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PAPER

Comparing the EU and China Wind Energy Policies

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Abstract This paper examines the driving forces of the EU and China's wind energy policies change as well as critical problems in practice. Germany is used as a major case study representing the EU. However, this paper emphasizes less on Germany and more on China's wind energy policy changes. This is because China's wind energy policy appears to be less mature than that of Germany, and that the former seems to be changing more often than the latter. A contribution of this paper is that the data on China's wind energy policy is mainly collected from interviews with Chinese central government officials, state-owned enterprises, and scholars. By comparing Germany and China's wind energy policies, this paper uses a set of analytical factors. They are institutional framework, policy objectives, national government intervention, market and advanced technology. This paper concludes that it is not possible for both countries neglect concerns of both energy security and climate change in wind energy policy-making. Even though Germany is advanced than China in wind power development, both countries seem to face a common future problem in expanding grid connection for off-grid wind. For both counties, grid connection plays a crucial role in ensuring stable wind energy supply for the future.

Keywords Wind energy policy - China - Germany - EU

JEL Classification Q48

1. Introduction

The EU is aware that 80% of its greenhouse gas emission comes from energy consumption, from which 28% is of economic and industrial development, 33% of transportation, and 39% of household use and service industry (European Council,2011). Apart from the use of coal, the EU uses 22%solid combustion fuel, 30% nuclear power, 20% natural gas, 14% petroleum and 14% renewable energy. Over the last decade, the internal energy production within the EU

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seemed to be short of energy demand; in 2006, energy import took up 54% of the EU's total energy supply. It is estimated that by 2030 the EU will import up to 70% of petroleum and natural gas, and that the energy price will rise as well (European Council, 2011.)[1]

In the 1970s and 1980s, renewable energy development in the EU was mainly on research and development (R&D) and less on actual implementation. The largest contributor at that period was Germany, followed by Italy, the Netherlands, Spain, Sweden and United Kingdom. Research on wind energy technology took up nearly one quarter in the EU. In the 1990s the emphasis of the EU on renewable energy development shifted to market expansion; Germany, Denmark and Spain were the leading roles in expanding wind energy markets (Guest editorial, 2006: 251)

Throughout the last decade, the EU has made efforts by developing renewable energy on a large scale through institutional regulatory framework. For example, the Lisbon Strategy in 2000 focused on green economy. The "Treaty of the Functioning of the European Union (TFEU)"in 2009 advocated solidarity of an internal (renewable) energy market. To address climate change, the EU also established the DG Energy and the DG Climate Action in 2010. The Energy 2020 Communication (also called 20-20-20 plan) aims to increase the share of renewable energy in the EU energy mix to 20%. These policy changes are made with specific goals and they indicate the EU's determination to address climate change through renewable energy development.

China has been experiencing changing patterns of production and consumption in many areas of the economy since the economic reform of 1979 (Bruyninckx 2008: 165-166; Mol and Carter 2006: 150). Industrial production has increased, and standards of living have risen, requiring a greater energy supply, and raising issues of energy security.

Energy supply is subject to external pressure. For example, oil supply has been falling short due to instability in the Middle East or foreseeable shortages of oil in later years. Pressure on energy supply can lead to an increase of energy prices. China's large reserve of coal is available at a low price. Therefore, it has been chosen as a major source of energy supply.

Energy security was first mentioned in 1994 by China Economic News, a database of Chinese periodicals (Guy C. K. Leung 2011: 1330), and later in relevant literature, such as the China Modernization Report, which incorporated the environmental factor in China's overall national development (CAS 2007: 8). Scholars have defined energy security as "the consistency of energy supply at affordable prices" (Rosen and Houser 2007: 40). Another definition is "to assure adequate, reliable supplies of energy at reasonable prices and in ways that do not jeopardize major national values and objectives" (Alhajji, 2007). Both definitions are considered as suitable for the case of China regarding its dependence mainly on coal and oil (Guy C. K. Leung 2011: 1335).

China's reliance on coal and oil to meet a rapidly increasing energy demand explains why, in 2006, the country surpassed the US as the biggest carbon dioxide (CO_2) emitter in the world (the Netherlands Environmental Assessment Agency 2007).[2] Industrial waste gas is the largest contributor to air pollution in China. This problem is not only an energy issue but also has severe environmental implications. Excessive CO_2 and other harmful gas particles from the

[1].The EU imports petroleum mainly from OPEC countries (Organization of the Petroleum Exporting Countries) of 38%, 33% from Russia, 16% from Norway, 5% from Kazakhstan. The EU imports natural gas from Norway of 26%, 21% from Russia, 17% from Algeria and 5% from Nigeria.) Because the use of fossil fuels such as coal, petroleum and natural gas does lead to greenhouse gas (GHG) emission problem, the EU needs to increase the use of renewable energy to achieve a low carbon society.

[2] It concerns emissions by country, not per capita.

industrial use of coal and oil, has triggered the global debate on greenhouse gas emissions and China's role in this issue. The international community has invited emerging industrial countries, like China, to share the responsibility, together with developed countries, for the reduction of greenhouse gas emissions. Internally, the Chinese government sees the need to address the emission problem, which has led to environmental deterioration, problems of public health and social unrest. But China is especially challenged on how to balance economic development and environmental protection. China seems to be willing to participate in beneficial environmental changes, but it also wants to make sure that these measures are 'economically sound.'

The central government has placed a priority on cleaner production to address both of these challenges: increasing environmental protection and preserving economic growth. Chinese national policy has responded to excessive emissions of greenhouse gases and increasing energy demand by promoting renewable energy, including wind and solar energy. Renewable energy is receiving more attention as a sustainable solution to reduce China's emissions problems and it can contribute to a significant reduction in greenhouse gas emissions.

This paper aims to investigate wind energy policies of both Germany and China and intends to answer the questions: why do both Germany and China's energy policy change from fossil fuel use to increase use of renewable energy? What are the common problems in practice for both Germany and China in developing wind energy?

This paper examines mainly onshore wind power policy and development, not on offshore wind power development, because research of the latter requires investigation on various dimensions, such as military and public sea dispute, which are beyond the scope of this paper.

The analysis of wind energy policy and development, as a contemporary and on-going issue, requires interviews with policy-makers and other stakeholders in order to conduct an in-depth and detailed study. Therefore, this paper focuses on interviews as an essential method of data collection for this research. The added value of emphasizing interviews is that some interviewees can provide updated documents, which serve later as an input to document analysis.

The groups of interviewees are initially in three categories. The first category consists of officials from the Joint Research Center (JRC), the European Commission, the International Energy Agency (IEA), as well as Chinese central government officials. They provide an overview of renewable energy-related regulatory framework. The second category is multinational corporations or state-owned enterprises of China; they give insights on crucial problems in the actual development of renewable energy. The third category is academics from Europe and China, as well as non-governmental organizations (NGO); they offer critical analysis on policy-making and practice. The number of interviewees is in total 35 (Table 1)

Table 1 Number of interviewees

EU and Chinese officials	8
Multinational corporationsand Chinese state-owned enterprises	20
Academics and NGOs	7
Total	35

2. The EU Wind Energy Policy

Renewable energy development appears to be an ongoing process, and policy changes (i.e. objectives, market incentives) often take place more than energy conservation, energy efficiency and GHG emission reduction. That is why it is important to examine the energy-related regulatory framework (here refers to institutional change, treaties and their related directives, rules or regulations). The following section will examine the EU's recent (renewable) energy policy reform in three stages.

