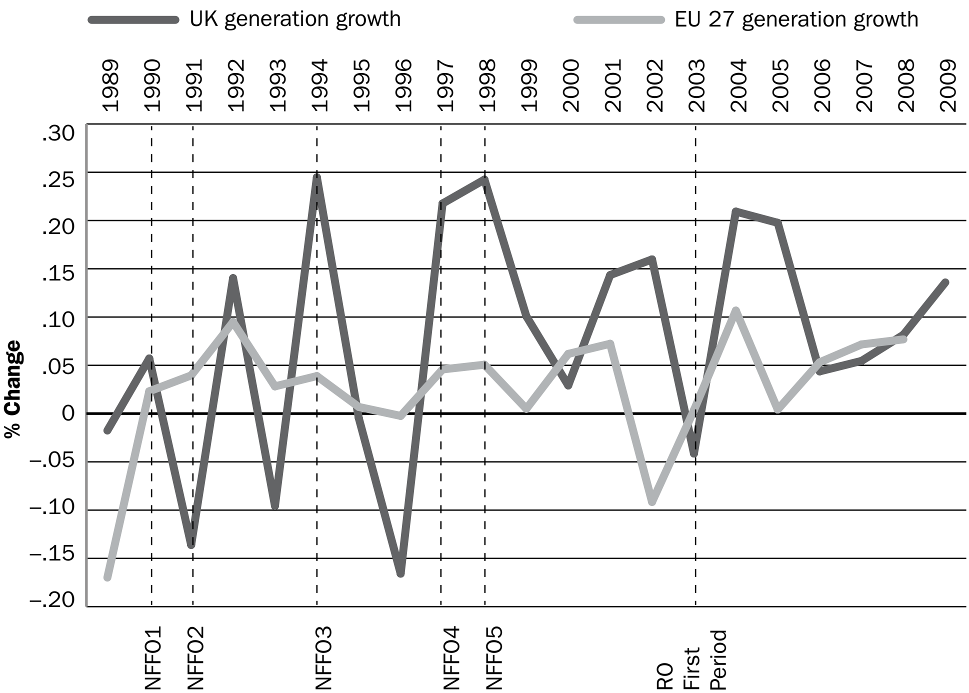
Source: Mitchell (2004)

The NFFO was thoroughly unsuccessful in actually bringing projects online, especially in the later stages. This was largely a result of firms making "best-case scenario" bids, which did not allow for potential obstacles or delays such as permitting problems. Even though many of the projects would have still been in the development period come the time of the Utility Bill Commission, the inability of the NFFO to deliver deployment was one of the principal shortcomings that the Labour Government sought to address in its successor policy (Mitchell and Connor 2004).

As the NFFO was the first major policy in the United Kingdom for promoting energy from renewables, there is no reason to believe that the policy interacted with policies supporting renewable energy. While standards and processes for environmental permitting appear to have led to reduced deployment, a system which invited reasonable, real-world scenario bids would have addressed this issue, without requiring a loosening of permitting requirements.

2.4.2 NFFO VS. RO

Figure 4: Growth in Renewables Generation in the UK and EU 27



Source: EIA

Contrasting the NFFO and the RO can help us extract some lessons from the British renewables experience. First, while the NFFO did successfully lead to competition, accompanied by a reduction in prices and the deployment of some renewable energy from a variety of sources, growth in overall generation from renewables was erratic during the NFFO period, as shown in Figure 4 above. Since the adoption of RO, the UK has had smaller variability in renewable generation growth, dipping below 0 just once, in 2003, the first year of the RO. This would appear to indicate significant success of the RO, and in 2004 and 2005 renewable generation did grow significantly, though not much faster than the EU-27 as a whole.

While the NFFO had technology bands, the RO was technology neutral. It would thus be natural to expect that the cheapest renewable sources (wind, potentially hydroelectric) would grow the most, while more expensive sources of renewables would grow significantly less. This has been true to some extent. From 2005 to 2008, wind capacity more than doubled in the UK, increasing from 1.6 Million kW in 2005 to 3.4 Million kW in 2008. Hydroelectric growth has been low, understandably since a) large hydroelectric is not eligible under the RO, b) much of the UK's hydroelectric capacity has been utilized (Harrison 2005), and c) permitting and environmental concerns can make even small hydroelectric projects difficult to realize. The surprising part of the equation is the growth of solar, tidal, and wave, which grew proportionally about as quickly as wind during the 2005-2008, though given the relatively diminutive position in the market of these technologies, the absolute increase was not very large (13 MW) (EIA).

Section 3: China's Wind Power Concession Program

3.1 BACKGROUND OF THE WIND POWER CONCESSION PROGRAM

China is a large country with substantial wind resources. It has been estimated that the country's onshore capacity potential is 235 gigawatt (GW), which could yield 506-632 terrawatt hours (TWh) of electricity per year (NREL 2004). Given China's commitment to providing its populace with electricity, combined with its desire to be seen as a leader in the international sphere, particularly with respect to climate change, and a commitment to economic growth, it is not surprising that the country has undertaken measures to utilize the wind available to it.

Table 2: Important Events in China's Wind Energy Policy

Year	Event	Comments
1994	Strategic Development Plan for Generation of Wind Energy in China 2000 and 2020	
1994	Opinion on Wind Power Farm Construction and Management	Utilities are required to purchase wind power, fixed prices
2002	State Council breaks up State Power Corporation into five generation companies	
2003	Tariff Reform Program	Creates Wind Concession Program
2005	Renewable Energy Law	15% of Energy from Renewables by 2020
2006	Regulation on Prices and Cost-sharing in Renewable Energy	2 methods of setting wind prices
2009	Notice on Price Policy for Wind Power	Created Feed-in tariff for onshore wind

Sources: (Liu and Kokko 2010)

Grid-connected wind has a long history in China, which has pursued a variety of policies to develop the resource. The beginning of the story of Chinese wind occurs in 1988, when the first wind turbines were installed in Xinjiang. In 1994, the Ministry of Power's policy statement "Opinion on Wind Power Farm Construction and Management" required utilities to purchase all electricity generated from wind, at prices high enough to cover wages, material costs, repayment of principal, interest, and a 15% profit (Liu and Kokko 2010). This policy had a precedent in previous Chinese policies undertaken to combat shortage of supply in the 1980s. In the case of conventional electricity, this had been successful as an inducement to private investment in the electricity sector, and it led a number of Chinese generation companies to prosper (Raufer, Litong, and Shujuan 2003). As applied to wind in 1994, however, the policy did not have the force of law, nor did it have a significant enforcement mechanism, and as such, many utilities were unwilling to take on the extra costs of wind electricity (Liu and Kokko 2010).

