Addressing Large Developing Country Emissions

The Case for Strategic Sino-European Collaboration under Joint Commitments

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Summary for Policy Makers

Objective

The objective of this Report is to explore the potential for addressing developing country emissions at scale through bilateral '***Joint Commitment Framework Agreements***' (JCFA). To provide a realistic context, this exploration focuses on the potential to reduce the growth of ***coal-based emissions in the Chinese power sector*** through large-scale collaboration between ***European and Chinese enterprises***. Essentially, this Report explores the proposition that under a Sino-European JCFA, European companies will be more likely to collaborate with Chinese enterprises, to transfer and develop low carbon technologies and know-how that will help to achieve jointly agreed carbon emission reductions in the Chinese power sector. Specifically, we focus on exploring the likelihood of an agreement that could unlock the potential for a significant increase in the production of electricity from wind. It is important to point out from the outset that this sort of strategic collaboration under a bilateral agreement is complementary to, and indeed reinforces, the UN-sponsored multilateral climate change regime.

Structure

The Report is divided into three Parts. ***Part I*** describes two different types of commitments which have been used to deal with the problem of reducing greenhouse gas emissions in general, and of addressing developing country emissions in particular. Both of them – ***sovereign commitments*** and ***conditional commitments*** – are precursors to the ***joint commitments,*** which are the topic of the Report and are discussed more fully in Part III.

Part II introduces data concerning the Chinese power sector and projected growth of CO_2 emissions along business as usual (BAU) trajectories, and it explains the potential benefits from a joint commitment to lower the trajectory of CO_2 emissions growth from coal-based generation in China, in particular through an increase in wind-based electricity generation. The key points from a case study on the Chinese wind power sector – which has seen spectacular growth over the past five years, but is still small compared to its potential – are summarized. This part of the report also points to China's changing priorities in the wind power sector, and to new opportunities for large scale China–EU collaboration – specifically in wind park development, grid extension, and system operations – which could significantly increase wind power output and lower the projected trajectory of CO_2 emissions.

Part III explores the requirements for promoting large-scale collaboration. It proposes a top-down JCFA between the governments of China and the European counterparties. The aim of Part III is to introduce the concept of '***joint commitments***' and to investigate if and how a framework agreement involving such joint commitments could unleash the potential of large-scale substitution of coal by wind in the Chinese power sector.

Main conclusions and recommendations

The Report draws two main conclusions. The first is that both Chinese domestic policy and international agreements (bilateral and multilateral) have succeeded in supporting technology transfer by European companies involved in the wind turbine and related manufacturing sectors. The result has been growth in Chinese manufacturing capacity in the wind power sector, driving down the cost of wind power equipment and increasing Chinese wind generation capacity and output, supported by financial contributions under the Clean Development Mechanism (CDM).

The second conclusion is that China has changing priorities in the wind power sector – creating new opportunities for large-scale Sino-European collaboration. In particular, this Report identifies opportunities for collaboration, specifically in: wind park siting, development, and operations; grid development and extension; and the system operations required to integrate and back up wind power. Such collaboration could significantly increase Chinese wind power capacity and output, and thereby lower the projected path of CO_2 emissions. European companies are leaders in these fields and are interested in collaboration, provided the terms of participation can be agreed.

The Report makes a number of recommendations. The first is that the EU and China should explore further the potential of promoting large-scale collaboration between European and Chinese enterprises in the areas mentioned above related to wind park development, transmission extension and system operations.

Second, the existing EU–China Partnership on Climate Change seems ideally suited to establish a JCFA focused on promoting large-scale collaboration of this type. It allows both for EU–China commitments, as well as commitments between China and individual Member States.

Third, the Report recommends that the JCFA identify an agreed, quantified, target (with a date) for wind power production and related CO_2 emissions avoided. This target would preferably involve an increase over the targets already set by the Chinese authorities. The aim is to increase the scale of wind-based generation capacity and output, and in the process help to drive down the costs of displacing coal-based generation.

