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Renewable Energy Credits: Prevailing Practices

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Renewable Energy Credits: Prevailing Practices

Introduction

The Renewable Energy Credits/Certificates (RECs), or the similar concepts, have been employed for promotion of renewable energy (RE) based power in several countries. The REC is a relatively new instrument, which essentially proves that a generator has produced a certain quantum of power from a renewable energy source. RECs, used in conjunction with Renewable Purchase Obligation (RPO), offer a way to establish compliance with RPO. The concept was introduced to facilitate a robust and credible market for trading the green attributes of the electricity, with a view to provide an additional source of revenue to RE generators. Therefore, it is hoped that this market may help reduce the cost of renewable energy purchase obligations. RECs are either traded on the mandatory markets or voluntary markets. On the mandatory basis, RECs are used as a market-based instrument to meet the mandatory quota within the specified duration. Here, RECs can also be used to track and verify compliance to RPO.

RECs (or RECs equivalents) in many cases are created and defined by statue as part of the Renewable Portfolio Standard (RPS) in countries such as US [18], Japan [28] and Australia [29] or as part of the similar Quota schemes in countries such as UK [27]. Renewable energy sources eligible for the certificate, and degree of freedom in trading RECs, vary from country to country (or states).

There have been many discussions on the effectiveness of RECs in achieving quotas in an economical way. It is often compared with Feed-in-Tariff mechanism that is considered a non-market, but subsidy type instrument. However, it may be too early to draw final conclusion of its effectiveness. Presently, REC's market predictions and analyses are made based on the minimal past experiences or the theoretical simulation models.

The following sections cover the definition, international experiences related to RECs, their pricing and markets.

Overview of RECs mechanism

"Renewable Energy Credits" is one of the several names for "Renewable Energy Certificates". Other names that represent

fundamentally the same idea are “Green Tags”, “Tradable Renewable Certificates”, “Tradable Renewable Energy Credits” (mainly in USA), Renewable Obligation Certificate (in UK), “Tradable Green Certificates”, “Green Electricity Certificates and “Green credits” (mainly in Europe).

A REC is aggregation of non-energy and societal beneficial attributes (e.g. environmental and socio-economical benefits) of a quantifiable unit of RE power production, represented as a tradable product.

Though most mechanisms are similar, detailed rules relating to RECs such as ‘tradability’ of certificates, the quota, penalty and duration given to meet the quota of RPS differ depending on the countries and states. The following section presents a brief overview of such practices in Japan, Australia, UK and USA (Texas).

Japan

RPS law in Japan formally called “Special Measures Law Concerning the Use of New Energy by Electric Utilities” has been in force nationwide since April 2003 [28]. Japanese RPS law requires electric power retailers to obtain a certain percentage of their sales from new energy sources (new energy by definition in Japan is the renewable energy sources that are still not economical). The Ministry of Economy, Trade and Industry (METI) sets annual targets of utilization of RE electricity. The target for 2010 is 12.2 TWh, which equals 1.35% of national electricity supply. Eligible sources are solar, wind, small and medium-sized hydro (< 1 MW and without a dam), geothermal energy using vapour recycling technologies, biomass, and organic waste [42].

The retailers have three options to fulfil their obligation:

- Generate electricity from new energy sources by themselves
- Buy electricity derived from new energy sources, generated by other parties
- Buy a part of the obligations fulfilled by other parties in the form of transaction of applicable amount of New Energy Electricity i.e. "New Energy Certificates" from another party.

"New Energy Certificate” is the amount of RE that has been generated and supplied by an accredited facility. This account is managed by the government and only the new energy electricity generators and electricity retailers are permitted to open the account. In order to acquire a "New Energy Certificates”, the new electricity generator or purchasing retailer makes a submission to the government whereupon acceptance of the submission, government records it as a “New Energy Certificate” in the electronic account. This is done on a quarterly

basis. After that it is possible to sell the Certificates to other generators and retailers. The certificates are recorded in units of 1 MWh and an ID is attached to each unit. The “New Energy Certificate” is valid for a period of 2 years, including the year in which it was generated (referred to as 'banking') [42]. This is quite similar to the tradable green certificate system introduced by other countries [4].

The electricity retailers are required to follow the following procedure:

- Submit their obligation amount of electricity from new energy to the METI by June 1st of each year
- Fulfil their obligation to use a volume of new energy electricity in excess of the obligation amount.
- Make a submission by the following June 1st as to the status of the fulfilment of their obligation.

If there is a shortfall of up to 20% of the obligation amount, the shortfall may be carried over to the next period (referred to as 'borrowing').