In 2000, Professor Timothy Brennand, with the support of the UNDP, conducted a study into the use of a Wind Resource Concession in order promote the deployment of renewable energy. As mentioned above, price provided one of the principal constraints on the diffusion of wind energy in China. Examining the economics of a 500 MW concession, Brennand argued that large-scale projects were required in order to reduce wind-generation costs (Raufer, Litong, and Shujuan 2003). Also in 2000, Professor Ni Weidou of Tsinghua University in Beijing produced A New Approach for Wind Power Development: Final Report. The Ni Report identified a series of concerns, including: high price, availability of capital, manufacturing and service capabilities, institutional arrangements, and lack of private-sector competition (Raufer, Litong, and Shujuan 2003). When private investment in wind remained absent and prices remained high in 2002, policy makers in the National Development and Reform Commission (NDRC) determined that price and lack of demand were two of the principal barriers to wind power development, and ultimately decided to adopt the Wind Power Concession Program to address them (Lema and Ruby 2007).

3.2 ADOPTION AND STRUCTURE OF THE WIND CONCESSION PROGRAM

The beginning of China's experience with an auction system for renewable energy came with the Tariff Reform Program of 2003. According to the government, the concession approach would reveal the true cost of wind power in China, in contrast with the high prices that had been mandated under the Opinion on Wind Farm Construction and Management (Lewis 2004). The program was set up for the purpose of developing large-scale (100 MW+) wind projects. In the period from 2003 to 2007, there were five rounds of bidding. The National Development and Reform Commission (NDRC) conducted auctions to give developers access to a particular site, initially selecting the lowest bidder to give the contract to.

The Wind Resource Concession approach is different from the other cases examined in this paper. Whereas in the other cases (the United Kingdom and Brazil) the developers propose their site, China's Wind Concession program took a different approach. Concessions have long been used for oil and gas, resources that are found within a limited geographic area. The idea of a concession is that companies bid for the right to develop the resource within the area in question. This approach has previously been used in Morocco and Argentina, though China is the first country to undertake a Wind Concession Program at the scale proposed (Raufer, Litong, and Shujuan 2003). In the

Chinese version of the Wind Concession Program, this structure meant that, while the developers would be responsible for the construction, operation and maintenance of the project, the government was responsible for the land rental and environmental permitting, though the costs would be borne by the bidding company (Li et al. 2006).

Initially, China's bidding process was a straightforward lowest-bidder gets the contract. However, it soon became apparent that underbidding would be an issue. This was partly due to the prestige that was gained from winning one of these large projects (Sinton et al. 2005). Thus, in 2007, the NDRC reformed its policy, and altered the contracts such that the new agreement would be for the average bidding price, rather than the lowest (Liu and Kokko 2010).

The Wind Concession Program had a contracting system that gave the potential for a long contract period, but limited the cost of the contracts. PPAs were signed with winning bidders for 25 years. However, after 30,000 load hours had been produced, the price was to be reduced to the local government-established price for wind power. These prices were based on feasibility and would later become the basis for China's adoption of a feed-in tariff for wind energy. Companies were expected to begin operation within three years of winning the contract (Sinton et al. 2005).

China attempted to marry the growth of its domestic wind component industry to its deployment growth through a Local Content Requirement (LCR). At first this requirement was set at 50%, but in 2007 it was raised to 70% in order to help promote the development of the local wind power industry (Liu and Kokko 2010). This continued until 2009 when the US-China Joint Commission on Commerce and Trade met and China agreed to remove its LCR on wind turbines (Howell et al. 2010). 2009 was also the year that China effectively halted its Wind Concession Program. After 2005, no foreign company won any of the Wind Concession Tenders, and local content, being cheaper in initial cost, was often chosen for projects (Howell et al. 2010).

While foreign companies can participate in the Wind Concession Program, the vast majority of concession projects have been won by Chinese companies. Indeed, through five rounds of bidding, and eighteen projects, only one sino-foreign joint venture won a concession project, in the fourth round, in 2007 (Li, Shi, and Hu 2010). While an "in" into the Chinese market can provide an additional incentive for foreign companies, some wanted to avoid the disclosure of proprietary information involved in the bidding process, and would prefer to work out individual power purchase agreements with the government, anticipating higher prices (Lewis 2004).

3.3 END OF THE WIND CONCESSION PROGRAM

In 2009, the NDRC issued the "Notice on Price Policy Improvement for Wind Power," adopting a feed-in tariff for wind generation and effectively ending the Wind Concession Program. Building on the work that had been done starting in 2006 in establishing pricing for non-concession wind projects, the policy established four pricing areas, with the lowest prices (0.51 RMB/kWh) being offered for projects in Inner Mongolia and other areas where wind resources are most plentiful, and more being offered, going up to 0.61 RMB/kWh in much of the country (Li, Shi, and Hu 2010). Through a standard pricing system, China may address the underbidding issue, though it remains to be seen whether the prices, having taken concession project prices into account, are sufficiently high to encourage deployment.

China's wind energy resources are plentiful, but are largely concentrated in the Northern areas, many of which are less inhabited. As a result, under the leadership of the National Energy Bureau, the state has begun development of seven "Wind Power Bases" — in Gansu, Xinjiang, Hebei, the eastern and western part of Inner Mongolia, Jilin, and the coastal area in Jiangsu — to be combined with an expansion of the electricity grid. These "bases" are enormous wind energy projects, on a 10 GW capacity scale, with an aim of having the seven amount to a total of 138 GW by 2020 (Li, Shi, and Hu 2010). As the bases in Hebei, Jiangsu, Inner Mongolia, Gansu, and Xinjiang are mostly at the end of the grid, the power system is basic, and will require upgrades for the wind bases to come online (Li, Shi, and Hu 2010).

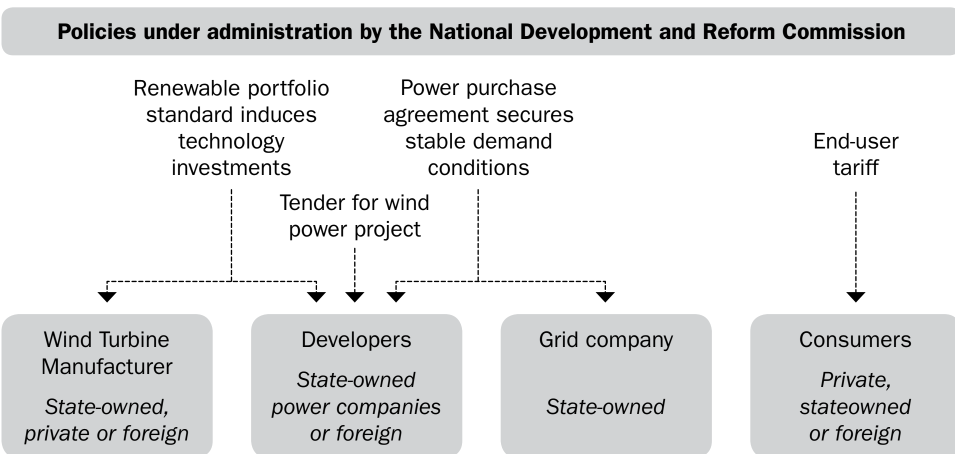
While the onshore concession program has come to an end, China has begun to develop its offshore wind resources, including an offshore wind concession program. The 2009 offshore wind development plan divided the offshore into intertidal, offshore, and deep sea sections. The plan requires provinces to develop their own wind development roadmap to 2020. Jiangsu was the first province to submit its plan, and the National Energy Administration (NEA) then initiated a tender for a 300 MW and a 200 MW plan.