First energy package

The initiation of renewable energy law in the EU can be traced back to 1996 and 1997 when the EU passed electricity and gas directives, which formed the first energy package (Horng 2013: 3). A specific policy paper was in 1997 with the introduction of the "White paper for a Community Strategy and Action Plan, Energy for the Future: Renewable Sources of Energy."(European Commission 1997).The objective was to increase renewable energy resources from 7% in 1997 to 12% of the EU gross inland energy use in 2010. Being a landmark for the take-off of renewable energy development within the EU, this White Paper was considered merely as a policy objective due to a lack of concrete operation measures. It was not until 1999 did the Commission formulated an implementation strategy for the White Paper (Guest editorial, 2006: 253). In addition, the 2001 Directive on the promotion of electricity from renewable energy sources was introduced, which all member states had to implement accordingly. (European Commission 2001; Harmelink et al. 2006: 34; Reiche and Bechberger: 844)

Second period of energy legislation

The second period of energy legislation was shown by the Lisbon Treaty in 2000 advocated highly on green economy and energy law reform, which took effect in 2003. Art. 13 of the EU Treaty under the Lisbon Treaty incorporated the European Council into a single EU institutional framework. This indicates that the European Council has power to function as the EU constitution; any decision made by the Council has high political implication and high degree of policy change. For example, the European Council introduced the Lisbon Strategy in March 2000 with four major targets: improve R&D, create dynamic economic environment, invest in human resource, and develop green economy, which is the essence of the LisbonStrategy(European Council 2000). The "EU Directive for the promotion of renewable energy sources (RES) electricity production" came into force in September 2001, which required all member states to implement by Oct. 2003 (Reiche and Bechberger 2004: 844).

In 2001 the EU was trying to include the US to play a leading role in reducing carbon emissions, which the Bush administration did not seem to be enthusiastic, because the priority of the US at that time was mainly about the war against Iraq. Without the partnership of the US, the EU assumed that it must take on the leadership in carbon emission reduction. After rounds of negotiation with the member states, the EU introduced the first carbon market, the EU Emission Trade System (EU ETS)(Skjaerseth and Wettestad2009:118).

The establishment of the EU ETS in 2003 was based on the 2003/87/EC Emission Trading Directive by the European Parliament and the European Council. The 2004/101/EC directive linked the Emission Trading Directive and three flexible mechanisms (Joint Implementation, International Emission Trading, and the Clean Development Mechanism) of the Kyoto Protocol, thus making the EU ETS compatible with the Kyoto Protocol (Blanco and Rodrigues, 2008: 1510). The operation of the EU ETS took effect in 2005; it was the largest carbon emission trade market in the world (Point Carbon 2010).

A special feature of the linkage between the EU ETS and the Kyoto Protocol was that the use of the Clean Development Mechanism (CDM) allowed non-industrialized countries (also called non-Annex I) cooperate with industrialized countries in reducing GHG emissions. During the period of 2008-2012, the greenhouse gas emission of the emerging economies such as Brazil, China, Russia became rather serious, the emission problems was mostly related to energy use, therefore, the CDM registered projects were mainly energy-related ones, of which wind energy took up the most amount. According to UNEP, China issued the largest share (63%) of certified emission reduction (CERs) in 2012. This revealed that China had become the largest seller of carbon credits in the world. The EU was then the largest buyer of CERs in this period, with 77% carbon credits bought from China, of which wind energy projects took up over 30% (1510 projects) (UNEP, RISO Center 2013).
More elaboration on China's wind energy policy will be given later.

The European Council in 2007 emphasized energy efficiency and set up the Energy 2020 Communication "20-20-20", which was a mid-term plan to increase energy efficiency, establish internal energy market, strengthen EU external position on energy; that it, to take a leading role in energy technology and innovation. Specific objectives included to increase 20%renewable energy share in the energy mix; improve energy saving by 20%; reduce carbon emission by 20%. (European Council, 2007)

Third period of energy law reform

The third period of energy law reform was in 2009 with the renaming of the Treaty of the European Community into the "Treaty of the Functioning of the European Union (TFEU)."The reform the EU treaties reveals the intention to balance development and the environment with emphasis on green economy. For example, after the Lisbon treaty took effect on Dec. 1 2009, the so-called three pillars were merged into the single European Union. The Treaty of the European Community was renamed as "Treaty of the Functioning of the European Union (TFEU)"(Treaty of the Functioning of the European Union, OJ 2010, C83/47).

Art. 194 of the TFEU emphasizes the importance of the functioning of an internal energy market, including energy efficiency and conservation, development of renewable energy, interconnection of energy network, and security of energy supply.

There are three major principles of the Art. 194: first, the establishment of the internal energy market and operation; second, the need to preserve the environment, esp. in addressing climate change. Third, solidarity with the internal energy market (Horng, 2013: 5).These three principles aim to ensure sustainable energy supply, large scale development of RE as well as energy efficiency and conservation .

A special feature of the Art 194 (1) is that it gives authority of the EU to establish legal measures to ensure the above mentioned three principles and aims are fulfilled. In other words, the laws or measures based on Art. 194 are not symbolic declarations but *legally binding* to the member states (Horng 2013: 5).

In 2006 came the "Green paper on a European Strategy for Sustainable, Competitive and Secure Energy." The purpose was to create an internal energy market and ensure its solidarity, create diverse energy supply structure, and eventually unify a single external position on EU energy policy.

In 2008, the EU Commission introduced the "Climate action-Energy for a Changing World", which was a strategic plan for low-carbon energy technology (grid, carbon capture). In 2009, the European Council passed the "Climate and Energy Package," which touched upon renewable energy, carbon trade, carbon capture and storage; car emission, member states sharing carbon emission reduction targets.

The EU also conducted institutional changes in 2010 as demonstrated by the creation of the DG Energy and the DG for Climate Action. Both institutes are to ensure operation of a common energy market, sustainable energy supply, energy efficiency, renewable energy development and, in the long run, a Pan-Europe energy network.

The DG Energy is responsible for general and specific tasks. General tasks include promoting a single internal energy market and energy security, which means securing lasting energy supply. In addition, the DG Energy supervises the construction of public grid network as well as the EU energy research budget. A specific task of the DG Energy is to promoting renewable energy development to reach the objective that 20% of the EU energy consumption comes from renewable energy in 2020.DG for Climate Action presents the EU in global environmental negotiations, and assists the EU in achieving the above-mentioned targets for 2020.

The European Council in Feb. 2011 set a goal in creating an internal pan-Europe energy market by 2014. The purpose is to construct a well-structured grid network so that the member states can transport electricity and natural gas to neighboring countries. In the same year, the "2050 Energy Road Map" was proposed, aiming to reduce 80% to 95% GHG by 2050 relative to emission in 1990.

In 2013, the EU introduced a green paper on the "2030 Climate and Energy Policy Framework." This green paper would be based on the implementation of the 20-20-20 targets (proposed to reduce 40% GHG by 2030.) (European Commission. 2014).

Policy analysis

Based on the above renewable energy-related regulatory framework, this section will analyze the internal, external driving force of the EU (renewable) energy policy change and remaining problems.

The above renewable energy-related regulatory framework reveals an evolving trend in the EU energy development. That is, the EU intends to build a pan-European energy community with shifting focus from the reliance of fossil fuels to large scale production of renewable energy, which is essential in going towards a green economy by balancing economic development and the environment, as demonstrated by the Lisbon Strategy in 2000, which promotes a green economy as a major guidance for the future development of the EU. The environmental factor, in respect to the increasing public awareness of the climate change problem, appears to be an *external* driving force of the EU energy policy change. This is demonstrated bythe "Climate action-Energy or a Changing World" in 2008, the introduction of the "Climate and Energy Package" in 2009, the establishment of the DG Energy and the DG Climate Action in 2010. Both the first and second principles of Art. 194 TFEU indicate that a balance between(economic) development and the environment is a crucial concern of the EU energy policy-making. The EU's intention to initiate "a high level of environmental protection" as a prevailing goal of its energy policy-making further supports the assumption that environmental concern is an important concern in the process of the EU policy-making.

The above mentioned policies reveal an *internal* driving force for institutional or policy change is the concern of energy security, as demonstrated by the third principle of Art. 194 of the TFEU emphasizes "solidarity with the internal energy market" mainly refers to "mechanism for rapid solidarity," That is, a total back up support system among the member states when any of a member state is in energy crisis, such as breaking down of its energy infrastructure. This again shows that energy security is an important driving force for the EU (renewable) energy policy change. On a long term basis, the EU aims to consolidate an internal energy market by advancing its technology in establishing an operational public or pan-European grid so that some member states can transport additional electricity to support their neighboring countries in case of energy shortage. This goal is not just a wishful thinking, but it is set and approved by the European Council, which has high political implication but also high degree of power to conduct policy change.

