Wind and Solar Energy in China

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Abstract. This paper looks at wind and solar power potential in China. The level of environmental problem in connection with energy consumption has been introduced in terms of air pollution, water pollution and CO_2 emission. The major pollutants are sulfur dioxide and soot that are generated in the combustion of coal and this cause acid rain that affects 30% of China's total land area. Industrial boilers and furnaces consume about 50% of the coal and it is believed to be the major source of pollution in urban areas. The level of development, legislation and regulations and challenges facing wind and solar power development has been discussed at length. Industrial boilers and furnaces consume about 50% of the coal and is believed to be the major source of pollution in urban areas. In 1997 there was initiation of China's Ride the Wind Program which established two Sino-foreign joint ventures where wind turbines were to be manufactured in China plants. Initially the domestically manufactured parts was 20%, but with technology transfer as well as R&D, new goals were set with aim of having the number of domestically manufactured components increased to 80% by the end of this program consumed 9.8% of all the energy used worldwide as per "China country analysis brief" which was published by the US Department of Energy (2001) and in 2006; China import of oil was 162.81 million tons. The reaction from private players will be important in further development of wind and solar power. Putting into consideration the problem of having discontinuous policy as experienced before 2006, it is obvious that success China Renewable Energy policy will be dependant on whether the legal framework and policies would be perceived to be long lasting directives or just some makeshift patchwork.

1. Introduction

Energy consumption associated with the economic activities and consumption has some negative effect on environment as direct pollution or production of CO_2 and other green house gases (GHGs) cause global warming. Also dependence on exhaustible resources such as fossil fuel is not sustainable because of the possibility that these resources can be exhausted at one point. With the major constituent of GHGs being CO_2 there has been a global concern reduction of its emission. It is with this regard that having necessary policies in place is very important so as to ensure reduction in CO_2 emission including enhancement of energy deployment and promoting technological innovations. A country like country is very important in addressing the issues of CO_2 emission considering its huge population which was put at 1.3 billion in 2005[1]. With such a big population China cannot use the traditional fossil fuel which has been the model of development for many western countries. This is in light of the supply of fossil fuels being finite which in long term will

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results to high prices and consequently resulting to a slow down in economic growth. The extent of energy problem in China and be looked at in terms of air pollution, water pollution, energy consumption level and CO_2 emission level. The aim of this paper is to show that wind and solar energy have the potential of being a substantial fraction of energy mix in China.

2. Air pollution

The air and water in China has been reported to be among the most populated in the world, with the World Health Organization (WHO) report in 1998 indicating that seven of the ten most polluted cities in world are in China. The major pollutants are sulfur dioxide and soot that are generated in the combustion of coal and this cause acid rain that affects 30% of China's total land area. Industrial boilers and furnaces consume about 50% of the coal and are believed to be the major source of pollution in urban areas. Also cooking and heating in China cities involve consumption of coal and this account for the remaining share of coal consumption. In transportation sector there is use of oil and gasoline and this has been recognized as the other major source of air pollution with the major source of emission being automobiles and jet engines.

Water pollution is a major concern in China with coal power plants being one of the contributors of the pollution. The coal power plants release mercury into the air and this is then captured into raindrops and end up in surface water, ground water and in the soil. The mercury polluted surface water finds its way to various water bodies , natural and artificial where it is ingested by fish which is then consumed by people.

In addition to the quality of water being affected, China has also a shortage of the resource. In important cities like Beijing and Shanghai we have low water beds that results water shortage. Also the supply of water from rivers such as Yellow and the Yangtze has been reduced considerably because the water is diverted for irrigation purposes or for generating electricity.

With China steadily industrializing, there is no doubt there will be an increase in pollution resulting from an increase in production output and level of consumption. The consumption increase will majorly be attributed to an increase in number of automobiles as well as an increase in air travel. This concern can only be addressed if there is a reduction in pollution per unit output

2.1. Energy consumption and CO_2 emission

China consumed 9.8% of all the energy used worldwide as per "China country analysis brief" which was published by the US Department of Energy (2001) and in 2006; China import of oil was 162.81 million tons according to a session paper by G.C.Chow[3]. It is projected that by 2025, China will consume 14.2% of world energy supply.