3.4 POLICY INTERACTION WITH THE CHINESE WIND CONCESSION PROGRAM

Rather than follow one particular policy course, China utilized a suite of policies to promote renewable energy deployment. These included a system of prices based on feasibility for non-wind concession projects, and quantitative requirements for renewable energy in the form of an RPS and Mandatory Market Share (MMS). It also benefitted from the Clean Development Mechanism (CDM), one of the principal flexibility mechanisms of the Kyoto Protocol.

The Wind Power Concession Program was an attempt to get large-scale wind farms operational, but it was not the only preferential price policy available to wind developers. Since 1994, the Opinion on Wind Power Farm Construction and Management had theoretically guaranteed wind generation a 15% profit. However, when the 2006 Regulation on Prices and Cost-sharing in renewable energy came about, a significant effort was made to determine required prices for wind energy to be successful. This "Approved Prices" policy meant that regional authorities were examining projects on an individual basis and setting a price, after which the price would move toward an approved price decided by the NDRC (Li, Shi, and Hu 2010). From 2003, the year the Wind Power Concession Program was introduced, to 2009, when the program ended, wind capacity in China increased from 0.57 GW to 25.83 GW, an increase of more than 4,400% (GWEC 2011). During its lifetime the program contracted 3.35 GW worth of wind energy, some of which had not yet come online by 2009. Thus the majority of the capacity increase came from outside the Wind Concession Program. The feasibility studies required for the "Approved Prices" would form the basis for the policy, which was to succeed the Wind Concession Program, the Feed-in Tariff Policy (Li, Shi, and Hu 2010). Given that the approved prices policy allowed for significantly smaller projects, it did not directly interact with the Wind Concession Program, but contributed to increased demand for wind development and manufacturing in the country, a prerequisite for the development of a strong component manufacturing industry (Lewis and Wiser 2007).

Figure 5: Policies and Actors in the Wind Concession Model



Source: (Lema and Ruby 2007)

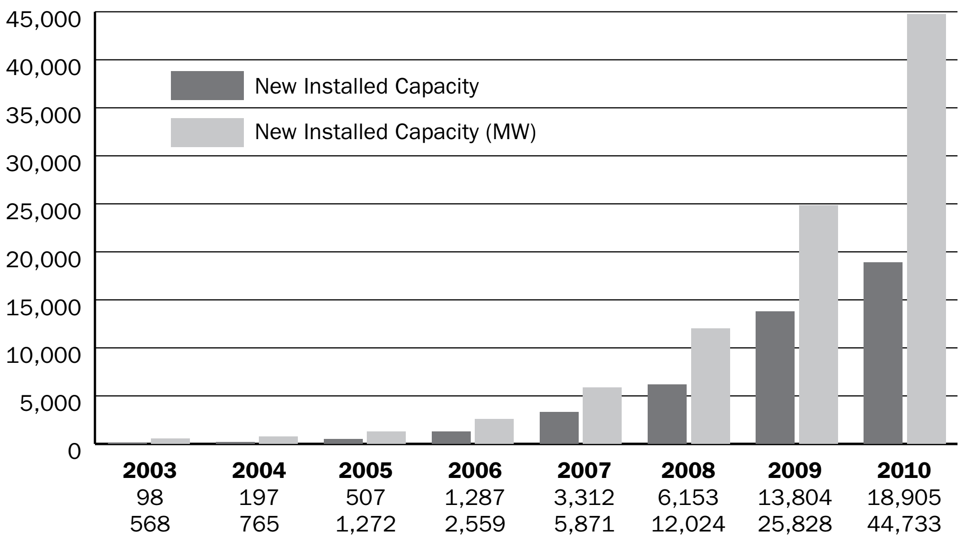
With the 2006 Renewable Energy Law, the government instituted a Mandatory Market Share of 15% of national energy consumption coming from renewable energy by 2020 (Liu and Kokko 2010), as well as a RPS requiring 10% of electricity to be purchased from renewable sources by 2020 (Lema and Ruby 2007). As can be seen in Figure 5, Policies and Actors in the Wind Concession Model, the RPS and Concession ("tender") approaches both had effects on developers, as both created a demand for wind power that, as mentioned above, had not previously existed.

The Clean Development Mechanism has also played an important role in the development of wind within China. While China's wind prices do not take the CDM into account, the profits generated through the mechanism are regarded by many developers as important compensation for losses caused by failures in resource evaluation, quality of equipment, and cost of operation (Li, Shi, and Hu 2010).

As of July 2009, China had registered 120 wind projects as CDM projects, accounting for 63.4% of the wind CDM projects globally, and 6.6 GW (WWEA 2009). Assuming a price of $16.50 (approx. 12€) per Certified Emissions Reduction (CER)[4], and an avoided emission level of 10 tonnes of CO_2 per MWh, a wind project could receive a maximum of 1.65 cents/kWh (WWEA 2009). At a capacity factor of 29% (the high end of the spectrum as measured by NREL[5]) the largest wind concession projects (300 MW) would generate 75 GWh, which would in turn be worth $1.2 million under the CDM. The mean PPA price awarded for 300 MW wind farms under the program was 0.4574 RMB/kWh, or $0.0716/kWh. At 75,168MWh, that would mean revenue of $5.4 million. Thus, provided a wind farm was able to get credit for avoidance of CO_2 under the CDM rules, CDM payment would represent a significant sum. While the CDM is soon to expire, this is not unlike cases where reverse auctions might be used in conjunction with policies, which allow them to produce tradable Green Certificates.