The development of (renewable) energy has been institutionalized by the EU treaties. Lisbon treaty, which took effect on Dec. 1 2009, promoted a common energy policy and a single energy market. Art. 14 of the TFEU elevated again the importance of energy in the EU policy-making; it is also legally binding to the member states to implement an internal energy market.

As the implementation of the Energy 2020 Communication continues, the EU needs to increase the share of renewable energy in order to reach the 20% share of renewable energy in its total energy mix (Jacobsson and Lauber 2006: 256).

These indications reveals all the more that the EU has a definite goal of moving towards increasing use of renewable energy and that this goal is driven by policy support to make it feasible to practice. The EU appears to be moving towards rethinking the change energy structure and the energy market, increasing dialogues with citizens and international–level cooperation on renewable energy development, as proposed by the Energy Roadmap 2050 Communication.

There are general problems of the EU energy policy. First, the EU energy policy is still under national control (Brown 2013: 1). Each member state has different concerns in its national energy policy-making and this depends on their natural energy reserves or imports. For example, the UK replies mainly on petroleum and natural gas due to its oil reserves in the North Sea. France relies on nuclear power, while Germany has coal, natural gas and oil as conventional energy, although its policy is moving towards increasing the use of renewable energy.

Difficulty remains in changing the energy structure of each member state. Until 2010, some countries like France, Germany, Spain and the UK were continuing subsidizing their national coal industry, which made it difficult for renewable energy to compete with coal (Reiche and Bechberger 2004:844).

Second, the collapse of the EU ETS, an instrument to tackle global warming, seems to reflect the ineffectiveness of the EU energy policy. The divided position of the member states shows that coordination needs to be strengthened. For example, Britain sees that carbon price is too low as up to 2013 the price was 3 euros per ton. The European Parliament did not have intention to raise the carbon price, and this indicates the continuity of energy *market weakness.* Germany is facing internal division over the subsidies for renewable energy and carbon. These different voices reveal that the EU lacks of a unified (renewable) energy policy, because most member states are developing renewable energy according to their national policies. (Lewis and Barbara 2013).Before 2013, the EU ETS were compatible with the CDM, which consisted of mostly registered wind energy projects, partly because the member states agree mostly on developing wind energy as a major alternative energy. After 2013 the EU ETS will not be compatible with the CDM, which will be replaced by a new market mechanism.

To sum up for this section, we conclude that the internal and external driving forces for the EU (renewable) energy policy change are the concerns of climate change and energy security. The problems of the EU energy policy are that most member states have different energy structure, energy policy is under national control, and that strong coordination is needed, as demonstrated by the EU ETS.

As mentioned in the introduction, the early development of renewable energy in the EU was mainly on research and development (R&D), the EU did not emphasize technology implementation until 1990s. The focus on creating a renewable energy market in the EU from 1990-2000 saw a high growth rate particularly on wind energy, with an average 40% annual growth; 80% of the OECD wind energy production comes from the EU, such rapid annual growth also leads to a soaring wind turbine industry, which took up 90% of the global market share (EWEA 2004; Guest editorial, 2006: 253).

Wind power has the largest growth (33%) of all renewable energy development in the EU.Until2010, wind energy development hit the largest growth (55GW) of the renewable energy development within the EU. Up to 2013[3], the total wind power installed capacity in the EU reached 117.3 GW. The electricity produced from onshore wind energy was enough to cover almost 8% of the EU's total electricity consumption (EWEA 2014:12)

Literature review shows that the rapid growth of the EU wind energy market is mainly initiated by policy initiatives and central government intervention of the member states (Blok, 2006: 251;Lauber and Mez 2006: 105;Lewis 2013; Guest editorial, 2006: 253; Lewis and Wiser. 2007; Arantegui 2014: 31.). For example, the national government intervention in Germany by pushing national policies has led to market growth in wind energy development (Blok, 2006: 251).Literature review shows that Germany has been playing a major role in the EU wind energy development (Reiche and Bechberger 2004: 848; Saidur et al. 2010: 1749-1750; Jacobsson and Lauber 2006:257; EWEA 2014). Over the past 13 years, wind power installation has grown from 3.2 GW in 2000 to 11.2 GW in 2013 (EWEA 2013:3)with an average annual growth rate of 10%.

In 2013, Germany represented the largest market share of wind energy for total installed capacity (34.3 GW; 29%), followed by the Spanish market (23 GW; 23%) and the UK market (11%) (EWEA 2014: 12) (Table 2).

Table 2: EU member state market shares for total installed capacity (total 118GW)

Germany	29%
Spain	23%
UK	11%
Italy	9%
France	8%
Denmark	4%
Portugal	4%
Sweden	4%
Poland	3%
Netherlands	2%
Others (13)	11%

EWEA 2014: 12

[3] In 2013 alone, the total wind installed capacity across the EU in 2013 was 11159 MW, which was 8% less than 2012. The 8% decrease was due to negative impact of wind market, uncertainty of the regulatory framework, which discouraged investmentand thus led to concentrated growth in certain countries, such as Germany, Spain and the UK(EWEA 2013:3). This was different from the market scenario that Germany, Spain and Denmark altogether represented 58% of annual installation from 2007 to 2012 (EWEA 2013:5).

3. Germany wind energy policy under the EU framework

This section will use Germany as a representative case of the EU wind energy policy, which has undergone mainly four time periods (Jacobsson and Lauber 2006). From 1974 to 1988 wind power development was about to take formation, partly due to the energy shortage in the 1970s, which raised public concern on the future of energy supply. The Chernobyl accident in 1986 also triggered debate and controversy on the safety of nuclear power.From1988 to 1998 was the early formation of wind market; various instruments were deployed to form a market in 1988 for wind energy development, such as subsidies, tax exemption and low-interest loans (Jacobsson and Lauber 2006:266; Saidur et al. 2010: 1750).But in mid-1990s there were oppositions from coal and nuclear industry against renewable energy. The Ministry of Economic Affairs saw that renewable energy was developed to support or complement conventional energy and could never replace coal and nuclear power production (Jacobsson and Lauber 2006: 264); this worry partly led to slow down of the wind market.From1998 to 2003 wind power was revived, thanks to the national government (Red-Green coalition) in office at that time, which was highly supportive to renewable energy development. From 2000 to 2013 wind power in Germany continued to grow, thanks to a strong national policy.

The following section will further investigate German wind energy policy impact on wind sector with the application of a set of analysing factors. They are institutional framework/energy structure, national government intervention, policy objective, policy instruments, market andadvanced technology. The policy impact on wind power development in Germany can be considered as effective (Saidur et al. 2010: 1751; Jacobsson and Lauber 2006: 258). Elaboration is as follows.

Institutional framework/energy structure

The concept of 'energy transition' (energiewende) can be traced back in 1970s which elevated the negative impact of nuclear power and that economic development should go hand in hand with reducing emissions through renewable energy development and energy efficiency through less energy consumption (Stiftung 2012).

The Chernobyl accident in1986 led to increasing public opposition to nuclear power, and such opposition strengthens pressure to the German federal government, which agreed that renewable energy development should be expanded and later adopted the Feed-in Law to attract investors. The impact of this change of institutional framework was that it stimulated the growth of the domestic market from 20 MW in 1989 to almost 490 MW in 1995(Jacobsson and Lauber 2006: 264).

Germany's energy concept adopted in 2010 mainly promoted renewable energy development, by which the power sector aimed to increase the share of renewable energy in electricity use to 80% by 2050. The 2011 nuclear accident in Fukushima, Japan, triggered strong determination of Germany's national policy to completely phase out nuclear power by 2022. (Brown 2013: 18).

The energy policy seems to be consistent in opposing nuclear power as demonstrated by its major anti-nuclear concern from the 1980s to 2022.This is driven by external forces such as the Chernobyl and the climate change concern (Jacobsson and Lauber 2006: 266), which led to public acceptance of alternative energy.