Non-compliance with the interim and final targets is subject to penalties of up to Yen 1 million. The price of certificate is determined through a relative trading between the retailers. Upper limit is set as Yen 11/kWh but no floor value is set.

Apart from the certificates that are traded in a controlled environment by the government, there is a voluntary scheme called `green power certification system’ in which the Green Power certificates are traded. This system is managed by Japan Natural Energy Company Limited, a company funded by several power companies, banks, and trading companies. It receives requests for power generation service (from natural energy sources) from corporate consumer and then carries out the power generation by itself or entrusts it to a subcontractor (power generation companies). The consumer receives a "Certification of Green Power" according to the amount of electricity generated as a proof of achievement of environmental protection measures. The power generated is sold to regional electric power companies. A neutral third party (called Green Power Certification Council) certifies the actual record of natural energy power generation [48].

Australia

Australia’s Mandatory Renewable Energy Target (MRET) was implemented through Renewable Energy (Electricity) Act 2000 and Renewable Energy (Electricity) (Charge) Act 2000. The MRET scheme, commenced on 1st April 2001, requires all electricity retailers and wholesale electricity buyers to contribute towards the phased target of 9500 GWh of extra RE

electricity generation per year by 2010, after which this target is to be maintained until 2020. All renewable energy sources are eligible. The office of Renewable Energy Regulator was established to oversee the implementation of this measure [44, 46].

A certificate is created from accredited and registered 1MWh of 'new' renewable electricity generation, where 'new' means the generation from new generators or increased output from existing generators [29]. Certificates can be traded in financial markets that are separate from the physical National Electricity Market. Liable parties are required to annually surrender renewable energy certificates equivalent to their requirement to the Regulator and then that certificate expires. Certificates can be banked for use in the future. However, the borrowing of certificates is not permitted. The penalty for non-compliance is set at AU$40/MWh that is reimbursable if the shortfall is made up within the next 3 years.

MRET was the world's first mandatory renewable energy target, and has also already gone through the detailed assessment by a committee appointed by the government. The assessment started in March 2003 and findings were released on 16th January 2004 [46]. Australian government reconfirmed its commitment to MRET with some improvements such as the enhancement of market transparency, increase of opportunities for bio energy and solar technologies, and improvement of business certainty; however with the same target and the commitment period [44]. This is despite the recommendations that the target should at least be raised to 205,000 GWh in 2010 just to maintain the 'additional 2%' ('additional 5%' was recommended for the renewable energy industry to maintain its operation) and the end date of schemes to be extended by 15 years [46].

United Kingdom

The Renewables Obligation (RO) is the successor of the Non-Fossil Fuel Obligation (NFFO). NFFO was the major instrument to encourage growth within the renewable energy industry before the introduction of RO. It was applied in England and Wales and provided premium payments for electricity derived from renewables over a fixed period, with contracts being awarded to individual generators. Although no additional NFFO contracts will be awarded, NFFO projects are currently operational and existing NFFO contracts will continue in their present form. Electricity from generating stations built under the NFFO arrangements will be eligible for the RO if it meets the requirements of the RO. The Non-Fossil Purchasing Agency sells the electricity output generated under NFFO contract into the market. Renewables Obligation Certificate ROCs will be

used to offset the cost of these contracts to consumers through the Fossil Fuel Levy.

RO is enforced by an Order (Statutory Instrument) made under the terms of the Utilities Act 2000. The Order was introduced in April 2002. The Obligation was introduced after an extended period of consultation with the industry, consumers and other interested parties[1].

The RO requires licensed electricity suppliers to source RE electricity at an annually increasing percentage. The target for 2005-06 is 5.5%, increasing up to 15.4% by 2015-16. All types of renewable sources are eligible except for Hydro exceeding 20 MW declared net capacity, Co-firing of biomass and energy from waste, for which some conditions apply[2]. Renewables Obligation Certificates (ROCs), which are the tradable certificate, are issued for each megawatt hour of electricity generated from renewable sources. Office of Gas and Electricity Markets (OFGEM) administer the scheme, which includes monitoring the compliance, issuing and tracking the ROCs on behalf of DTI. An obligation period runs from 1 April to 31 March each year. The suppliers can meet their obligation by either

- Purchasing ROCs, or
- Paying a buy-out price of £30/megawatt hour, or
- A combination of above two options.

Suppliers are required to produce evidence by one of the above option to OFGEM of compliance with RO before a specified day each year (for example 1 October 2005 was the specified day for 2004 -05). The buy-out price paid by suppliers goes into the buy-out fund. At the end of the 12-month Obligation period, the buy-out fund is recycled to ROC holders. Suppliers will be subject to a renewables obligation until 31 March 2027 [50].