3.5 ANALYSIS

Figure 6: Installed Wind Capacity in China



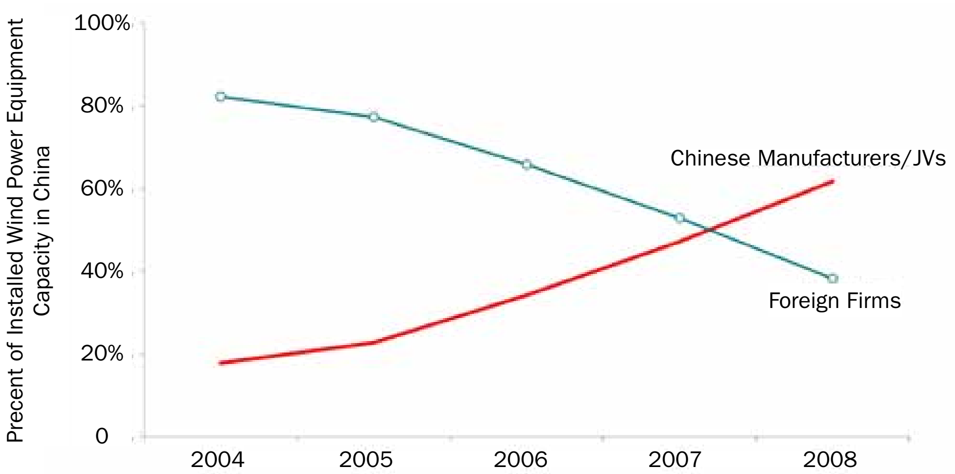
Source: (GWEC 2011)

[4] Equivalent to one tonne of CO_2 avoided
[5] United States' National Renewable Energy Laboratory

While the Wind Concession Program had flaws, it was a significant cause of the massive expansion of wind power in China. As noted above, and visible in Figure 6, from 2003 to 2009, China went from less than 600 MW capacity to over 25 GW (GWEC 2011). From 2005 to 2009, capacity was doubled each year. China now has the largest deployed capacity of any country on the planet (WWEA 2009). While national wind concessions only accounted for a portion of the capacity growth, the experiences with concessions at the province level provided a basis for the establishment of approved prices within the provinces (Li, Shi, and Hu 2010), which in turn informed the fixed price approach for onshore wind, which followed the end of the onshore wind concession policy.

Furthermore, the concession program did appear to contribute to bringing down the price of wind energy. A comparison of concession and non-concession projects in 2006, for example, shows that on average concession projects were significantly cheaper than their Approved Price counterparts, with concession projects costing an average of 0.43 RMB/kWh to an average cost of .71 RMB/kWh for non-concession projects (Li et al. 2006).

Figure 7: Success of Policies to Promote Local Manufacturing: Share of Cumulative Installed Wind Equipment Capacity in China



Source: (Howell et al. 2010)

One of the key results of the concession program, with its strong local content requirement, was the development of a strong domestic wind component manufacturing industry. As Lewis and Wiser (2007) have argued, the creation of a domestic market can be critical to the development of an energy manufacturing industry, which is what happened in China. LCRs surely assisted, as had the adoption of pro-manufacturing policies such as the Ride the Wind policy in China in the late 1990s.

The demand growth for wind power manufacturing meant that China went from having one of its companies, Goldwind, ranked 15th in the world in 2004 (Lewis and Wiser 2007), to having four manufacturers within the top ten in 2010 (GWEC 2011). Similarly, where the cumulative share of locally-produced components was 18% in 2004, by 2008 this had risen to over 60%, as seen in Figure 7 above (Howell et al. 2010).

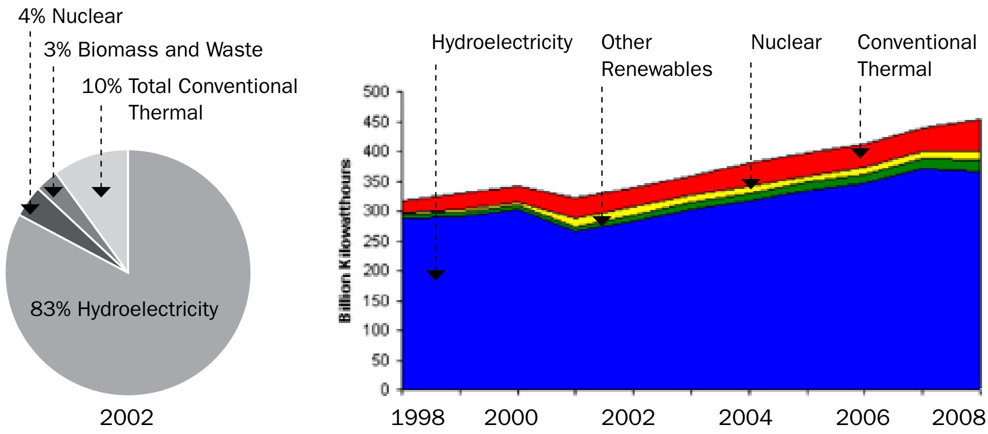
Despite these successes, China did not effectively learn the principal lesson of the British NFFO: address underbidding. Underbidding remained a pervasive problem in the concession program. While in later rounds of the concession project criteria besides price were taken into account, the lowest price continued to prevail. Private and foreign investors were driven from the market (though foreign investors appeared to have been discriminated against in the Concession program regardless). As a result, the companies that bid were State Owned Enterprises that were able to count on financial support from their parent company, which were funding them through fossil-fuel profits (Li et al. 2006, 27). While this cross-subsidization may ensure deployment, it frustrates attempts to analyze the policy's cost-effectiveness, undermines the goal of finding the "true cost" of wind power, deters foreign investment, and indicates a structure incompatible with a fully competitive electric generation system.

Section 4: Brazil's Wind Auctions

4.1 PRELUDE TO THE AUCTION AND BRAZIL'S PROINFA SCHEME

Brazil's electricity supply is dominated by renewables. Unlike a number of other countries with large amounts of greenhouse gases they are seeking to abate through a transition to RES-E, Brazil is blessed with plentiful hydropower resources, which it has successfully developed. In 2002, when Brazil's Programme of Incentives for Alternative Electricity Sources (PROINFA) scheme began, only 10% of Brazilian electricity was being generated through conventional thermal electricity, while 83% came from hydropower (EIA 2011). Thus, use of renewables for abatement of greenhouse gases only becomes apparent if we take into account Brazil's desire to diversify its generation mix, in which case the use of renewables avoids the addition of conventional thermal capacity.

Figure 8: Brazil's Electricity Generation by Source, 2002 and 1998-2008



Source: EIA

First established in 2002, the PROINFA scheme was an attempt to spur renewable energy development and increase the share of renewable energy to 10% of the electricity supply by 2020. The goal was to stimulate the addition of over 3,300 MW of renewables, to be divided equally among small hydro, wind power, and biomass. Under the program, Electrobrás, the state-owned electricity company, purchases renewables at pre-set preferential rates ("economic values"). PROINFA contracts last for 20 years, and accepted projects are eligible for special funding through the Banco Nacional de Desenvolvimento Economico e Social (BNDES) (IEA). The program also allowed large consumers (demand of 500kW+) to contract directly with renewable generators for their electricity.

Following an unsuccessful attempt at restructuring in the electricity sector in the 1990s, and an energy crisis in 2001-2, regulatory changes were made to Brazil's electricity sector in 2004. These changes led many of the country's PPAs to be secured through a competitive bidding process. In 2008, it began using auctions specifically for renewable sources of energy.

The electricity crisis of 2001-2 was a wakeup call for Brazilian energy authorities. Decreasing water storage levels over nine months led the extremely hydropower-dependent country to impose rationing measures. The crisis had significant economic repercussions, and had an influence on the 2002 presidential election, in which the leader of the opposition, Luis Ignácio Lula da Silva, won (Barroso et al. 2006). Blame was fixed on the inefficiencies of the electric system and artificially low prices.