National government intervention

In the early period (1989) of wind power development when large electricity industry was hesitate in absorbing wind energy, the federal government targeted local and rural communities to launch initial wind power development, most of the wind farms were owned by private individuals. Increase participation of local/ rural communities or private individuals was the strategy of the federal government versus resistance from the large electricity industry (Wong 2005: 136).

The EU regulation to liberalize energy market coerced Germany to open its market in 1998, allowing consumers to choose their power suppliers, this helped stop monopoly and provided access to developers to transmission and distribution networks. As a consequence, general electricity price went down (Wong 2005: 137).

The renewable energy policy in Germany was considered lukewarm until the Red-Green coalition took office from 1998 to 2005. To ensure wind power developed at large scale, the Schroder government in 1998 restructured the energy sector by establishing a new Ministry of Economics and Technology, partly aimed to strengthen energy research in technology (Wong 2005: 138) to ensure wind power to be developed at larger scale.

Even though at this period, there was no direct funding to wind developers, yet soft loans and special tax were available. To ensure profits for investors, the federal government introduced a wind energy conversion system, by which investors could calculate profit before a project was initiated. At the end of the 1990s, the number of wind farms increased at a steady rate and in 1997 Germany replaced the US as the world's largest wind power producer, and was able to supply 18% wind turbine manufacture in the global market. In this period, the accumulated capacity of wind turbines was six times larger than that in the UK (Wong 2005: 137).

During the reign of the Red-Green coalition, Germany achieved the first rank installed capacity of wind energy in the EU. The Red-Green coalition also aimed for a long-term policy objective that over 50% electricity generated by renewable energy sources by 2050. This shows that national government intervention can be a driving force for wind energy growth (Lauber and Mez 2006: 105). The intervention from the federal government as illustrated by the Red-Green coalition is a driving force for effective wind power development. Later, the Conservative-Social Democratic Coalition, which took office at the end of 2005, expressed intention to continue the policy course of increasing renewable energy electricity. In 2010, Germany witnessed that over 12% of its gross energy consumption came from renewable energy; among which wind energy had the largest amount of electricity generated (Saidur et al. 2010: 1750).

Germany does not seem to have much public resistance to wind power development. Literature reveals that state power will be deployed for regulation if disputes happen (Wong 2005: 135-136). Strong federal government intervention throughout 1990s witnessed steady growth of wind energy market, and coordination between the federal government and large industry continued from 2000 onwards to motivate the latter in purchasing more wind energy (Reiche and Bechberger 2004: 848).

Policy objective

In 2010 the government published a National Renewable Energy Action Plan (NREAP). (Federal Republic of Germany. 2010).A future goal at the federal level is to increase wind capacity to 45GW by 2020; 30% of electricity to be generated from renewable energy, and that 50%

by 2050 (Saidur et al. 2010: 1750; Arantegui 2014: 31; Brown 2013: 6-7), this is the same objective previously set by the Red-Green coalition. With strong government policy and public support, the above targets are likely to be achieved (Arantegui 2014: 31).

Germany has plans to gradually phase out its nuclear power plants by 2030 and, instead, replace them with large-scale wind and other renewable energies (i.e. solar, biomass). Other countries will probably follow suit, they are Belgium, the Netherlands and Sweden (Reiche and Bechberger 2004: 844).

Policy instrument

At the initial stage of wind power development (1974-1988), various market instruments were deployed, such as subsidies, tax exemption or low-interest loans.

An example of policy/institutional change was the Feed-in Law in 1991 operated at the federal and local levels. This law led to more investors for market participation, because it was based on a concept to cover cost payment to ensure profits for investors. Wind market soared from 20MW in 1989 to nearly 490 MW in 1995, making the German wind turbine industry the second largest in the world (Jacobsson and Lauber 2006: 263-264).

But mid-1990s Feed-in Law suffered a setback as there were oppositions from coal and nuclear industry, and the Ministry of Economic Affairs was not enthusiastic in further developing renewable energy. The ministry considered Feed-in Law a burden to national budget and called a reduction in supporting renewable energy sector, including wind energy (Jacobsson and Lauber 2006: 261-264).

Nevertheless, a survey conducted in 1993 in 24 countries shown that Germany had the greatest concern over global warming, and such concern was reflected at the later stage of policy-making. The Red-Green coalition reversed the earlier concern of the Ministry of Economic Affairs and revived wind power development in Germany.

The Feed-in Law was reformed into the Renewable Energy Sources Act of 2000, which introduced four major differences from the Feed-in Law.

First, the Renewable Energy Sources Act continued the concept of the Feed-in Law by taking external costs into consideration. This means that polluters must pay for the external cost to recover the environment back to how it was before pollution occurred, and such cost should not be paid by taxpayers or future generations. Second, conventional energy benefit much from government subsidies than renewable energy, which was in disadvantage position to compete, and this situation should be reformed. Third, there should be less disparity between the high production costs of renewable energy and low amount of actual energy production (Jacobsson and Lauber 2006: 268).Fourth, the Renewable Energy Sources Act offered 20 years of guarantee to subsidize wind investors. But the amount varies according to the quality factor on site (e.g. from 0.091euro /per kWh to 0.062 euro/ per kWh for offshore wind) (Reiche et al. 2004: 868). Price-setting results from coordination between the federal government and centralized electricity industry (Wong 2005: 138). Such guarantee policy greatly boosted the wind sector (Jacobsson and Lauber 2006: 268).

Gradually, fixed feed- in- tariff (FIT) has been used as primary subsidies to support wind energy electricity transported to a public grid. In other words, such tariff targets on subsidizing technology in renewable energy electricity generation; FIT for onshore wind power development is different based on project size and location (Brown 2013: 8).

FIT is granted at two stages of a wind project operation (Table 3). Firstly, an investor receives initial tariff for the first five years of a project based on the estimate power generation cost. Secondly, at the end of five years, the actual amount of electricity generated is compared to the revenue as a reference if the same amount of tariff can be extended or reduced in the remaining period(Brown 2013: 8).After the initial period ends, the basic tariff is paid for each kilowatt-hour of electricity produced (Brown 2013: 9).

In 2012, Germany witnessed a shift from FIT to market premium or some other market-integration incentives, the purpose is to encourage more investment in renewable energy (Brown 2013: 8). For example, a bonus subsidy was introduced to encourage the industry strengthen technical solutions for quality service and maintenance (Brown 2013: 8).

The difference shown by market premium is that renewable energy projects must participate in the wholesale power market. That is, a project owner must sell electricity to electricity exchange or to a buyer through power purchase agreement (Brown 2013: 8).In 2013, the Germany Federal government (the Federal Environment Ministry and the Federal Economics Ministry) proposed FIT to be gradually replaced by market premium for projects larger than 150 kW (Bloomberg New Energy Finance. 2013.

The revised Renewable Energy Sources Act extended subsidy period from 9 to 20 years, assuring more investment security to the market actors (Reiche et al. 2004: 847).

Table 3 Feed-in-tariff for onshore wind power development

Year	Initial tariff Euro cent/kWh	Basic tariff Euro cent/kWh	System service bonus
2012	8.93	4.87	0.48
2013	8.80	4.80	0.47
2014	8.66	4.72	0.47
2015	8.53	4.65	--
2016	8.41	4.58	--
2017	8.28	4.52	--
2018	8.16	4.45	--
2019	8.03	4.38	--
2020	7.91	4.32	--
2021	7.79	4.25	--

Brown 2013: 9

Market

The German wind market was not coming into formation until 1991. From 1974 to 1988 R&D was funded for developing off-grid technology for exports to the Third World, not for the domestic market (Jacobsson and Lauber 2006: 261).

Renewable energy technology was at the early developing stage and there was weak link between research projects and market competitive products (Jacobsson and Lauber 2006: 261). In the 1980s, more R&D programs in universities, institutes and firms began to expand; some of these programs were integrated into national policy for renewable energy technology. Consequently, more funding was granted to the wind turbine industry from 1983 to 1991,and thus a small national market began to take shape.