Texas, US

In US, 21 states and the District of Columbia have adopted RPS with varying target values, ranging from 1% [54] to 30% [34] within an implementation schedule varying from 5 to 20 years [23]. Eligible renewable sources also vary from state to state. Compliance Markets are created when the state passes RPS and currently only limited numbers of states allow RECs trading. In November 2004, out of 21 states that enacted some form of RPS; only Texas, Wisconsin [39] and the North East Power Pool (NEPOOL) - already equipped with REC tracking system that support the REC trading - were considered to have formal “compliance REC markets”. Others states were still in the

[1] http://www.dti.gov.uk/renewables/renew_2.2.3.htm
[2] http://www.dti.gov.uk/renewables/renew_2.2.1.htm

development or establishment stage, as their markets neither allow REC trading for compliance purposes nor are equipped with the tacking systems [2]. By October 2005 [40], tracking system in Pennsylvania, New Jersey, and Maryland control area was also operational.

According to the definition on the website of Energy Efficiency and Renewable Energy of U.S. Department of Energy [18], RECs represent the environmental attributes of the power produced from renewable energy projects and are sold separately from commodity electricity. Customers can buy green certificates whether or not they have access to green power through their local utility or a competitive electricity marketer. And they can purchase green certificates without having to switch electricity suppliers. It is to be noted that this definition of RECs does not accurately apply to all states in USA as in the case of CA [16], trading of green certificate separate from the electricity is not allowed.

Amongst several RPS systems that allow RECs trading, Texas's RPS system has often been referred to as the well-designed RPS [30]. The Texas RPS came into effect in January 2002. RECs have been mandated as part of Texas' electricity deregulation requirements. Electricity generators are granted RECs in direct proportion to the megawatt hours (MWh) of RE power produced. In turn, all retail electricity providers in Texas are required to hold RECs based on the level of their annual retail electricity sales in the state [2]. Each year, the Electricity Reliability Council of Texas (ERCOT, responsible for the power grid) allocates RECs to renewable power generator. Then ERCOT assigns REC holding requirements to the retail electricity providers (REPs). The exact REC requirements for each REP are posted on March 1st of the year, which is one year after the year in question [2]. ERCOT hosts a tracking system of RECs [25]. In fact in May 2001, Texas established web-based platform that allows the issuance, registration, trade and retirement of RECs [30]. Penalty for under-performance is 5 US cents/kWh [30].

The salient features of the Texas system are as follows [2]:

- Instead of setting incremental targets each year in percentage, it mandates the absolute quantity (2000MW of new renewable capacity to be built in Texas by 2009 with a goal to have 10,000MW by 2025 [25]
- Existing renewable energy facilities are given a status, what is called as 'REC offset', in order to prevent competition between existing renewable facilities and new facilities constructed under the RPS law. REC offsets may be used to meet compliance obligations, but

may not be traded nor banked for the future use. REC offset are calculated based on the ten-year average energy production and are issued annually.
- REPs are allowed to purchase only the RECs without the associated power. RECs are valid for 3 years [2].
- RECs can be from anywhere in Texas and can be from any type of renewable sources [25].
- Price of RECs is the same regardless of resource type unlike most of other states in US.

Price of Texas RECs was US$11.50 in 2004, whereas in 2005 it was US$10.75 [25]. There is no on-line trading platform for RECs and typical transactions are through Brokers, Auctions, Bilateral trades, and Power Purchase Agreements. Most of the trading is through spot transactions, but forward agreements are also becoming popular. Strip contracts are becoming more attractive for buyers now that adoption has occurred and hedging is becoming a more common practice [25]

The assessment of Texas RPS conducted by Langniss and Wiser [30] in 2003 attributes the early success of Texas RPS to the following factors:

- Strong political support and regulatory commitment
- Predictable long-term purchase obligations that drive new development and economy of scale
- Credible and automatic enforcement through strong penalties
- Flexibility for the suppliers to meet obligations in a cost effective manner, through mechanisms such as banking and borrowing of RECs; and providing early compliance period

The aforementioned study also states that though certificate trading may not be essential for the effective design of a state RPS, and little trading has yet taken place in the Texas market, a REC system should ease compliance demonstration and tracking, improve liquidity in the market, provide additional flexibility to suppliers, and lower the overall cost of policy compliance. In fact, they argue that the following conditions played important roles in the early compliance of Texas RPS:
- The outstanding wind resource in Texas
- Federal production tax credit (PTC) - that made wind power in Texas nearly competitive to new natural gas facilities even with relatively low natural gas price
- The fact that the PTC was not to be extended after the end of 2001 and the resulting fear of REC prices hike, provided strong incentive for early RPS compliance and long-term contracting between REP and renewable energy projects

- The state's favourable transmission planning and costing approach

It is also pointed out that Texas RPS was largely supporting wind power - the lowest cost renewable in the states while other states in US had developed additional policies to ensure a diversity of renewable energy sources.