Fourth, under the JCFA, the EU (or Member States of the EU) and China would make certain commitments. On one side, the EU would commit to financial flows to China to support and accelerate the growth of wind power capacity and output in China, either through offsets or Nationally Appropriate Mitigation Actions (NAMAs). The EU would also finance technical and policy support to assist China in the development and extension of grids, and for improved system operation, to allow for the integration of an increased capacity of wind power on the Chinese power system. On the other side, China would agree to adapt its regulatory framework to make foreign investment in wind parks feasible.

For instance, focusing on wind parks, the EU could agree to provide financial support to supplement feed-in tariffs for wind power production from wind parks involving EU company operators. Some preliminary estimates of the costs of providing financial support to such projects can be derived from the extra costs of producing electricity from wind rather than from coal, assuming that the grid has been paid for separately and that back-up power will be available when the wind is not available[1]. Box 1 summarizes the additional costs of supporting the development of wind power in China and the potential to avoid CO_2 emissions.

With regard to Chinese contributions towards this type of collaboration, the Report recommends a reform of the conditions for awarding wind power concessions and deciding eligibility for financial support. Research has demonstrated that it is currently unattractive for a foreign investor to participate in a wind park concession for a variety of reasons, in particular those that make it difficult if not impossible to have management control of the park and to obtain CDM Credits. The Report makes a number of specific recommendations

[1] The calculation assumes 1€ = 9.25 RMB.

Box 1. Sample estimation of the cost and the benefit of supporting wind power in China

Here is a simplified example of how the EU could contribute to a significant increase in wind-based generation in China, together with estimates of how much CO_2 could be saved and how much it would cost. At the end of 2009, Chinese wind power capacity was about 26 GW. Let us examine the implications of reaching the goal of 100 GW of wind-based generation.

First, we estimate that the additional unit cost of wind-based generation (i.e. the difference between the average cost of a kWh from wind compared to coal) is about 0.1 RMB. If 74 GW of new wind power plants ran 30 percent of the time, that would amount to an additional 194 TWh of wind-based generation per year at an annual cost of about €2.15 billion. If the EU were to contribute 50 percent of the additional cost, that would be approximately €1.1 billion per year.

Second, assuming this wind power displaces coal, we estimate an annual reduction in emissions of about 196 tCO_2. Dividing the additional cost by the avoided CO_2 emissions works out to an average abatement cost of about €11/tCO_2. Current annual CO_2 emissions from the Chinese power sector are about 3,000 $MtCO_2$, so the implied reduction in emissions would be about 7 per cent, which is a substantial volume of emissions at a cost that is below the current price of emission allowances in the EU ETS.

that aim to overcome the barriers to foreign direct investment in wind parks.

The overall conclusion is that there is room for a win–win agreement. European counterparties would agree to provide financial and technical support to promote rapid development of efficient wind parks, as well as the needed grid extension and improved system operations to integrate and back up the increasing number of wind power installations. China would agree to develop new regulatory formulas to facilitate collaboration in these activities with European wind park developers, and with grid companies having special expertise in grids designed to accommodate growing amounts of wind power capacity. Beyond promoting collaboration in China, the proposals also aim to establish the basis for collaboration and joint ventures (or mergers) between European and Chinese enterprises in the wind power sector of other countries.

Finally, we want to stress the rationale for a joint commitment agreement. There is nothing in our list of proposals which could not be introduced in the absence of joint commitments. So, what could the adoption of joint commitments achieve, over and above the sort of commitments already undertaken in, say, the EU–China Partnership on Climate Change? The chief purpose is to ***provide an additional assurance to the relevant private sector companies*** that the government counterparties to the agreement are ***fully committed to the scheme at the envisaged scale***.

Introduction: Objective and Structure of the Report

Objective

The objective of this Report is to explore the potential for addressing developing country emissions at scale through bilateral '***Joint Commitment Framework Agreements***' (JCFA). To provide a realistic context, this exploration focuses on the potential for reducing the growth of ***coal-based emissions in the Chinese power sector*** through large scale collaboration between ***European and Chinese enterprises***. Essentially, this Report explores the proposition that under a Sino-European JCFA, European companies will be more likely to collaborate with Chinese enterprises, to transfer and develop low carbon technologies and know-how that will help to achieve jointly agreed carbon emission reductions in the Chinese power sector. Specifically, we focus on exploring an agreement that could unlock the potential for a significant increase in the production of electricity from wind. It is important to point out from the outset that this sort of strategic collaboration under a bilateral agreement is complementary to, and indeed reinforces the UN-sponsored multilateral climate change regime.