Changes of institutional framework and policy instruments can lead to market opening. The EU council of energy ministries liberalized the EU electricity market in 2002 (Reiche and Bechberger 2004: 846). Unbundling the EU electricity market resulted in more competition[4]. Liberalization of the EU energy market also led to six mergers in the German electricity industry, but this did not solve the structural problem. These six large industries did not have

[4] Interview with a grid expert from VTT, IEA in Beijing, Oct 16, 2013.

clear task division in power generation, transmission and distribution. In order to conform to the federal government's obligation to purchase more expensive wind energy, the six large enterprises charged additional costs from residential consumers (Wong 2005: 139). The federal government since 2000 has been trying to expand wind power development by minimizing the cost of energy production (i.e. minimizing capital, operation, maintenance costs), while maximizing reliability and energy production (Arantegui 2014: 16). A major approach is to initiate new rounds of wind power funding to motivate the unwilling enterprises absorb more wind energy, and such coordination between the federal government and large industry still remains.

Advanced technology

Changes of policy instruments can influence technology development. For example, the considerable amount of financial incentives from the Feed-in Law boosted the improvement of technology (Jacobsson and Lauber 2006: 264).

Germany is the leader in Europe to shift from conventional energy to renewable energy. The country made efforts in combining renewable energy into national electricity grid; such integration requires rather advanced technology to be successful (Jacobsson and Lauber 2006: 256); any problem can easily cause instability of electricity transmission and lead to investment loss.

Although advanced technology is essential in developing wind power, the German market is able to tone down the production cost. German scholars point out that the total cost (all costs considered) of wind energy technology is reasonable to strike a balance between technology and market operation. (Jacobsson and Lauber, 2006: 261).An example is batteries used for wind electricity storage. Without quality batteries, it is not easy to store excessive wind electricity in a national grid, let alone to dispatch to neighboring countries in case of energy shortage.

In addition, wind energy production is dependent on the weather factor. On a less windy day, a wind turbine is not able to produce a certain amount of electricity, but quality batteries with excessive electricity storage from earlier time periods can secure the supply of wind electricity and ensures market operation.[5]

Apart from onshore wind power development, advanced technology in Germany is also pushing for offshore wind power, which is expected to increase to 7GW in 2015 and 30GW in 2030.The contribution of multinational wind companies cannot be ignored. For example, Siemens from Germany is one of the leading investors in global wind development (Martinot 2008:3). But a major problem of expanding offshore wind is that grid connection from offshore to national grid is not catching up with the speed of development. There is not enough grid extension to the North Sea, and has caused excessive electricity being wasted. To address this problem, the federal government in 2013 introduced the "Third Act Revising the Legislation Government the Energy Sector" which included proposal for controlling electricity waste and risk control (Li, 2013: 16).

To sum up, Germany wind power policy is considered effective, because of government intervention; clear policy objective for medium and long term development; public support for renewable energy; advanced technology; affordable market price, FIT shift to market premium, integrating renewable energy with broader power sector and wholesale power markets.

[5] Ibid.

4. China's Wind Energy Development

Interviews[6] and literature review reveal that, China's wind policy has been described as "crossing a river by feeling rocks," which indicates that trial-and-error is an integral part of its renewable energy development (Lema and Ruby 2007: 3880).China's wind policy development has gone through three stages: the early stage (from 1986 to 1993), when wind power development was mostly in *ad hoc* fashion; a progression stage (from 1994 to 2002), marked by a transition from *ad hoc* installation to a more programmatic approach; and a recent stage (from 2003 to 2013), characterized by a shift from programs to a national strategic policy.

This section will further investigate China's wind energy policy impact on wind sector with the application of the same set of analyzing factors applied to the case of Germany.

Institutional framework/energy structure

In recent years, international scrutiny forced China to seriously take into account environmental issues. Examples such as the Harbin incident in 2005 (water became polluted by industrial toxic waste), the Taihu Lake incident in 2007 (the third largest freshwater lake in China, which was polluted by a severe algae outbreak) and the controversial Three Gorges Dam project (which caused pollution to the local environment) drew much international attention (Chen et al. 2008:10). These environmental incidents triggered both social discontent and protests in China. Pressures from environmental groups and the international community forced the Chinese government to respond to these problems, at least by taking some measures. In order to pursue a "harmonious society" with less social discontent, the Chinese government gradually realized that "institutional changes and balanced policies were vital to better governance and social harmony" (Chen et al. 2008: 12).

Hu Jintao, who took office from 2002 to 2012,was probably the first political leader who stated that environmental problems should be taken seriously. His ideology of "harmony between man and nature" appears to have influenced China's national policy-making, as demonstrated by the Renewable Energy Law (REL), which took effect in 2006. The REL indicates a major energy policy from fossil fuels to increased use of renewable energy.

Despite the influence of the REL, a senior official from the NDRC[7] emphasizes that China's energy structure is still a major obstacle to wind power development and needs to be transformed. He points out that China's energy structure stays mostly the same as thirty years ago, and that there is still room for renewable energy development. In recent years, China has been suffering from serious air pollution, which is caused by PM2.5 substance, which is a kind of compound factor attached to other air pollution substance and cannot be released when absorbed into human lungs. In November 2013, the accumulation of PM 2.5 in Beijing reached to 380; this was much higher than the average amount of 20 set by the World Health Organization (WHO). The accumulation increased to 900 in winter time, due to intensive use of burning coal. The geographic shape of Beijing is surrounded by mountains, together with air pollution from mass traffic and factories, caused more difficulty in releasing the PM 2.5 substance, and thus posed negative impact on local economy. The serious air pollution has driven the Chinese government to push for a change. The local governments are asked to alleviate air pollution

[6] Interviews were all in Beijing, with ERI, on May 26, 2009, CBD (a MNC) on May 27, 2009, Energy Foundation (NGO) on May 30, 2009 and Baoding SOE on June 5, 2009.
[7] Interview with the NDRC, in Beijing, Oct. 18, 2013

as top priority; negligence to this problem can affect their further advancement in their career. This senior official from the NDRC pointed out that the air pollution problem caused by PM 2.5 substance is a current driving force for China's energy policy change. China's air pollution, especially, in Beijing, has posed negative impact on the national economy, and has caused social anger (CNN Oct22, 2013) it's a problem that has to be tackled without delay. The Chinese government has allocated 5 billion RMB in October 2013 to tackle air pollution; this amount is twice the amount of China's annual national defense budget.

National government intervention

There is no institution more powerful than the National Development and Reform Commission (NDRC). The NDRC approves large-scale projects and budgets, sets energy prices, plans energy policies and interprets detail provisions. Even though offices of the National Energy Bureau and National Energy Administration are located inside the NDRC, implying that the NDRC is the actual institution assisting the National Energy Commission.

Policy objective

The changes of the policy objective can be traced back to the initial two periods (from 1979 to 1993 and from 1993 to 2001) when the government stimulated oil, electricity and coal production without concerns about environmental pollution, to a shift from the supply to the demand side, integrating the environmental factor into national energy policy (from 2001 to 2005), to striking a balance in increasing renewable energy output, reducing energy intensity and mitigating climate change (from 2005 to present).The REL obliges state grid companies, in the long run, to distribute 5 to 7% of the electricity generated by renewable energy. That compulsory regulation is considered a driving force for the development of renewable energy.

Policy instrument

The major subsidy is the Renewable Energy Development Fund (REDF). Established in 2006, the Renewable Energy Development Fund was based on the cost-sharing concept in the REL. From 2006 to 2009, every electricity end-user paid an additional 0.001 Yuan/kWh to this national fund. The amount collected was used to cover the difference between renewable energy power price and that of conventional power. This fund was seen as a budget source for the feed-in tariff, which the Chinese government could use to compensate state grid companies in buying renewable energy electricity. Following the REL amendment in 2009, each person paid0.004 Yuan/kWh, helping this fund increase from 2 billion Yuan, in 2006, to almost 5 billion Yuan,[8] in 2009 (NDRC 2009).The Renewable Energy Development Fund is considered a big incentive for the renewable energy industry, especially for wind and solar PV power. This is because half of the fund is reserved for wind power development.