4.2 BRAZIL'S ELECTRICITY AUCTIONS

Electricity auctions in Brazil are not solely a tool for promoting renewables, but part of an attempt to inject stability and generation diversity into the market. In 2003, the Brazilian government proposed a revised power sector model. Under the new model the goal was to look at long-term energy security. As a result, a planning committee was formed with the purpose of looking five years out.

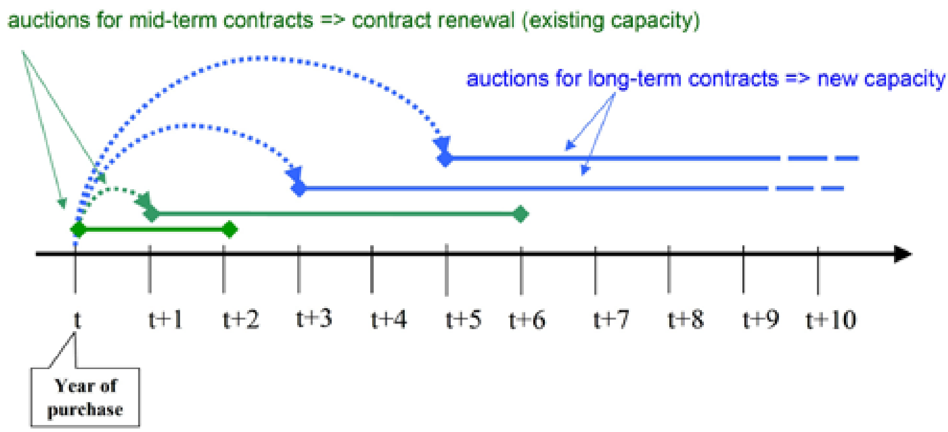
Two basic rules underlined the reforms that were taken under the new model (Barroso et al. 2006):

1. Every load in the system must be backed up 100% by a financial energy supply contract;
2. Every energy contract must be backed up by a physical plant capable of producing the contracted energy in a sustainable way.[6]

The rationale behind the adoption of these rules was to reduce "supply risk" by providing security to potential generators and thus stimulating investment in the generation sector. These obligations fell on distribution companies ("Distcos") and consumers with demands of more than 25 MW, known as "free consumers." Free consumers were allowed to negotiate their own contracts so long as they were 100% contracted, but regulated auctions became the means of awarding these contracts for Distcos, with contracts awarded on a lowest-tariff basis. Contract terms are standardized, and range from 5 to 30 years.

[6] The alternative translation for "sustainable" here is "firm," indicating reliable, rather than environmentally sound.

Figure 9: Existing and New Energy Auctions Products and Delivery Dates



Source: (Barroso et al. 2006)

The auctions are divided into new and existing energy. For existing energy, contracts are awarded to begin the following year, with duration of 5 to 15 years. New energy auctions in turn are divided into main and complementary auctions. Main auctions offer long-term bilateral contracts for projects, which will enter operation in five years' time, giving the project ample time to obtain project financing. Complementary auctions have shorter lead times of three years. Main auctions, with longer lead times, are aimed at allowing the participation of new hydroelectric projects, which provide lower-cost generation than many other sources, but require longer construction times (Barroso et al. 2006). Auctions are organized by the government and carried out jointly by the Distcos, each of whom determines how much electricity they need to contract.

4.2.1 BRAZIL'S FIRST WIND ENERGY AUCTION

Brazil's first wind energy auction was held in 2009, hosted by ANEEL, the country's electricity regulatory agency. 71 projects were contracted for a total of 1,800 Megawatts (MW). The price ceiling established by the agency was Brazilian real (R$) 189 (USD 113.1) per megawatt hour (MWh), but the final average price was R$ 148 (USD 65.3) (GWEC 2011).

In 2010, Brazil hosted another auction — this time for small hydro, biomass, and wind — as well as a second wind-only auction on the same day. Each of the contracts auctioned off had short preparation times — the first auction required the projects to be online within 2 years and three months, whereas the second allowed a lead time of three years (GWEC 2011). The PPAs for these projects were to last 20 years.

There were a series of prerequisites for participation in the wind auction. First, environmental permits needed to be obtained prior to bidding. Similarly, the investor had to present grid access approval issued by the system operator. The investor also had to present measurements of the resource provided by an independent authority.

There are differences between the general auction process and that of the wind auctions. For one, the price of the auctioned energy is paid by all consumers as a system charge (Porrua et al. 2010). Furthermore, the government determines demand for the renewable electricity rather than the Distcos. As such, the auctions are less about meeting a perceived need than they are about promoting a public good.

There are a series of incentives and penalties connected to meeting the established reference annual production. For one, if the annual production is less than 90% of the energy contracted, the investor is responsible for 115% of the contracted price as well as making up the deficit in the following year. In contrast, if the annual production is above 130% of the reference point, the product receives a feed-in tariff of 70% of the contract price and the surplus 30% is accumulated for accounting in the following year. Lastly, any deviation between 90% and 130% is accumulated for four years and can be used in the accounting process of any of the years in that four-year period (Porrua et al. 2010).

Another safeguard in place for the wind auction is the guarantee. The auction requires a deposit of 1% of the candidate's investment costs. Auction winners have this deposit returned when the contract is signed, but are then expected to deposit a 5% guarantee for the project's completion. Auction losers are returned the deposit shortly after the auction (Porrua et al. 2010).

Brazil has undertaken a number of efforts to claim a share of the manufacturing resulting from its wind promotion schemes. The PROINFA project had LCRs of 60% and 90% for its first and second phases respectively (GWEC, ABEEolica, and REEEP 2011). The 2009 wind auction also had a requirement that no imported turbines could be of less than 1.5 MW, though this was dropped for the 2010 auction.

However, Brazil has made special financing available through its central bank to companies contingent upon companies' commitment to manufacture domestically within a short time frame (GWEC 2011) and have at least 60% local content (GWEC, ABEEolica, and REEEP 2011).

4.3 ANALYSIS

Unlike developments in many other countries, the use of an auction for the promotion of renewable energy in Brazil evolved from an existing policy. Whereas others used wind auctions in parallel to either a regulated or liberalized market for electricity, in Brazil the auctions were an extension of the current system.

Given that the wind auctions began only two years ago, it is difficult to make any determinations about their effectiveness in assisting deployment. The conclusions that we can draw herein are based on an understanding of the structure of the auction, based on previously assessed pitfalls.

Perhaps as a result of their experience with auctions, the Brazilian government took prudent steps to address the underbidding pitfall that plagued the NFFO and to a certain extent the Wind Concession Program. While a penalty for breach of contract may seem like an obvious necessity, this provision distinguishes Brazil from the other cases examined. This penalty, combined with the deposits required — 1% and 5% for signing the contract and completing the contract respectively — may create a sufficient deterrent for breach that only serious bids are placed.