More recently, Toke [15, 35] argues that the success of Texas RPS was largely dependent on its modest RPS target, good wind regimes, and the fact that utilities rushed to construct wind power due to uncertainties over the federal tax issue rather than the design of the system.

Apart form compliance market - as described in the Texas example - voluntary markets for "green power" are supported by many companies, government agencies, and private consumers of US; either buying directly or through a variety of voluntary retail programs. Purchases are usually RECs-based, and rely on certification programs that certify (i) the origin of generation from 'claimed' renewable sources and (ii) that there is no double counting of RECs [2]. Currently there are more than 40 active green power marketers at the wholesale or retail level in USA for both green product and renewable energy certificates [18]. Various retail certificate products generated from variety of renewable energy sources are available.

Characteristics of RECs

The key aspects of RECs in the US context are listed below [19]: Retail electricity providers who may not own or operate generation assets can meet their portfolio requirement by purchasing the RECs.

1) RECs give utilities the opportunity to meet their portfolio requirements in cases of temporary and unexpected short fall in a given compliance period (due to cases such as equipment failure, sudden increases in demand, poor renewable resource availability or faulty equipment design.)
2) With the possibility of purchasing RECs for a few years, electric utilities gain extra time to plan for investments in their own renewable generating facilities.
3) RECs may lower the costs of meeting a portfolio standard because due to the cost differences in renewable energy projects from place to place, utilities can shop around for more efficient and cost effective suppliers. Another source of cost reduction is economies of scale where a large project can serve several utilities' portfolio requirements.
4) RECs enable transmission of benefits of renewable energy sources to the distant locations.

5) However, acquiring RECs without generating the corresponding kWh locally does not provide visible renewable energy generation resources and environmental benefit associated with it for a community.
6) RECs markets are valid only within the area where the underlying regulation or legislation permits resources to be eligible for a portfolio standard. Therefore, RECs of one state may not necessarily be used in other states.

RECs Tracking

With the well designed RPS system, RECs are useful instruments for implementation of RPS. Being a facilitating tool; RECs give the market credibility, and their use makes it easier to have a regional, national or even international markets to comply with local, state or national standards. In this context, well-designed RPS refers to the RPS combined with RECs mechanism that is equipped with a `RECs tracking system' to provide credibility by (a) tracking, monitoring, and verifying RE power generation and (b) by ensuring that the REC corresponds with the requirements of regulations and the law [53]. REC tracking systems are also helpful in addressing the following issues associated with the trading of RECs [39, 53]:

- Inter-temporal transactions: Transactions of RECs that were created in previous years (banked RECs) or that to be generated in future years (borrowed RECs).
- Double counting: Use of REC by more than one party at the same time or by one party for more than once. This may take the following forms:
    - Double sale: A REC is sold to two different parties at the same time
    - Double claim: More than one party claims the renewable benefits from the same REC
    - Double use: A single party owns the REC and uses it for two purposes, such as for RPS compliance and to support a voluntary green marketing claim or for a green marketing claim and to earn emissions reduction credit

Several issues relating to the design and functionality of tracking systems were identified based on the exiting tracking systems in operation. Issues include geographic scope; ownership in terms of costing and housing; as well as coordination and scope of functionality of the tracking systems [39].

Discussions

Renewable Energy Feed in Tariff (REFIT) vs. Quota/Certificate

The comparison of the EU renewable energy programmes between 1993 and 1999 reported by European Environment Agency in 2001 [51] describes that countries that guaranteed fixed purchase prices of wind-generated electricity, namely Germany, Denmark and Spain, contributed 80% of new EU wind energy output during the period.

As Reiche writes in 2002 [20], "it is questionable to assume natural superiority of any instrument without a full evaluation of schemes.....Though the feed-in tariffs have been successful to expand the wind energy use in Germany, Spain and Denmark and viewed as one of the favourable schemes, there are also many countries with feed-in tariffs that were not so successful in the wind energy sector, like Finland and Greece. The main difference is that the country that uses feed-in tariffs successfully offers investors a long-term security. Germany, for example, guarantees investors the feed-in tariff for a period of 20 years. In Netherlands, not only the systems but also the frequently changing regulations gave little security to the investors."