In 2013, a reform took place for central subsidies that each user must pay more to support wind power development. Each end user including SOEs/ industry (different from Germany that industry is exempted) has to pay additional 0.015 Yuan/kwh from

2013(0.004→0.008-→0.015 Yuan/kwh). Late payment is the problem, but there is ***no*** pen-

[8] Conversion to USD is 750 million dollars. Exchange rate calculated at www.xe.com on December 27, 2014.

alty system from the Chinese government. A main reason is that electricity dispatch is from a unified central system to all places nationwide.

If a penalty (e.g electricity cut) is imposed to a certain industry or individual end user, other users or industry will also be affected. This is a problem in operation.[9].

In short, China's wind market is stimulated by government subsidies. The central government is thinking to gradually reduce subsidies, because the market seems to be mature with many wind equipment manufacturers participating in the market. Giving more subsidies to a mature market can distort competition and the industry.[10] However, SOEs argue that in practice national subsidies are insufficient, and that the application process is complicated.[11]

Market

China's wind market is mainly for state-owned enterprises, which are the major actors in national bidding rounds. To avoid bidding in low price in low quality, the NDRC was planning to gradually replace the existing bidding system with a fixed electricity price by region.[12]In other words, the central government would pay wind electricity producers an additional amount, which was higher than production cost, to ensure that wind electricity could be connected to the state grid system. This reform was eventually conducted on August 1, 2009, the Chinese government introduced price-based feed-in tariffs applicable to different regions with rich wind resource capacity: 0.51Yuan, 0.54Yuan, 0.58 Yuan and 0.61Yuan per kWh (Table 4).

Table 4 Wind price evolution from 1985-2013

Development periods	Price
1985-1993	Less than 0.3 Yuan/kWh[13]
1994-2002	Between 0.38 and 1.2 Yuan/kWh[14]
2003-2013	Prices by regions: 0.51, 0.54, 0.58, 0.61 Yuan/kWh[15]

Source: CREIA 2013 [13][14] [15]

Up to 2013, China's wind installed capacity has been rising higher than expected (84GW). The outlook of further development is positive, with the future potential to reach over one million GW by 2020 and possibly 450 GW in the long run[16]

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[9] Interview with Prof. Chang in Tsinghua University, Beijing, Oct. 18, 2013

[10] Interview with ERI, in Beijing, May 26, 2009.

[11] This is because a central government subsidy is given to a fixed number of projects annually, it seems to be not enough to support the increasing number of wind projects. Another reason can be that there are various local wind electricity prices in different regions; in some provinces, average subsidy to grid-connection (usually no more than 0.25 Yuan/kWh) and can be lower than production cost. Interviews with local government officials in Baoding city and regional NDRC (Inner Mongolia), in Beijing, June 5 and May 21, 2009.

[12] Interview with a research fellow of ERI, in Beijing, May 20, 2009.

[13] Conversion to USD is 0.045 USD/kWh.Exchange rate calculated at www.xe.comon October 12, 2010.

[14] Conversion to USD is 0.057 USD/kWh and 0.181 USD/kWh.Exchange rate calculated at www.xe.comon October 12, 2010.

[15] Conversion to USD is 0.074 USD/kWh, 0.079 USD/kWh, 0.085 USD/kWh, 0.089 USD/kWh. Exchange rate calculated at www.xe.com on October 12, 2010. According to the ERI, the purpose of introducing a fixed-in tariff per kWh is to replace the existing bidding process, which focuses on low power tariffs as a winning criterion. 0.51 Yuan/kWh applies to the Xinjiang Uyghur Autonomous Region, the Inner Mongolia Autonomous Region. 0.54 Yuan/kWh applies to Hebei Province and Gansu Province. 0.58 Yuan/kWh applies to Jilin Province and Heilongjiang Province, Gansu Province, the Xinjiang Uyghur Autonomous Region and Ningxia Autonomous Region. 0.61 Yuan/kWh applies to other regions which are not mentioned above. (China Renewable Energy Scale-up Program (RESP) 2009).

[16] Interview with International Director of Research Center, National Energy Administration DG of Dept .of Renewable Energy, Beijing, Oct 16, 2013.

A recent crucial problem has been that large scale wind projects are challenged by wind electricity curtailment. This problem is related to energy market mechanism, which is still bound by conventional coal-fire power contract, known as “take or pay” contract. This traditional contract obliges a government to dispatch coal-fire as priority than renewable energy, including wind power; violation can result in penalty to cover the loss to coal-fire developers. Due to observation of the take or pay contract, national grid company would ask wind farms produce less energy, and thus leads to curtailment, which means wind energy can be overproduced and without being consumed, because of the inflexible market mechanism which needs to be reformed.

Advanced technology

The Secretary General of the Global Wind Energy Council (presenting the industry) points out that China lacks of advanced technology especially in grid connection and wind electricity curtailment.

Grid

In principle, the government reviews the proportion/percentage of the renewable energy in the state grid Every year. This is a form of control and kind of coercion to impose power plants to include renewable energy in their power output. For example, if the wind power grid does not reach the required percentage in a project, the central government will not approve similar related projects from a power plant. This controls and enforces the use of wind energy in the state grid. This principle is in line with the RPS/MMS (must produce) system. However, these quota systems are still disputable in reality. So far, there are no specific regulations requiring state grid companies to conform to those systems. Therefore, state grid companies are not obliged to reach a certain quota of wind power output, nor is there empirical evidence on how a sanction is applied in cases of violations.[17]

In practice, the annual operation hour/rate of wind (around 2000 hours)can be much lower than other energy resources (i.e. hydro power). There are technical problems to keep the grid system from being stable. As a backup to support the system, the grid must have the same capacity as either a coal or a nuclear power grid. If the share of wind power is too large or unstable, the grid system can break down and cause severe problems. This is a major concern that makes state grid companies reluctant to purchase wind electricity.[18]

Advanced grid modification technology and very powerful backup energy mechanisms are necessary to ensure a maximum volume of power and stability. On the other hand, grid modification can enhance the implementation of RPS/MMS(‘must produce’) and PPA (‘must buy’) mechanisms, which need to be pushed by a strong national policy.[19]Unless the central government intervenes, state grid companies will not be interested in buying unstable wind electricity. Before that happens, grid-connections must first be modified. Only with stable grid-connections can wind project developers and state grid companies implement produc-

[17] Interviews with Datang SOE, in Beijing, June 4, 2009.
[18] In reality, grid instability and the quality of output can be a cause of conflict of interests among SOEs, local governments and state grid companies. Interview with Datang SOE, in Beijing, June 4, 2009.
[19] Interview with ERI, in Beijing, May 26, 2009.

ing (RPS/MMS) and buying (PPA) a fixed percentage of wind electricity output, as required by the REL. If the grid problem is not solved, the wind industry and market will probably come to a standstill.[20]

Grid modification will be the key determining factor, and a future trend, if China wants to reach the goal of 150 GW installed capacity by2020.[21] The industry suggests that, in the future, a flexible system, which has quick response to power needs, has to be introduced in grid network to share excessive wind electricity among different provinces.[22]

Abandonment of excessive electricity

The prevailing problem of grid connection also led to wind electricity curtailment, which became rather serious and was the core issue in the Wind Power Conference held in Beijing in October 16-18, 2013.