In the year 2001, China consumed 40 quadrillion Btu of total primary energy, of which coal accounted for 63%, oil 26%, hydroelectricity 7%, and natural gas 3% . With regard to total energy consumption ranking, China has been reported to come second behind US with its per capita energy consumption and carbon emissions being lower than the world average[4]. There is an expected increase in per capita energy use and carbon emissions, as a result of the growing economy and increasing living standards. Even though per capita energy use is relatively low in China, the total level of energy consumption and the associated level of carbon emissions is high as a result of the high the level of coal consumption and the high population of the country.

China has been reported to be at the forefront when it comes to the problem of CO_2 emissions. According 2001 statistics China carbon emission stood at 13% behind Western Europe and US whose share were 16 percent and 24% respectively and by 2007 China had taken over to become the leading GHG producer. With China being categorized as a developing country, it is to no surprise that it has a per capital CO_2 emission of only 87 percent of the world average figure and only 33 percent in comparison to the levels registered in OECD countries.

The scientific community is in agreement that level of total CO_2 in the atmosphere is not to go beyond twice the level it was before Industrial Revolution[5]. It is believed if this level is to be exceeded, this could result to violent unstable weather, pronged draughts and massive melting of glaciers. It is feared that with the rate of increase in emission maintained at the level it has been in the last 30 years, there is high probability of the critical level being reached in about 50 years and this makes CO_2 emission to be an urgent and critical issue.

While China may have no problem with reduction of coal-fired power plants that result to emission of CO_2 , but the price of coal generated power has been used as the basis of making the decision and that the alternative energy source price is expected to be equal if not lower than that of coal. This condition can only be possible through sufficient technological innovations with regards to the production of the clean energy guaranteeing the low prices. Friedman[6] has pointed out that with market incentives there is likely to be a success.

3. Methodology

A research design gives a blueprint or framework for conducting the research. The research design also elaborates on the research methods chosen, the sampling method, sample size, measurement and data analysis process. The research design must be suited with the purpose of the research.

In this study previous research papers were located online using the phrases such as renewable energy in china, solar energy in china, wind energy in china among others. These were dissertations and papers published in journals. Out of the numerous research papers which were found six of the papers were found to be more relevant and thus were used in this study. The papers were then reviewed thoroughly with the aim the level of wind power and solar power development in China.

4. Results

4.1. Introduction

This section gives the findings on the level of wind power and solar energy development in china and also the country's standing in this area of renewable energy development in the world.

4.2. Wind power

According to Chinese Academy of Meteorological Sciences it is estimated that the developable power to is 253GW for land while for off shore production the potential is 750GW[7].

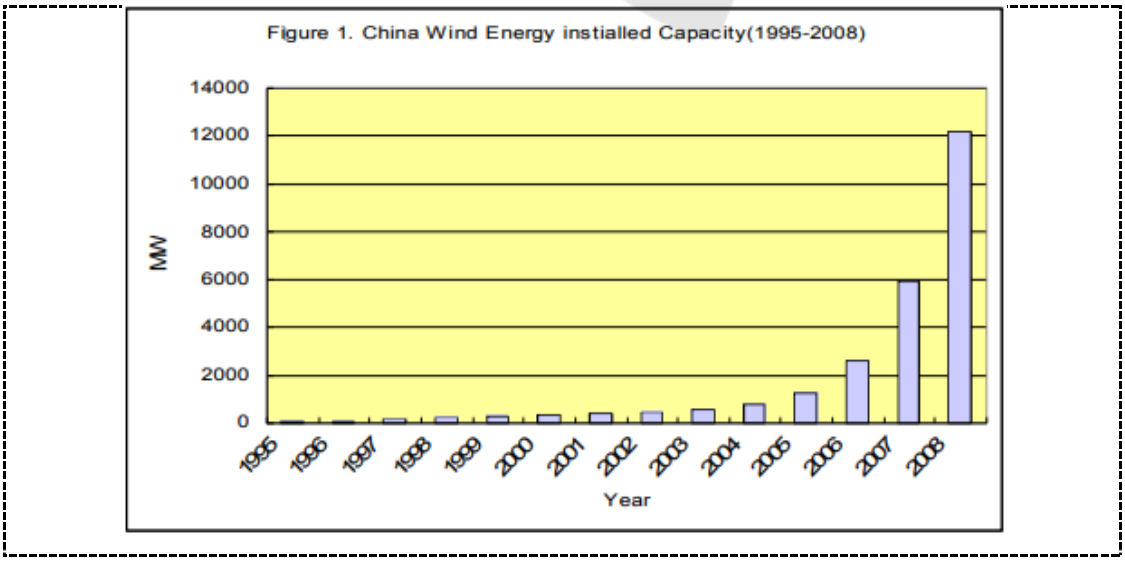

Figure 1. Annually installed and cumulative wind power capacity 1996-2008[3].