Also noteworthy is the frontloading of work within the context of the auction itself. The requirement that companies come to the auction with a submitted feasibility study and environmental approval helps to keep away the less serious bidders. This indicates an understanding of potential pitfalls in a reverse auction process, and should help to address underbidding, a problem in both of the previous cases, as well as the permitting challenges, which created insurmountable delays for NFFO projects.

Lastly, Brazil's auctions have successfully attracted foreign investment into the country to create a manufacturing base. While traditionally only Wobben Windpower, a subsidiary of the German company Enercon, has been present in Brazil, with the 2009-10 wind power auctions, Alston, Gamesa, GE Wind, and Siemens entered the market (GWEC 2011). As a result of positive results obtained in the 2009-2010 tenders, General Electric, Alstom, Vestas, Siemens, Suzion, and Guodian United Power have all announced investments in Brazil (GWEC, ABEEolica, and REEEP 2011). Though no guarantee is offered for the length of the programs, these investments indicate confidence on the part of industry that Brazil is committed to growing its wind deployment.

The first auctions look to be promising with regards to price. In the 2009 auction, prices averaged R$ 148/MWh, which was significantly lower than the price ceiling of R$ 189/MWh. The following year's average price was lower, reaching R$ 134/MWh. Another auction the same year saw prices of R$ 123/MWh (GWEC 2011). Initial price reduction may indicate familiarization with a new policy rather than actual cost reductions. However, if further reductions in price come without a cost deployment, it will indicate strong policy design.

Section 5: Analysis and Comparison of Cases

5.1 RESULTS

Reverse auctions have come out of a number of different policy situations and goals. In the United Kingdom, the NFFO emerged from a combination of environmental concerns, a desire to support the nuclear industry, and a goal of privatization. China has sought to reduce its carbon intensity as well as promoting a robust domestic industry for renewable energy components. Brazil's goal is largely to diversify its energy portfolio.

Table 3: Comparison of Cases

	United Kingdom	China	Brazil
Years Active	1989–1998	2003–2009	2009–present
Site choice	Developer	Government	Developer
Permitting	By developer, after award	By government, after award	By developer, before award
Technologies covered	Solar, Landfill Gas, Municipal and Industrial Waste, Biomass	Wind	Wind, Biomass
Prerequisites for bidding	N/A	Local Content Requirements	Deposit, Environmental Impact Assessment
Penalties	None	None	Developer pays difference between contracted generation and actual at 115% of contracted price, makes up difference following year
Simultaneous policies	None	Approved prices policy, RPS	Preferential financing, PROINFA
Successor policy	Renewables Obligation	Feed-in tariff, wind bases	N/A

Source: (Mitchell 1995; Barroso et al. 2006; Azuela and Barroso 2011; Porrua et al. 2010; Mitchell 2000; Liu and Kokko 2010; Li et al. 2006; Li, Shi, and Hu 2010; Lewis 2004; GWEC 2011)

Reverse auctions can be useful for reducing the price of renewables. In each of the three cases examined above, tenders were accompanied by a reduction in the domestic price of electricity from renewable sources. In the UK, prices dropped until they were approximately half that of the prices in Germany's feed-in tariff. In China, the average price for a concession project was 0.47 Renminbi (RMB)/kWh, whereas the average for a non-concession project was 0.71 RMB/kWh (Li et al. 2006). In Brazil, auction prices for wind have decreased significantly, from 148 R$/MWh (Porrua et al. 2010) in the first auction to R$ 123 in the most recent (GWEC 2011).

In the design of a reverse auction, however, the clearest danger is that of underbidding. Underbidding was visible in both the British and Chinese experiences. In China, the lowest-bid wins criterion was theoretically replaced by one in which other criteria were taken into account, but this was largely ineffectual. In the Brazilian case, a combination of penalties and incentives appear to make the beginnings of a powerful mechanism for preventing underbidding. By requiring more work on the front end, and imposing penalties for failure to provide the anticipated quantity of generation, Brazil's auctions establish a number of obstacles to deter speculative bidding. Enforcement of these provisions will be critical to ensuring effective functioning of the policy.

Interestingly, the tendency towards underbidding indicates that collusion has not been a significant problem in any of the cases in which we have seen realized auctions (China and the United Kingdom). While there is little literature that directly addresses the question of reverse auctions, the theory should be similar in many ways to that of standard uniform-price or ascending auctions, in that the bidders have a common interest in a high price per kWh. Auction literature universally notes collusion, whether explicit or implicit, as a potential challenge to the efficiency of an auction. In the case of the United Kingdom, this lack of collusion may have come from an unexpectedly high demand (Kettle 1999) or as Mitchell has called it "pent-up" demand resulting from an insufficiently high total cost cap (Mitchell and Connor 2004). In China, there was a certain prestige associated with winning a concession project (Sinton et al. 2005), which may have led to decisions made on other than purely economic terms. While some foreign bidders were driven off, many non-local bidders saw the concessions as an "in" to the market (Lewis 2004), and thus had an extra incentive to ensure that they were not left out. The fact that prices have dropped in the Brazilian case would imply no significant collusion to maintain high prices.

As a demand instrument, reverse auctions can be a useful tool in the development of a local market for manufacturing of components. The clearest example of this is China, where wind concessions had a high local content requirement. China went from having one of its developers of turbine equipment ranked #13 in the world in 2004 (Lewis and Wiser 2007), to having four companies in the top ten (GWEC 2011). In recent years, all of the major companies in the wind manufacturing industry have been establishing factories in Brazil. However, in the UK this did not materialize (Mitchell 2000). This is partly a result of the inconsistent time frame for auctions, as staggered and unpredictable Non Fossil Fuel Orders did not provide the certainty necessary for long-term investment, but also likely reflects insufficient size. Furthermore, the NFFO did not include a local content requirement. While an explicit provision may have been precluded by EU state aid rules, many Spanish regions successfully tied support for local manufacturing to their renewables energy promotion policies (Mallon 2005).

The experiences represent different approaches toward developing a local manufacturing base. China's auctions included a significant and rising local content requirement, starting at 50% and rising to 70%, prior to being abandoned as a result of a joint agreement with the United States in 2009. Brazil set a 60% goal for local content, and has allowed foreign companies, such as Gamesa, Alstom, GE Wind, and Siemens to enter the market and obtain financing from the national bank as a result of their participation in auctions and commitment to manufacture turbines within Brazil in a short time frame (GWEC 2011).

Reverse auctions are attractive because they can help to deliver financing. Long-term PPAs, which have been the norm in renewable reverse auctions since the NFFO, lessen risk in two ways. In picking individual projects, which are then provided a PPA, the bank can lessen the risk that the firm will be unable to sell its product. Likewise, the project is largely insulated from volatility in the price market. When combined with special programs for financing, such as those provided by Brazil's central bank, project risk is reduced significantly.