Yet, in recent years [14], debate has been emerging over the effectiveness of what is classified as two different policy paradigms especially in EU context "subsidies or quota". Though the first round winner seems to be the feed-in system having one big advantage of being low risk, it may yet be too early to make final judgment since no quota/certificate systems such as in a form of RPS and RECs have existed for long enough. It is also argued [3] that successful results in Germany, Spain and Denmark under feed-in laws plus the problems experienced in Denmark (when it tried to switch from a feed in tariff to a certificate trading system which was later abandoned) suggest that 'feed-in' schemes work better than Quota/Certificate mechanism adopted by Ireland and the UK. However they also argue that, REFIT type subsidies should not be extended forever and that while they are useful at the early stage of a technology's commercial history, they can be progressively withdrawn as the technology matures.

Toke [15] argues that as for the RO system in UK, its ability to achieve the target is doubtful because electricity suppliers would want to avoid situations where there is an over-supply of RECs leading to a crash in the price of and market of RECs. Wiser et al. [38] points out that one of the most important factors for the success of a feed-in policy is its ability to create a stable environment for the industries because the feed-in policy is

integrated into long-term planning with other policy options, such as favourable tax treatment. Mitchell et al. [31] compared RO and the feed-in system in Germany in terms of three types of risks, namely price, volume, and balancing risks. German feed-in system is superior in terms of reducing all three risks. Dinica [37] argues that rather than the type of support instrument, it is the risk/profitability characteristics of the instruments that influence investor behaviour and the rate of diffusion. Thus even the feed-in tariffs could results in disappointing diffusion if poorly designed.

Finally, another perspective to be considered when comparing two schemes pertains to the establishment of a common European market for electricity at the end of the liberalization process that is currently taking place at national level. As discussed by Ringel [22], in the electricity market with fully open borders between countries, certificate models would support most efficient suppliers of renewables better. In case of feed-in tariffs, subsidized renewable sources would be competing with each other in the market. As most of the consumers would opt for cheapest electricity provider, advantages would be on the side either of those energy types with high support tariffs and/or those countries with favourable natural conditions for renewables. Toke [35] points out that the integrated market may drive the investments to most cost effective schemes or sites and some member countries may consider the local social and environmental benefits of locating renewable outweigh the reduction of cost.

Despite feed-in tariffs being illustrated as first-round winner in many articles, general trend (not only in EU) has been to move towards market-based schemes. Eurelectric has been critical of German feed-in tariff for the cost-ineffectiveness and favours market-based frameworks and called for pan-European market in tradable green certificates [15].

According to Energy Project [3], UK is committed to continue with the Renewables Obligation, as UK's Renewables Innovation Review published in 2004 points out the contrasting success of the UK approach in terms of deployment of generation capacity, compared to that in Germany and elsewhere using REFIT type schemes. It is suggested that a' funding gap' for new renewable technologies could be filled by an expanded grant scheme, therefore, what could be emerging is the system which combines the Renewables Obligation, as a mechanism for ensuring market competition and certificate trading for operators; with a grant system to stimulate private sector investment in novel technologies.

Though Denmark failed to introduce green certificate in 2003

(described in section 3 of this report), it is interesting to note that in 2005 annual report by Danish Wind Industry association [1] lists Nordic green certificate scheme as one of the recommendations for the further expansion of wind generated electricity ("an efficient market place for renewable energy where wind power is paid for its environment benefits, for instance by means of a Nordic green certificate scheme").

The state of California, a state with one of the higher renewable energy target in USA (20% of electricity from renewables by 2017), currently does not allow RECs to be traded separately from the associated renewable electricity. The California Energy Commission favours the trading of RECs [16] while acknowledging issues associated with unbundled RECs, such as environmental justice, market manipulation, or double counting. The reasons to support the unbundled RECs include (a) it would assist utilities that have fewer local renewable resources to meet the state's renewable energy goals in the future and to reduce the need to add transmission lines, relieve transmission congestion, and (b it would also assist small entities to comply with the RPS. The small entities lack a guaranteed revenue stream or credit backing for long-term power purchase agreements. Electricity service providers and community choice aggregators may of necessity have to enter into short-term electricity contracts, with relatively small financial commitments and the flexibility to respond to market changes.

However, the latest EU commission report [41] is again inclined toward feed-in tariff mechanism for its effectiveness in comparison to quota mechanism because of the mechanism's features such as (a) investment security, (b) the stability for planning and handling, and (c) the low transaction cost.

Learning experience: The Denmark case study

To delineate the pros and cons of introducing RECs, Danish experience has been selected as an example. Denmark experienced difficulty in its movement towards a market-based system with tradable green certificates. The green certificate market was to be introduced to reduce a heavy financial burden on the government, subsidizing the renewable technologies while securing their development. However by 2003, the idea was abandoned due to the concerns expressed by both manufacturers and large industrial consumers that it might increase the price of renewable electricity. The following discussions are cantered around wind energy, wind energy being the largest renewable energy resource in Denmark.