There has been competition in the industry where Goldwin has been seen to compete with Sinovel Wind and Dongfang Electric with each of them aiming to be the largest China wind turbine manufacturer. As a result of this competition Goldwind doubled in size annually in the previous 8 years[8]. But the high cost of generating wind power electricity and in addition to some of the key components of the wind turbines being sourced from abroad has resulted to some negative perception from government officials. It is believed that having cheaper domestically produced wind turbines is the solution to the negative perception. According to WPM (2009), there were a total 50 active blade suppliers and 100 tower manufacturers.

Perhaps it is with the realization of the need to have local manufacturing that has seen a lot of effort being made to achieve this. In the recent past, Goldwind has purchased a number of technology licenses from German Repower and German Vensys[9]. The same have been seen in their competitors Sinovel Wind and Dongfang Turbine who have also purchased technology licenses from Germany and Austria[10].

In 1997 there was initiation of China's Ride the Wind Program which established two Sino-foreign joint ventures where wind turbines were to be manufactured in China plants[11]. Initially the domestically manufactured parts was 20% , but with technology transfer as well as R&D , new goals were set with aim of having the number of domestically manufactured components increased to 80% by the end of this program[12].

NDRC launched four bidding events through public tendering aimed at issuing wind concessions. In the allocation process, the extent to which components were domestically manufactured was an important factor in the process of allocation and this stimulated transfer of advanced technology from foreign turbine manufacturers[13].

Capacity factor is an important issue that needs to be addressed with regard to wind power. Capacity factor looks at the fraction of power potential which is actually realized by a turbine per year, which in China is 23% much lower when compared to the American wind turbines where the figure stands at 34%[14]. By having capacity data used directly or being converted to electricity production data using a series of some set factors, which is the practice engaged by IEA, the end results will be a substantial level of overrating in Chinese wind turbines. The low level of electricity that seems to be generated could be linked to about one fifth of Chinese wind farms not being connected to grid system by 2009 despite the attempts that have been made to ensure grid connection[15]. Consequently we had the issue being addressed following the amendment of Renewable Energy Law even though the effect was expected to take at least a year to be realized. It is also in the same year when there was abolishment of the rate of localization of the equipment on wind power projects, which saw the abandonment of the requirement of having a 70% domestic manufacturing rate, a move that was meant to increase rate of technology transfer which would then result to increased efficiency and enhanced durability. In 2009 the construction of the first offshore wind farm commenced. The Shanghai East Bridge Wind Power Plant was to consist of 34 turbines each with 3 MW capacity and it was expected to produce 267 GWh of electricity per year to provide renewable energy to the Shanghai World Expo[16]. As the construction progressed, NDRC received at least six more requests for wind farm construction that was to be undertaken in Shanghai region.

The Shanghai East Bridge project epitomizes the speed of development of the Chinese wind power sector. It is also important to note that 3MW wind turbines were manufactured domestically and this came as a result of R&D involving Sinovel. By 2010 the NDRC had a 5MW turbine which was in R&D phase and the same applied to Goldwind and Dongfang Electric.

This is a clear indication that from international perspective comparison, China is catching up with advanced western countries in matters technology and progress is not only in the area of production and making some improvements on original products but also coming out strong in

matters innovation. This in return has allowed more active learning and has opened up potential of reducing costs and resulted to an increased return on investment.

At one point there was exemption of Wind power from the system of feed-in tariffs installed by the Renewable Energy Law of 2005 with prices being a subject of competitive bidding instead. This was aimed at giving policy makers a chance of evaluating market prices so as to set competitive FITs after a study period. In 2009, the NDRC released the Circular on Refining the Policy for On-Grid Pricing of Wind Power, that so the division of the Chinese mainland into 4 onshore wind power production areas and with FIT being set accordingly. FIT was to be set higher in the eastern coastal regions (Guangdong, Zhejiang, Fujian) and north eastern provinces (Liaoning, Shandong, Jilin) because of the higher and transport costs traditionally having a bigger part in electricity prices. Although the legal principle for establishing these FIT is well known –they are to be defined as to ensure 'a reasonable profit'- reliable and exact data of these most recently installed FIT is sadly hard to come by.