Structure

The Report is divided into three Parts. ***Part I*** – based on ideas originally put forward in Müller (2008)[2] – describes two different types of commitments which have been used to deal with the problem of reducing greenhouse gas emissions in general, and of addressing developing country emissions in particular. Both of them – ***sovereign commitments*** and ***conditional commitments*** – are precursors to the ***joint commitments*** which are the topic of the Report and are discussed more fully in Part III.

Part II introduces data concerning the Chinese power sector and projected growth of CO_2 emissions along BAU trajectories, and it explains the potential benefits from a joint commitment to lower the trajectory of CO_2 emissions growth from coal-based generation in China, in particular through an increase in wind-based electricity generation. The key points

[2] Benito Müller, 'St Petersburg 2008 − Developing Country Emissions: Common and Joint Responsibilities', *Oxford Energy and Environment Comment*, Oxford: OIES, September 2008. Available at: www.oxfordenergy.org/pdfs/comment_0908-1.pdf

from a case study[3] on the Chinese wind power sector – which has seen spectacular growth over the past five years – are summarized. This case study illustrates that Chinese domestic policy and international agreements (bilateral and multilateral) have supported technology transfer by European companies involved in wind turbine and related manufacturing sectors. This part of the report also points to China's changing priorities in the wind power sector, and to new opportunities for large scale China–EU collaboration – specifically in wind park development, grid extension, and system operations – which could significantly increase wind power output and lower the projected trajectory of CO_2 emissions.

Part III explores further the requirements for promoting large-scale collaboration. It proposes a top-down JCFA between the governments of China and the European counterparties. The aim of Part III is to introduce the concept of '***joint commitments***' and to investigate if and how a framework agreement involving such joint commitments could unleash the potential of large-scale substitution of coal by wind power in the Chinese power sector.

[3] The case study is in the Appendix to this Report.

Part I. The Nature of Commitments

The aim of this Part, based on Müller (2008), is to provide the conceptual background underpinning the notion of a 'joint commitments', which is at the heart of the envisaged Joint Commitment Framework Agreement.

1.1. Sovereign Commitments

Traditionally, the problem of reducing global anthropogenic greenhouse gas emissions has been couched in terms of whether or not countries should take on legally binding sovereign commitments to reduce 'their' emissions (i.e. the emissions emanating from their sovereign territories). This tradition is very much alive.

A global survey of 'Climate Decision Makers',[4] for example, states that *respondents are almost unanimous in calling for an effective international post-2012 agreement that includes all major emitting countries, and has rich countries transferring aid and technology to developing country signatories, as well as* ***legally binding country targets****. They are not confident this will be in place by 2009*.

The lack of confidence in this happening by 2009 was clearly justified. Given the prevailing differences in historic responsibilities for the problem, and the respective capacities to deal with it, it is indeed highly unlikely that the 'major emitting' developing countries will be willing to adopt (internationally) binding mitigation commitments/targets any time soon. This became very clear during the UNFCCC workshop on *voluntary commitments* – a proposal put forward by the Russian Federation – held in Bonn, Germany in July 2007.[5] Almost all of the developing country interventions rejected the idea, for fear of being led down the slippery slope towards binding commitments. This was expressed by Egypt, which saw the proposal *as a kind of way of bringing pressure to bear on developing countries in the context of voluntary commitments that would become binding commitments*.[6]

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[4] Globescan (2008) 'Climate Decision Maker Survey: WAVE 1 Report of Findings', 2 July 2008. Available at www.globescan.com/news_archives/climate_panel2/GlobeScan_Climate_DecMaker.ppt