In 1999 wind power in Denmark was purchased according to long-term agreements on "almost" fixed feed-in tariffs that were

fixed at fairly high levels where approximately half of the tariff was a governmental production subsidy [13]. The introduction of green certificate model would have transferred this renewable production subsidy from the public budget (tax-payers) to the electricity consumers (rate-payers).

The proposed RPS system required all Danish electricity consumers to buy 20% of their electricity from renewable energy sources by 2003, which was to be backed by a market for green power credit trading. These certificates were to be issued to the producers (generators) in proportion to their electricity output [11]. The generators were supposed to be able to sell these certificates to the highest bidding electricity supplier. This market was likely to have been in place by January 1, 2000 but was postponed to 2002. Wind turbines owners were to be paid for their electricity in two forms: a fixed price of DKK 0.33/kWh and a renewable energy certificate that they can sell at a price determined by the market (within politically set limits of DKK 0.10/kWh to DKK 0.27/kWh) [12]. Full life cycle of the certificate is as follows [12].

A certificate is conceived when a specific amount of electricity is produced through renewables. This certificate is issued by "issuer" such as the electricity system operator or the grid company since they know the level of renewable energy production. Every certificate is assigned a date of issue, but not necessarily a maturity date. It is registered and deposited in a producer account in a bank or Depository Trust Company, where it would be held until the day it is sold in the market. The producer and consumer accounts are supervised by a registry that ensures that the dictated quota is being met. Every certificate has a serial number in order to keep track of certificate's location in the system. Consumers would meet their obligation by handing over certificates to an institution, such as the Danish Energy Agency, which then destroys them.

The main features of the Danish proposal for a green certificate market were as follows [13].

- All consumers of electricity in Denmark were obliged to buy a certain share of electricity generated by renewable energy technologies. A major part of this was to be covered by the electricity distribution companies, which will buy the green electricity on behalf of their consumers. Large companies (or other consumers) trading directly with power suppliers were required to cover an equivalent share of their consumption with green electricity.
- All renewable energy technologies were eligible for producing green electricity and one green certificate is issued for every MWh of electricity produced through

renewables.

- Certificate could be sold to distribution companies or other electricity consumers with the obligation to cover a certain share of their electricity consumption.
- The Danish Energy Authorities would determine the share, presumably for a number of years in advance.
- The market functions solely as a financial market. The relation to the physical electricity market is by way of the upper limit of green certificates, which could not exceed the amount of electricity produced by the renewable technologies.

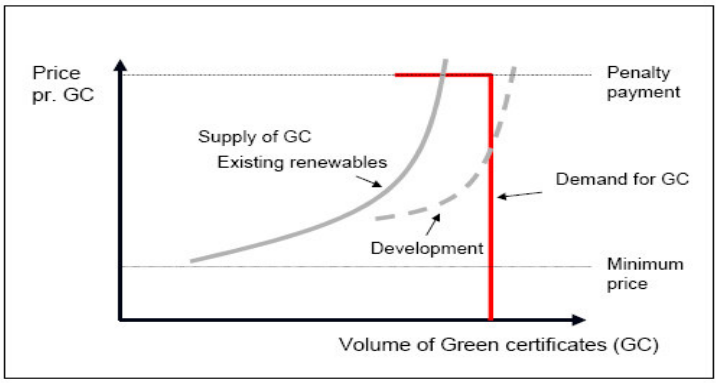

Figure 1: Demand and supply at a green certificate market (figure 4 of [13])

The functioning of a green certificate discussed in [13] was as follows.

The demand for green certificates is given by the obliged demand covering the quota of domestic electricity consumption on an annual basis, shown as a vertical line in Figure 1.

Two curves represent a supply of green certificates. The first curve represent supply from existing renewable plants and an upper limit of it is set by the total annual electricity production from these plants. The other curve represents supply by renewables that are developed within the specific year, as a consequence of spot market and green certificate prices in earlier years. Market and the price of certificates have following characteristics.

- The shape of the certificate's supply curve would depend on economic conditions for each type of renewables, age of facilities and the associated financial arrangement of the generator.
- If the quota is set too low, the resulting low price of green certificate may not encourage the development of new renewable capacity, while the too high quota may cause shortage of green certificate and electricity consumers would have to pay a penalty.