Wind resource is mainly concentrated in the northwest while electricity consumption is in the southeast, the distance of electricity transmission is too long, thus it is not feasible to supply wind electricity alone due to the concern on collecting and consumption. China's wind power resource is concentrated in the northern region (the Three North: Northeast, Northwest and North China) and the eastern coastal area. The North regions mainly dependent on the fire electricity, and the need of wind electricity is around10%, if large scale wind electricity produced is larger than the need of local market, this leads to collecting and consumption problem. At this stage, the central government has started to build two large grid cables for electricity dispatching, which are due to be functional in the near future.[23]

A recent crucial problem has been that large scale wind projects are challenged by wind electricity being produced and wasted in 2012.This problem is related to energy market mechanism, which is still bound by conventional coal-fire power contract, known as "take or pay" contract. This traditional contract obliges a state grid to dispatch coal-fire as priority than renewable energy, including wind power; violation can result in penalty to cover the loss to coal-fire developers. Due to observation of the take or pay contract, Chinese state grid company would ask wind farms produce less energy, and thus leads to curtailment, which means wind energy can be overproduced and without being consumed. The energy market also lacks of prediction/estimation mechanisms on how much electricity need to be collected or consumed, and thus results in a large amount of wind electricity being wasted.[24]

5. Lessons learned from Germany and China Wind Energy Policies

This paper has listed the following differences and critical problems in comparing wind energy development between Germany and China (Table 5)

[20] Interview with a wind energy-related foreign corporation, in Beijing, June 3, 2009.
[21] Interview with Datang and Baoding SOEs and a wind energy-related foreign corporation, all inBeijing, June 3, 4, 5, 2009.
[22] Ibid.
[23] Interview with a Chinese state-owned enterprise in Beijing, Oct. 16, 2013.
[24] Interview with Global Wind Energy Corporation (GWEC) in Beijing, Oct. 18, 2013

Climate change as common concern

The EU aims to be free of carbon dioxide as an ultimate goal, which requires a large percentage of renewable energy to make this goal feasible. Germany is obliged by the EU in GHG emission reduction and, like most of the member states, Germany opts for wind power in order to achieve its own emission reduction targets. Climate change concern is evident as a driving force that both Germany and China are aiming for large expansion of wind power.

Being the largest carbon dioxide emitter in the world, China has external and internal pressure in addressing its emission problem. This is very much in line with the EU, despite that China does not have obligation from the Kyoto Protocol.

Climate change concern (external force) and energy security (internal force), lead to a major energy policy change from overreliance of fossil fuels to increased use and production of renewable energy. The exclusion of large hydro as renewable energy by the REL and rich wind resources in the Northern China lead to China's targeting wind as a major option for expanding renewable energy.

Both Germany and China share the same concept that a balance is needed between economic development and environmental protection. This is demonstrated by the energy transition (energiewende) concept of Germany and China's harmony between men and nature.

There are different international obligations in the Kyoto Protocol. The EU has to reduce its GHG emissions by 8% of 1990 levels during 2008-2012. Germany has high reduction target (20%) (Reiche and Bechberger 2004:845). By contrast, China does not have obligations in emission reduction, but only voluntary targets.

Institutional framework

The institutional framework of the two countries reveals that policy change is a common pattern in promoting wind power development.

The EU energy 20-20-20 communication appears to be a driving force to the increased production of renewable energy (CNREC 2012: 140). In respond to this policy, Germany has proposed a National Renewable Energy Action Plan (NREAP). A future goal at the federal level is to increase wind capacity to 45GW by 2020; 30% of electricity to be generated from renewable energy, and that 50% by 2050.

While in China, renewable energy was not elevated until the REL took effect in 2006. The REL is considered by the industry as a driving force to the increase use and production of wind power. Without the REL, Chinese enterprise would not have been motivated to develop large scale renewable energy development, in particular wind power. However, due to a lack of detailed operational measures, this law was reformed in 2009, and later several relative policies based on this law were introduced. China's wind energy policy change seems to be a trial and error, reactive approach.

In Germany, opposition to nuclear power seems to be a major concern, which leads to its energy restructure by developing renewable energy; such concept was already developed in 1970s. Germany has a long-term plan to gradually phase out nuclear power plants by 2030 and replace them with large-scale wind and other renewable energies. By contrast, China's approach is to take the pattern of energy mix, which means that renewable energy together with conventional energy (fossil fuels and nuclear) combined. Because wind electricity storage can sometimes be unstable, and China's national grid still needs support from conventional energies. Apart from climate change concern, the severe problem of China's air pollution (PM 2.5) in recent years will possibly be an additional driving force for its energy structural change in the coming years. As emphasized by a senior officer in the NDRC, China's energy structure needs transformation from coal-fired electricity to wind electricity, meaning wind should replace coal-fired electricity rather than being simply complementary source of energy. In the long run, China must change its energy structure fundamentally from the dependence of burning coals to increase use of renewable energy, especially wind power is of great potential in the case of China.

National government intervention

Both Germany and China have strong national government intervention in wind power development. This is demonstrated by the Red-Green coalition in Germany and the ideology of Hu Jintao in China.

The German federal government will intervene in disputes if local residents protest against a nearby wind farm. In China, citizens are required to collaborate with the instructions from the central government when a wind turbine is set up in a certain area (Wong 2005: 136).

In order to oblige large industry absorb wind energy, the German federal government has been coordinating with large industry by initiating funding. Chinese central government is conducting the same approach, but in practice, funding application is time consuming and complex. This again demonstrates that national government intervention is crucial in boosting wind power development.

Policy objectives

Germany and China have common objective to expand renewable energy development, and these three countries focus on wind power as a major source of renewable energy production. But Germany and China emphasize more onshore than offshore wind.

The EU set a specific goal that wind energy will cover 7% of the entire EU electricity demand. Germany aims to achieve 35% electricity consumption from renewable energy (wind takes half of this percentage) by 2050. The ultimate goal for Germany is to be nuclear free by 2030. According to the "Burden-Sharing Agreement" in June 1998, Germany (together with Denmark and Luxembourg) are obliged to reduce GHG emissions in order to reach the overall target of emission reduction by 8% of 1990 levels during 2008-2012 (Reiche and Bechberger 2004: 845). An external force of the Kyoto Protocol, together with the internal force of the Lisbon Treaty, the TFEU and the "EU Directive for the promotion of renewable energy sources (RES) electricity production" push the member states, especially Germany, to speed up renewable energy development (Reiche and Bechberger 2004: 845).

China's revised REL after 2009 obliges industry to distribute 5% to 7% of electricity generated by renewable energy in the long run. Whether this objective is reachable remains to be seen.

Policy instrument

Germany and China rely on subsidies from the national government as a major support to promote wind power development. The practice of policy instruments of the three countries appears different from one another.

Germany has reformed FIT and deployed additional market premium to support large scale wind projects, in order to integrate wind electricity to the wholesale electricity market. Overall, Chinese wind industry relies mainly in the Renewable Energy Development Fund (REDF), half of this fund is used to support wind projects. China also has fixed feed-in-tariff in four regions, but these prices are seen as guidance yet in reality are not operational, because grid companies do not purchase wind electricity by the fixed price and there are no sanctions against violations. From 2013 onwards, China has obliged each electricity user must pay more to support national wind power development. The SOEs/ industry are included. This is different from Germany that industry is exempted from paying additional costs.

Market

German wind market appears to be restricted and regulated by the federal government. Wind electricity prices of Germany are decided by the federal governments through heavy coordination among centralized without participation of independent power producers (Wong 2005: 138).

China's wind market competition is dominated by state-owned enterprises, which have good relationship with the central government. It is not easy for foreign or private investors to participate in large-scale projects (i.e. national bidding projects), so the market appears to be restricted as well.

National electricity industry of both Germany and China countries act as both transmission and generators (Wong 2005: 139).

There is also a difference in price setting and quality. China does not have fixed price to be practiced in reality, and investors compete with low bidding price as possible. This problem often leads to a lack of quality production or unstable electricity supply. For example, a wind turbine made by a Chinese company can run less than ten years, while a turbine made by an European company can last over 10 years. The time span of a turbine operation is crucial for profits, this shows that China is in need of advanced technology transfer even though Chinese SOEs have ability to produce turbines on their own. By contrast German wind industry considers total cost and quality in market competition. The wind prices can be a bit higher than those in China, but the quality of turbines or a wind farm can guarantee profit return.

There is also a difference in terms of other stakeholders' participation in wind markets. In China, the will to develop renewable energy is mainly dominated by political leaders or the central government (NDRC), and that the voice of civil society plays a small role.

By contrast, there is local level participation in Germany. Apart from the German government, there seems to be a supportive civil society (bottom-up) to phase out nuclear and expand renewable energy development. For example, local residents can have shares of a nearby wind projects (Lal and Von Malmborg, 2006: 11). This is because of resistance from centralized power sectors against high cost wind power in the early period, the federal government then allowed private individuals or local/rural community to own small scale wind farms since 1989 (Wong 2005: 136).