[5] For more on this, see Benito Müller, 'Bonn 2007: Russian Proposals, Policy CDM, and 'CER Put Options' (CERPOs)', *OIES Energy and Environment Comment*, July 2007. Available at www.oxfordenergy.org/pdfs/comment_0707-1.pdf

[6] Benito Müller, 'Bonn 2007: Russian Proposals, Policy CDM and 'CER Put Options' (CERPOs)', *OIES*

The UK House of Commons Environmental Audit Committee, in its report on *Reaching an International Agreement on Climate Change*,[7] has been rather more circumspect in its demand that *the* [UK] *Government must take a subtle approach to the negotiations, particularly with respect to developing countries. It will have to work closely with them to explore the actions that they might be willing to commit to. … Emission reduction targets for developing countries would not be equitable in all cases given historic emissions.* The conclusion − namely that *all developing countries will need to commit to a range of actions, but those in which per capita GDP is growing quickly will need to commit to more robust measures* − however, remained in the traditional conception, albeit with the concomitant acknowledgment that *substantial developed country financing will be required in order to shift developing countries onto a low-carbon path and also to encourage them to agree to mitigation actions.*[8]

1.2. Conditional Commitments

As has been argued elsewhere,[9] there is a fundamental conceptual difference between sharing the burden of developed and that of developing country emission reductions. The traditional conception illustrated above may be appropriate in the case of industrialized countries. Developing countries have always insisted, on the grounds of the UNFCCC principle of differentiated responsibilities and respective capabilities (Art. 3.1), that their emissions cannot be dealt with in the same way. Indeed, that difference was already clearly reflected in the Convention, which in Article 4.7 states that *the extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology …*

In other words, developed country commitments in the Convention − and elsewhere − are

Energy and Environment Comment, July 2007:5. Available at www.oxfordenergy.org/pdfs/comment_0707-1.pdf

[7] House of Commons Environmental Audit Committee (2008), 'Reaching an international agreement on climate change', Sixth Report of Session 2007–08, July 2008.

[8] *Op. cit.* p.3.

[9] See, for example: Benito Müller, 'Bonn 2007: Russian Proposals, Policy CDM, and 'CER Put Options' (CERPOs)', *OIES Energy and Environment Comment*, July 2007; and Benito Müller, 'Bali 2007 – On the road again! Impressions from the Thirteenth UN Climate Change Conference', *Oxford Energy and Environment Comment*, February 2008. Available at www.OxfordClimatePolicy.org

unconditional ('sovereign'), while those entered into by the developing world have been conditional on actions by the developed world. This conditional conception has been consistently reaffirmed by developing countries. In Bali, it manifested itself in the final and most acrimonious debate of the whole Conference on whether 'MRV' ('measurable, reportable, and verifiable') should apply only to developing country mitigation actions, or also to the supporting and enabling finance, technology, and capacity building.

Another prominent manifestation was in the Statement by the Leaders of Brazil, China, India, Mexico, and South Africa ('G5') in the wake of their participation at the Hokkaido G8 Summit (July 2008), where they committed themselves *to undertaking nationally appropriate mitigation and adaptation actions which also support sustainable development. We would increase the depth and range of these actions supported and enabled by financing, technology and capacity-building with a view to achieving a deviation from business-as-usual.*[10]

There is, however a third option – beyond sovereign and conditional commitments – to address the problem of developing country emissions, as highlighted in Mr Kapil Sibal's (Indian Minister of Science and Technology and Head of the Indian Delegation) Bali closing statement conclusion that:

*It is not a question of what **you** will commit or what **I** will commit.*
*It is a question of what **we** will commit **together** to meet that challenge!*

There is, of course, a sense in which what we commit to *is* a question of what you and I commit to. What Mr Sibal had in mind was clearly something different, namely a question of making a *joint commitment*, as opposed to synchronous independent ('sovereign') commitments. To be sure, he may have had in mind the sort of binding conditional commitments discussed earlier − i.e. 'I commit to emission reductions if you commit to finance and technology' − but the interesting point is that there are other, and arguably more promising/realistic forms of joint commitments which are at the heart of the envisaged JCFAs.