- If the price exceeds the penalty payment consumers will prefer not to fulfil the quota. On the other hand, the renewable energy producers/generators have an option of carrying forward some green certificates to the next year if prices of green certificates were too low, creating a timing gap in terms of demand and supply in the market.

Some of the important issues concerning the green certificate market, addressed by Morthorst [13] are:

- Time lag in capacity development: For some renewable energy technologies the construction would take at least 3-4 years.
- The intermittent and fluctuating nature of renewable resources: It introduces a level of uncertainty in the supply of green certificates. For wind-generated electricity (where the maximum variability is approx. +/- 20%) the changing wind conditions may have a significant influence on prices of green certificates.
- The importance of getting the quotas right: The long-term determination of demand quotas would be most important for determining prices of green certificates and the development of new renewable capacity.

In addition to unstable nature of supply from renewable resources, expected price fluctuation of electricity in the power market moving toward the deregulation would add a higher degree of uncertainty, especially for plants with high investments and low operating costs, as is the case for wind turbines and most other renewable energy technologies. In such a scenario, market for the green certificates might turn out to be a market with heavily fluctuating prices unless the suitable measures to stabilize the green market are taken.

Besides, estimation of price for a green credit in the initial phase became an issue. Danish buyers of wind turbines were required to include green credits in their budgetary projections because turbines that were to be contracted after January 1, 2000 were to be eligible for green certificates. However, since there was not any such market, it was difficult to arrive at a likely price of green certificate. Details like possible "banking" of certificates and the introduction of financial instruments such as "futures" and "options" were not worked out [11]. Ultimately, the wind generators were interested in determining a specific minimum price for electricity over a period of the investment, typically ten years. In absence of a well laid out mechanism, the Danish wind turbine owners were likely to demand a risk premium in return for the lack of a properly functioning system, The uncertainties inherent in a small national green certificate market could easily be so large that the risk premium would

have pushed the price of green certificates towards the DKK 0.27 ceiling. Consequently, no contracts for new wind turbines were signed in year 2000 in Denmark. All the turbines that got erected were actually contracted before January 1, 2000, and were thus entitled to the old fixed price tariff of DKK 0.60/kWh, for a transition period of five to six years, before entering the certificates market. Ultimately, it was combination of concerns of both, the wind generators as well as large industrial electricity consumers - that the system would lead to much more expensive and inefficient subsidies than either an environmental kWh bonus or a tendering system for offshore wind - that led to the proposed mechanism being dropped altogether. Other concerns were that (a) the mechanism would favour the cheaper renewable energy technologies and would have brought the development of more expensive technologies to halt [10] and (b) the mechanism could gradually erode the local ownership (the wind co-operatives and individual owners control approximately 80% of Denmark's turbine capacity), unless political action prevents it, due to the large transaction cost, economies of scale for large investors and the lack of transparency for small investors [11].

There was also a view that although fixed tariff systems were considered as subsidy while the green certificates as market based, both were only pseudo markets, because governments set at least one parameter: price or quantity [9]. It was pointed out that inadequate purchase obligations, overly broad renewable energy eligibility guidelines, unclear regulatory rules, insufficient enforcement, and wavering political support can lead to certain failure of RPS [30], and Danish case appears to be one of such examples.

REC Price and Market

Market characteristics and Price Estimation

The literature review brings it out very clearly that prediction of prices of RECs and the behaviour of the markets is difficult. While the basic features of the RECs market have been discussed in the earlier section, some of the negative attributes are listed below [25]:

- Trades being sporadic, the prices tend to jump - the market has very little liquidity
- The participants are buying not to speculate but to meet the requirement

Price of RECs is a function of the difference in prices between electricity generated from renewables and that from conventional technologies (and as a consequence, the uncertainty about the future market prices of conventional

generation also must be considered) [19].

Ford et al. [23] conducted a simulation based on simplified and idealized market for tradable green certificates with wind generating companies and electricity distribution companies as market participants. It showed that the certificate price rise rapidly to the cap in the early years after the market opens. The investors react to the high price by constructing a new wind capacity. Then after a few years the total capacity exceeds the RPS requirement. Their simulation also indicated that in the second half of RPS interval, the market is highly uncertain and there are major oscillations in prices even when using the assumptions to opt for stable market. They argue that because the existing markets are still new, finding evidence of price stability is difficult. The early experience in the Nord Pool showed steep price hike in the first year nearly reaching penalty prices. The price history of RECs trading in Texas [25] showed that the price in the beginning started at US$4/MWh in April 2002. The price then shot up close to US$19 within 6 months then came down to US$12 in a few more months, ultimately stabilizing in a band of US$11 - 14 between 2003 and 2005. Ford et al. [23], based on their simple model, made suggestions such as having longer interval to meet the RPS target (to encourage investor), not allowing the penalty price to float over time (for price stability and prevention of price hike of RECs), allowing 'borrowing' of certificate to distribution companies (for market stability).