4.3. Solar energy

There is a huge potential in China with regard to solar energy. The land surface in the country receives solar radiant energy in the tune of 1.7 million Mtce and with two thirds receiving more that 5 GJ/m².radiation annually[17]. Most of the sunshine hours are located in the Western and Southern provinces of the country. Solar energy can be used for many applications, including solar water heaters, greenhouses, passively heated houses, solar cookers among others. With respect to reducing pollution and GHG emission focus will be on PV because it is a means of generating electricity which can be used to provide energy that is produced from coal or oil.

By the 2005, the total installation was 70MW, representing about 0.02% of the total energy mix of the country[18]. It was projected by the State Council total installation capacity 2010 would be by 300 MW and this would increase to 1.8 GW by 2020. The single most barriers to growth of PV generated energy has been the cost, with the figures of 2010 giving the cost as $100/MWh. This puts the PV power about three times more expensive than hydropower and twice expensive in comparison to wind power. This is a clear indication that even though there is abundance of the natural resources associated with this form of electricity, there is still a lot to be done to make it cost efficient. It is therefore hoped that technological development, economies of scale, learning by doing, increased competitions and other cost reduction factors can play important desired role into future development of PV sector in China.

There has some considerable effort that has been directed towards solar power. In 2009 July the Golden Sun Pilot Project, a venture which involved the Ministry of Finance, Ministry of Science and Technology and the NEA and aimed at development of a 500MW solar capacity with a two year time span. The Minister made a declaration that the project aim was to ensure that PV power was to account for 2.5GW by the year 2015 surpassing the initial set target of 1.8GW by 2020[19]. The government also went on to pledge that it would give a 50% subsidy of total investment in PV projects and if the target area of investment has not power the subsidy was to be to be increased to 70%. Even after the subsidy promise, PV companies have been reported to have trouble supplying power at competitive prices.

China PV sector plays a very important role in the global market and in 2007 it contributed 30% of the total global manufacturing; with Chinese manufacturers delivering a capacity of 2,900 MW[21]. Even with the high manufacturing ability , the current situation seem to indicate it may take longer before it takes substantial share of the country's energy mix. But the Chinese government has full recognition that there is high probability of the industry becoming profitable with regard to export markets, more so if there were maintenance of Green Energy Certificates in European systems or with creating of similar system elsewhere.

There are very many Chinese companies that are involved in solar energy equipment with the number of companies being put at 600[22]. China was number one worldwide in manufacturing of solar cells according to 2008 statistics with solar capacity of 2000 MW[23]. In the 2010 the country 98% of all solar products produced in the country were exported[24]. In terms of export volume China had $6.232 billion and $15.44 billion for 2008 and 2009 respectively which is 147% year to year increase[25].

5. Conclusions

As have been seen from the introduction section of this paper rapid growth of economy that comes with an increase in energy demand results to a constant increase in the consumption of primary energy which is expected to persist in the foreseeable future. It also means that China energy share of world market will continue rising in foreseeable future. As seen from the discussion regarding solar power and wind energy, it is clear that that the country has made laudable effort in stimulating growth in these areas of Renewable Energy production including putting in place laws and regulations as well as supporting of numerous government programs aimed at supporting the two sectors. Where reluctance was shown when it comes to adaptation to guidelines provided by the government, legislation have been provided so as to take care of implementation problems which have been common especially before 2006. The approach taken in 2007 NPC amendment of the Medium and Long Term Plan of Energy Conservation should be copied in which case there should be identification of the execution of energy guidelines so that it is used as a criterion when it comes to the evaluation of career officials. China signing the Copenhagen climate change agreement increased ambition is setting Renewable energy targets for 2020 indicates a positive policy shift wherein case of self reliance and energy conservation is being taken seriously by the central government. The reaction from private players will be important in further development of wind and solar power. Putting into consideration the problem of having discontinuous policy as experienced before 2006, it is obvious that success China Renewable Energy policy will be dependant on whether the legal framework and policies would be perceived to be long lasting directives or just some makeshift patchwork.

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