The policy environments and sequencing within the three cases studied vary significantly. In both the United Kingdom and China, auctions systems were ultimately replaced by another form of policy. In the UK this was an RPS, whereas in China it was a feed-in tariff system. Brazil presents an alternative narrative, however, where a less-successful subsidy system has led to the adoption of a series of auctions, which appear to have been well-designed, well-attended, and may well satisfy policy goals. Similarly, the British adoption of an RPS appears to have led to more consistent growth in the renewables in the electricity mix.

The above analysis has been performed on the basis of the policy-level consideration involved in the auction product, such as contract lengths, penalties, and other project-level considerations. Further research might examine how different bidding processes affect outcomes, specifically within a context of renewable energy.

5.2 WHEN DESIGNING A REVERSE AUCTION…

From the above, we can extrapolate some policy guidelines to consider if and when designing a reverse auction. Among these are policy interaction, permitting, deposits and penalties, and how the increase in demand can be translated into growth of a component manufacturing industry.

A reverse auction can be used to complement other policies in force for the promotion of renewables. This policy interaction can be either direct, as in the case of the CDM, or indirect. An indirect policy interaction can occur, for example, when two policies contribute to the development of a domestic wind turbine manufacturing industry. This combination will likely bring down the price of projects being brought online through another complementary system. In the Chinese case, the auctions existed in parallel with an "approved price" policy, and interacted in that they worked together to create enough demand to encourage a local manufacturing industry, which in turn reduced costs.

Related to the policy interaction issue is the question of permitting. While it may not have been the root cause of the issue in the NFFO, environmental permitting created a significant obstacle to the realization of a number of the NFFO projects. China was able to make this less of an issue by having the government manage the rental of the land and the permitting. If this is done prior to the auction, this makes the process even more streamlined. In the Brazilian case, in order to bid, the company was required to obtain the permits and feasibility studies prior to being able to submit a bid. Not only does this make the process more efficient, removing potential obstacles to the realization of the project, but it can help to keep less-serious bidders out of the running.

Bidders need to have a financial stake in following through on a won bid. Though this seems self-evident, the NFFO did not have a penalty clause. Without a sufficiently large penalty and/or a deposit on the line, companies are free to submit best-case scenario bids to give themselves an option for development, as well as prevent a better-situated competitor from getting the contract.

Many countries' renewable energy goals include the development of a domestic manufacturing base for renewable components, getting a piece of a growing market and creating jobs. Policy options such as local content requirements can lead to the development of a domestic industry for renewable components. Lewis and Wiser have indicated, "Direct support for local manufacturing — through local content requirements, financial and tax incentives … — has proven particularly beneficial in countries trying to compete with dominant industry players" (Lewis and Wiser 2007).

Though local content requirements have been effective in developing a manufacturing base for renewables, they may be slowly disappearing as a policy option. While LCRs appear to violate both Article III of the General Agreement on Tariffs and Trade (GATT) ("National Treatment of Internal Taxation and Regulation") and Article XI on quantitative restrictions, thus far few disputes have been brought against them. Spain, Brazil, Canada, and China have all simultaneously been members of the World Trade Organization (WTO) and had LCRs active for renewable energy technologies. In the cases of Spain, China, and Brazil there have been no formal disputes under the WTO. However, Japan, the US, and EU filed a challenge to Ontario's Green Energy and Economy Act in 2010 (Hao et al. 2010, 15; ICTSD 2011). In the case of Canada, Article III: 8(a) of the WTO provides a potential escape, as it provides an exemption from the national treatment requirement for the purpose of government procurement (Hao et al. 2010, 16). While these exceptions were waived by the parties to the Agreement on Government Procurement (GPA), when Canada signed the GPA it stated that its provinces would not be bound (Hao et al. 2010). While Canada's case is somewhat unique, this defense is significant as a large number of countries are members of the WTO, but not parties to the GPA. If, as both Lewis and Hao et al. have indicated, the small size of the industry is a reason for the lack of trade disputes (Lewis 2007; Hao et al. 2010) we can expect to see more disputes as these markets grow. The recent US Solar Manufacturers requests that the US take anti-dumping measures against China, as well as the Japan-EU-US complaints against Ontario, and a December 2010 United States Trade Representative's accusation against China's Special Fund for Wind Power Manufacturing indicates that this moment is arriving.

Section 6: Implications for the United States

While the United States has a number of policies for the deployment of individual renewable projects, it is yet to undertake significant successful efforts to deploy renewables on a large scale at the federal level. Currently, there are residential-level financial incentives such as the Residential Renewable Energy Tax Credit, the Renewable Energy Production Tax Credit (PTC), renewable energy grants through the Department of Treasury, the Department of Agriculture's Rural Energy for America Program (REAP), and the Department of Energy's Loan Guarantee Program, among others (DOE 2011). Recent comprehensive legislative efforts, such as the Kerry-Lieberman-Graham "American Power Act," have failed to drum up the support required for passage.

The idea of using a reverse auction for the promotion of renewables has been proposed in the House of Representatives bill number 909 (H.R. 909), in the context of a gas and energy bill proposed by Republican Devin Nunes. H.R. 909 seeks to "expand domestic fossil fuel production, develop more nuclear power, and expand renewable electricity" (Nunes 2011).

Perhaps the most initially striking element of the bill's attempt to promote renewable energy is that the bill's author, Representative Nunes, is a conservative Republican who outwardly does not believe in humankind's contribution to climate change, his website referencing the "man-made global warming scam" (Climatewire 2011), and including in the bill a section that would eliminate the Environmental Protection Agency's (EPA) authority to regulate greenhouse gases. He thus bases his support for a policy of supporting renewable energy on concern for long-term energy security and uncertainty about the extent of the earth's fossil fuel resources (Climatewire 2011), continuing a tradition of reverse auctions that are not explicitly oriented at emissions abatement, and potentially indicating an area of common concern between the conservative Right and liberal Left in the current Congress.

The bill is analyzed here in terms of whether or not its design is proper for the accomplishment of its goals, given previous experiences with reverse auctions. Goals for any renewable energy deployment policy include increasing capacity and doing so at a low cost. As examined above, we will also look at the ability to create a local manufacturing base, which should in turn create jobs locally — a frequently cited goal of public policy, particularly within the United States.

Connected to the principal goal of increasing capacity, the policy should take care to ensure the principle of additionality; if the goal is to increase renewable energy deployment, to the greatest extent possible, the policy should not support capacity additions that would have happened in the absence of the policy — through state-level policies, for example. There may be valid reasons for replacing one policy mechanism with another — efficiency and reduced cost, for example — though where this is the case these should be indicated.

6.1 ANALYSIS OF H.R. 909 TITLE III

H.R. 909 instructs the Secretary of Energy to create an authority within the Department to conduct reverse auctions for renewable energy. The Secretary shall also appoint a Director of this authority who will be responsible for its operations. The legislation takes into account a number of the issues that we have discussed above, including policy interaction, deposits, and penalties. However, it is the definition of an "eligible entity" that significantly changes the character of the reverse auction and sets it apart from the auctions we have looked at above.