Advanced technology

In terms of grid connection, on long term basis, it is also important to establish flexible electricity support systems among the Chinese provinces. The EU has constructed a cross boarder grid system, yet China is still falling short of a similar mechanism.

Onshore wind

In 1997 Germany (overtook the US) became the world leader in wind power production, most of the global wind turbine manufactures were from Germany.

In the following decades, China's policy focus on expanding wind power and large amount of national subsidies boosted the market. Thanks to low production cost and labor, in 2013, China overtook Germany as the largest wind turbine producer in the world due to mass production and low cost labor. But a crucial problem for China is that there is a lack of advanced grid network in collecting and consuming wind electricity, which was overproduced and wasted. The root cause of this problem is mainly related technology (lack of flexible support system among provinces) and market (difficulty in collection and consumption, lack of estimated mechanism/correct statistics on how much electricity has been dispatched). In comparison, the EU is building an internal back up grid network, and Germany has advanced technology integrating wind electricity into a wholesale market.

Offshore wind

Germany needs to strengthen offshore electricity storage capacity, a possibility is to develop high quality batteries. Up to 2013, there was not sufficient flexible grid connection in both countries to catch up with the scale of onshore wind development. This requires more dedication and investment in R&D for state-of-the-art technology to be developed.

In terms of China, there are a couple of SOEs starting to explore offshore wind (i.e. Goldwind). However, due to a lack of experience, China is still at the initial phase of capacity-building in offshore wind, and is in need of technology transfer and consultation of operating a project from European enterprises. Other than technology transfer, China needs more experience or policy reform in addressing military or marine disputes.

Table 5 Comparing Germany and China wind power policies and development

Analytical factors		Countries: Germany	China
Institutional framework		R&D and market mechanisms	Limited R&D market mechanisms
			REL 2006
Policy objectives	Forces of change	Climate change Energy security	Climate change Energy security
	Different objectives	EU obligation	Expanding wind power production
		EU obligation	Voluntary obligation
National government intervention		Federal government regulation	National government NDRC regulation
Market		State regulation	Competition based on central government regulations
Advanced technology	onshore	More than offshore projects	Technology transfer needed
	offshore	--Not enough grid connection	Initial phase of capacity building

6. Conclusion

This paper examines wind power development of Germany and China by looking at their own institutional framework, policy objective, national government intervention, market, advanced technology. A further investigation by comparing the policies of the three shows that there are similarities and differences in policy making and practice.

The two countries share similarities in the following aspects. Climate change appears to be a common driving force for both countries as well as the EU to consider the environmental factor in policy making process. It seems that large scale wind power development will not be prosperous without policy change nor national government intervention. This is especially evident in China. The national government involves in wind power development through allocating subsidies and different market instruments to encourage investment. The two countries have the same common objective of expanding wind power development and use market instruments (i.e. FIT, national subsidies) as a major support to encourage their wind markets.

These two countries have different energy institutional framework and emission reduction targets. Among the EU member states, Germany is one of the countries which are obliged to reduce the highest amount of GHG emissions during 2008-2012. Germany also has ambition to establish a nuclear free homeland as an ultimate goal, and this is in line with the goal of the EU.

China chooses a framework of energy mix, because it needs tremendous energy supply for its economic development. Even though China is not obliged by any international agreements, the serious air pollution problem such as haze is driving for fundamental energy structural change. China's NDRC officials believe that renewable energy should ultimately replace fossil fuels rather than complementary to conventional energy. The Chinese central government should push harder for such fundamental change; otherwise, the pollution problems will remain.

The operation of policy instruments is different. Investors in Germany are guaranteed for certain percentage of profit in selling wind electricity, as seen in the FIT premium. By contrast, China has intention to guaranteed profit, but in reality, grid companies sometimes purchase wind electricity at a much lower price and investors are often taking risks.

Advanced technology development capacity of Germany and China are different from each other. Germany started earlier than China in technology R&D, most of the world-leading turbine manufactures are from Germany and they possess the key patent technology. Even though China in 2013 became the world's largest turbine producer, thanks to low production cost and labor, China still needed cooperation with Germany for advanced technology transfer to strengthen the quality of production.

Afterthought

As China's production in wind generators and relevant facilities has increased in recent years, it is possible that these products are exported and sold in lower prices than those produced in Germany. In 2012, China exported wind related products to Third World countries such as Bolivia and some countries in Africa,[25]where in the past, used to import wind products from the EU.As the EU-China solar panel dispute came to an end in August 2013, one is likely to hypothesize if there would be a similar situation happening to wind related products. China's export policy seems to be less strict compared to that of the EU, together with the Chinese

[25] Interview with a Chinese state-owned enterprise in Beijing, Oct. 16, 2013.

central government using half of the REDF supporting wind power production, what will the EU member states think of this situation that more Chinese wind products are possibly substituting EU- made products in the global market? Could China's increased exports lead to a global market distortion? If a trade dispute happens in the future, such problem would possibly be resolved either through trade negotiations between the EU and China or through the trade dispute settlement mechanism of the WTO. Nevertheless, both the EU and China would possibly try to find a win-win situation to remain bilateral cooperation, which is helpful to EU's export business and China's sustainable development.

It is not possible to combat climate change without either the EU or China. Both the EU and China are interrelated and interdependent to each other in the climate relations. For example, China and the EU are the largest seller and buyer in the global emission trade market. China needs advanced technology transfer from the EU, and to make china's climate targets feasible (i.e. 11.4% non-fossil fuels by 2015; 40-45% reduction in the carbon intensity of GDP from 2005 levels by 2020).The EU needs greater market excess to China regarding wind energy development. It is better for the EU to see China as a partner than a threat in combating climate change. China's leader Xi visited the EU on March 31st, this is a good gesture that China values the EU wants to learn from the EU experiences and reinterpret these into its own domestic circumstances for promoting sustainable development and a stable climate-energy relation.

Some western scholars believe that China, being the largest manufacture in wind energy, China should gradually reduce its protectionism and increase policy transparency in the global energy market. We see that China is still learning by doing in RE development, as says in Chinese crossing rivers by feeling stones. As for wind energy market, it is stable now because the market is of the best competitors survive from market competition since 2006. China's wind power is moving towards a higher level to strengthen its capacity in technology and policy to deal with crucial problems in practice

Any EU-China trade dispute (including wind and solar) can set both sides back from the closer economic partnership that is ultimately in their respective interest. Such tension is not beneficial for both sides and can lose focus on the importance of joint cooperation for the global climate concern.

Annex. Overview of (renewable) energy policy framework proposed by the Commission

Year	Name of policies	General goals	Specific goals
		Common position of the EU external energy policy	
2050	Energy Roadmap 2050 Communication	Long term plan	Change energy structure and focus on RE & energy efficiency; rethink the energy market; market incentive on investment; increase international–level cooperation; Dialogues with citizens.
2020	Energy 2020 Communication "20-20-20"	Middle term plan (lagging) Increase energy efficiency, establish internal energy market; Strengthenexternal position on energy; taking leading role in energy technology and innovation. Protect energy consumers	Increase the share of RE in the mix to 20%; improve energy saving by 20%; reduce carbon emission by 20%

Year	Name of policies	General goals	Specific goals
2009	Climate and Energy Package	To help achieve 20-20-20 goals	RE, carbon trade, carbon capture and storage; car emission, MS sharing carbon emission reduction
2008	Climate action-Energy for a Changing World	To help achieve 20-20-20 goals	
	Strategic Plan for low-carbon energy technology (grid, carbon capture)		
2006	Green paper on a European Strategy for Sustainable, competitive and Secure Energy	Internal energy market; Solidarity of energy market; Diverse energy supply structure; Single external EU energy policy	European Energy Supply Observatory; Mechanism for rapid solidarity Pan-European energy community
2001	Directive on RE electricity	All member states to implement by 2003 for the White Paper	
1999	Implementation strategy for the White Paper		
1997	White paper for a Community Strategy and Action Plan, Energy for the Future: Renewable Sources of Energy.		

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