Australia's certificate price estimation [47] prior to the start of MRET scheme was that the price would steadily increase to the peak until the year 2010 and then plateau at near the ceiling price until the end of the scheme in the year 2020. However, actual price of the certificate between 2003 and 2005 were already close to or well above (depending on the vintage of the certificate) the penalty price. They started to decline gradually from around January 2005 (just after the release of government white paper and the federal election results) and crashed by approximately 20 to 30 % in June 2005 and stayed at low price from then on [45]. According to Nishio and Asano [43], derived marginal price of certificates price in Japan is Yen 4.3/kWh in 2003 and they estimate it to rise to Yen 5.8/kWh by 2010 with assumption that the marginal price of electricity from wind and biomass is Yen 4/kWh (however, no general trends of price history and future scenario are presented).

4.2 Integrated Market of RECs

It is important to consider the usefulness of concept of 'integrated tradable certificate' market in order to compensate

(or supplement) disparities across the states of India in terms of availability of renewable sources and associated technologies and cost [33].

Implications of integrating REC market based on the RPS requirements across different state in the US have been discussed by Mozumder and Marathe [17]. The integrated market for REC is a system that allows the credit to be traded across the states. It presupposes that the integrated REC market should help meet the RPS in a cost effective manner. RPS target value, cost structures for producing renewable energy, and the price of the certificates can vary across the states. In an ideal market, the price of the certificate is the difference between the marginal cost of producing green electricity and the non-green electricity price, all of which would vary across the states. A simple example of two states shows that the trade of certificates across the states with variable conditions leads to higher overall efficiency even though some states experiences the price rise. This is so because the integrated market provides greater economies of scale in implementing RPS. In such a market it is expected that the price of RECs would fluctuate less. However, setting up integrated market is a complex task. Some of the drawbacks, barriers and associated risks with integrated market include incompatibility of regulations between states and the price fluctuation in the energy market. The following discrepancies need consideration while designing an integrated market for RECs [17]:

- The eligibility of renewable technologies for RECs
- Ceilings and floors of market to stabilize the market and the penalty
- Validity of the RECs
- Regulations that stimulate/support uncompetitive renewable technologies

It is suggested, therefore, to go through an experimental phase before switching to a fully integrated system. Some lessons can be learnt from ongoing EU pilot projects for developing Pan-European renewable electricity market such as RECS (Renewable Energy Certificate System) [24] or the EECS (European Energy Certification System) [52]. RECS was initiated upon demand of energy companies in Europe to trade their RECs in the free European energy market. EECS which is built on lessons learnt in the process of RECS development; aims to develop a market for international trade in renewable energy by commoditising environmental attributes of the physical energy and enabling these to be traded internationally. The only major difference between RECS and EECS is that the former is based on the voluntary market while the latter is imbedded in national legislations and the certificate traded in it has a legal status based on the EU directive. The EECS is likely

to be adopted as a uniform system for pan-European market.

Summary

RECs is a market base instrument, enabling the deployment of renewable sourced electricity in a cost effective manner. It is used with quota mechanisms to bring flexibility and economic efficiency to meet the quota. In recent years, a lot of work has been carried out to evaluate the effectiveness of the RECs vis-à-vis the feed in tariff (which is a non-market, subsidy based instrument). Feed in tariff, which was initially considered as a more expensive system to deploy renewable technologies has been successful in some countries such as Germany. The main factors in favour of Feed-in-tariff are, (i) it provides long-term security and predictability for investor and developers, (ii) this mechanism is easy to handle, and (iii) has lower transaction cost. On the other hand, RECs system is criticized as possibly being more risky and eventually costly. However, the fact that the RECs have not been around too long, especially the integrated RECs system, may make it premature to compare it with a tried and tested instrument like feed-in tariff.

Overall, RECs system, by allowing trading of green attribute separately from physical electricity, is expected to remove geographical or physical limitations (such as resource availability), time scale (such as seasonal availability or mismatch between supply and demand) or financial limitation associated with the supply of renewable sources. It provides more flexibility and time to suppliers and developers. RECs may also help overcome pricing policies or lack of market liquidity. However, at the same time, the flexibility may lead to the market manipulation as already observed in Scotland. The RECs, if tradable interstate, would compensate (or supplement) disparities across the states in terms of resources' availability.

Thus, introduction of RECs may be initiated through a pilot project, incorporating learning from experiences such as that of US on tracking systems or pilot project of integrated renewable energy market in EU.

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