The bill is similar to the NFFO in that it calls for auctions across a variety of technology bands. Subsection (c)(6)(B) states that over the course of a five year rolling average no more than 60% of the funds can be awarded to firms from a particular technology source, nor can 90% come from two or more. It is unlike the NFFO, however, in that it also requires that at least 25% come from small generation and at least 25% come from medium-sized generation, limiting large-scale generation to 50%. This requirement is essentially the opposite of the rationale behind the Wind Power Concession Program in China, which sought efficiency through economies of scale, and as such, had a floor of 100 MW capacity. If the logic applied by China's National Development and Reform Commission in undertaking large-scale concession projects is universal, then the promotion of small and medium-scale generation at the expense of large-scale generation may lead to significant inefficiencies.

The legislation addresses companies failing to meet their obligations by requiring them to put down a deposit. The quantity of this deposit is not specified, and is to be determined by the Director based on the quantity of electricity provided, similar to the Brazilian case. The deposit is to be refunded to firms without a winning bid when the winning bid is announced, and to the winning firm upon completion of the project. Unlike the deposit within the Brazilian auction, there is a single deposit. The implication of this is that, while in the Brazilian system if a firm bids but then realizes that it is unable to follow through on its commitment prior to the signing of the contract, its cost is lower than if it pulls out during the construction phase. Under H.R. 909, the penalty for pulling out at any point between bid and operation is the same, though the Director's authority to establish penalties for non-compliance may change this.

H.R. 909 acknowledges the existence of a number of federal policies for renewable energy, and seeks to isolate the program from them. The bill makes firms taking advantage of the policy ineligible for federal production tax credits for renewable energy, and the facilities shall not be treated as energy facilities for tax code purposes. The facilities are also rendered ineligible for the Department's Loan Guarantee Program. Furthermore, subsection (g), article (5)(A) states that "the contract amount shall be for the amount of the winning bid for the specified amount of electric energy minus the amount of any Federal subsidy received by the eligible entity for the construction, development, or operation of the qualified renewable energy facility before funds are awarded" (Nunes 2011). The limiting of federal assistance to that granted by the reverse auction authority makes sense; if the goal of the auction is to find a least-cost method for the promotion of renewable deployment, additional federal assistance would distort the results of the action.

While the bill does not make any direct mention of state policies, the two criteria stated for selection of awarding funds in (b)(6)(a) include i) price per MWh and ii) existing subsidies. While it is not expressly stated, the implication is therefore that all projects should be on equal footing, though this puts the determination at the discretion of the Director.

Finally, and perhaps most consequential for the program, is the definition of an eligible entity. According to subsection (i)(4), an eligible entity is "the owner or operator of a renewable energy facility that, with respect to such facility —

A. Is not participating in a Federal Loan Guarantee Program
B. Has a power purchase agreement in place at the time of the reverse auction"

This appears to indicate that the reverse auction is to be a means of providing subsidies for existing projects, rather than ones in the development stage, in contrast to the other reverse auctions examined above. This could seriously hinder the legislation's ability to create new generation for renewables. Where the other reverse auctions examined provided a project developer with assurance of purchase of the product, which can help in finding financing, in this case the developer of the project is required to take on the risk of development prior to being awarded the subsidy. Though the existence of subsidies can lead to the expansion of the renewable sector, a competitively awarded subsidy that can only be applied to an existing facility, appears to put the cart in front of the horse from a new generation perspective.

With a different definition of an "eligible entity," H.R. 909 would satisfy many of the criteria necessary for a successful reverse auction. There are, however, some issues of policy interaction within the states, which the proposed reverse auction does not appear to take into account.

For one, H.R. 909 does not address non-subsidy related renewable-connected policy tools in the states. Examples include interaction with an RPS. Forty-eight US states, territories, municipalities, or utilities currently have some form of RPS (Department of Energy). Where an RPS is present, if energy produced through the reverse auction is allowed to be counted by the utility for the purposes of meeting its requirements under the RPS, it is not clear that the government is helping to advance deployment beyond what would otherwise have occurred. This is especially the case given the eligibility requirements in H.R. 909. While this may be an issue that would need to be left to the states, the federal government should work with the states in development of a reverse auction so as not duplicate efforts and waste money on investments in deployment that would have occurred otherwise.

While the bill makes several references to permitting for nuclear energy, it makes no mention of permitting for renewables. As was seen in the NFFO case, and has been seen in the United States with the Cape Wind project, permitting can be a major obstacle for renewable energy projects. In the 2011 testimony to Congress, Susan Reilly of Renewable Energy Systems America said "In the immediate term, the biggest obstacle the renewable energy industry is facing when it comes to developing renewable energy projects on public (and private) lands is uncertainty relating to permitting" (Reilly 2011). As of the time of this writing, the Obama administration had undertaken a process of fast-tracking permits for renewable energy projects on federal lands, allowing renewable energy projects to be undertaken much more rapidly. While much of the permitting process occurs at the state and local level, this work through the Department of Interior, as well as encouraging federal agencies with jurisdiction over renewable energy projects, such as the Federal Aviation Administration in certain cases, and the Fish and Wildlife Service, to prioritize permitting for renewable energy, by order or legislation, may help to expedite the federal portion of the process.

From a distributional perspective the legislation does not address climate regulatory differences between states such as cap-and-trade systems for greenhouse gases. Two such schemes currently exist in the United States: California's Cap and Trade Program, and the Regional Greenhouse Gas Initiative in the Northeast. These should theoretically make little difference to the fairness or geographical distribution of a reverse auction. A cap-and-trade system is intended to make the price of energy reflect the greenhouse gases it emits. As a result it should make renewable energy more competitive by driving the price of its competitors up, rather than bringing the cost of renewable generation down. This will not make a project within a state with a cap-and-trade system more competitive with respect to those in other states. However, as with the RPS example above, what it might do is lead the government to pay for renewable deployment that would likely have occurred regardless.

The bill makes no mention of any strategy to localize production. As mentioned above, a number of these are illegal under GATT, and though a dispute might not be immediate, an actual LCR could be presented as hypocritical — it would be politically difficult for the United States to demand China drop its LCRs only to adopt its own. However, Lewis (2007) has indicated a potential for making locally produced content a criterion for selection of projects for development, as the legal status of this sort of program is unclear under GATT. Even if this is decided to be protectionist, the Department of Energy's Loan Guarantee or other support programs, if continued and expanded, could be focused toward promoting manufacturing and thus encourage the localization of component production, in support of the new demand created through auctions, similar to what Brazil has done using central bank financing.

In sum, an effective reverse auction in the United States would likely look in many ways similar to the one proposed in H.R. 909. However, it should focus on new, rather than existing generation and should take into account non-subsidy incentives for renewable energies, so as to ensure additionality of new deployment.

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