[10] Document available at http://pib.nic.in/release/release.asp?relid=40146

1.3. The Concept of 'Joint Commitments'

As explained above, different conceptions of 'commitment' have been used to refer to the problem of addressing developing country greenhouse gas emissions. In the context discussed here, the traditional '***sovereign***' conception would have China take on an internationally binding commitment to comply with a certain mitigation target ***on its own***. Under the ***conditional*** format, China would do the same, but the commitment would only be valid ***under certain conditions*** (e.g. that someone else, say the EU, provides sufficient finance/technology to meet the relevant mitigation target). Under a ***joint-responsibility*** arrangement, China together with some partner(s) − say again the EU − would commit themselves to ***achieve this target jointly***.

The difference between the three conceptions becomes apparent when one asks who would be praised/blamed if the target was or was not achieved. In the first case, the blame/praise would only be with China. In the second case, it could be with China, the EU, or with both, whereas in the joint-responsibility case in can only be with both.

The idea of taking on international joint commitments in this narrow sense is nothing new. After all, many if not most ***defence treaties*** seem to have this type of format. The North Atlantic Treaty of 1949, for example, establishes a collective responsibility for the defence of its signatories. Article 3 of the Treaty states that *in order more effectively to achieve the objectives of this Treaty, the Parties, separately and jointly, by means of continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack.* Indeed, the joint commitment idea emerges even more clearly in the 1999 revision of the Alliance's Strategic Concept[11] which, in Paragraph 8 states that

> *The fundamental guiding principle by which the Alliance works is that of common commitment and mutual co-operation among sovereign states in support of the indivisibility of security for all of its members. Solidarity and cohesion within the Alliance, through daily cooperation in both the political and military spheres, ensure that*

[11] Approved by the Heads of State and Government participating in the meeting of the North Atlantic Council in Washington D.C. on 23 and 24 April 1999.
Available at: www.nato.int/cps/en/natolive/official_texts_27433.htm

no single Ally is forced to rely upon its own national efforts alone in dealing with basic security challenges. Without depriving member states of their right and duty to assume their sovereign responsibilities in the field of defence, the Alliance enables them through collective effort to realise their essential national security objectives.

The first key question left open in this context is who should enter into such joint-commitment agreements in the context of mitigating developing country emissions? To be very clear, the idea here is *not* to supplant the principle of common (but differentiated) responsibilities of the Convention. As a matter of fact, there are a number of ways in which the Bali Action Plan strictures regarding mitigation actions in developing countries could be implemented – e.g. through Annex I CER (Certified Emission Reductions) Retirement Obligations – without recourse to such joint commitments. Indeed, it seems that joint-commitment agreements would probably be best suited to bilateral activities, supplemental to the UNFCCC.

The second question to be addressed is how one would implement such joint commitments for mitigating developing country emissions. This is the main subject of our report.

1.4. Strategic Collaboration: Partnerships and Joint Ventures

There have been a large number of 'strategic' international collaborative climate change efforts, that is to say collaborations with government involvement (for more on this, see Part II). Most, if not all were 'strategic partnerships'. For example, the US-led ***Asia–Pacific Partnership on Clean Development and Climate***[12] which in its non-legally binding Charter sets itself the aim of creating *a voluntary, non-legally binding framework for international cooperation to facilitate the development, diffusion, deployment, and transfer of existing, emerging and longer term cost-effective, cleaner, more efficient technologies and practices among the Partners*. Another example is the ***EU–China Climate Change Partnership***[13] with the aim, by 2020, *to develop and demonstrate, in China and the EU, advanced "zero-emissions" coal technology [and] to significantly reduce the cost of key energy technologies and promote their deployment and dissemination*.

[12] www.asiapacificpartnership.org/
[13] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/05/298

The form of these strategic partnerships is very similar to − and most likely based on − what the business sector calls '***strategic alliances***', that is formal relationships between independent partners with the aim of pursuing certain agreed business goals, but without creating an independent management structure. Given the longer-term goals of these strategic climate change partnerships, it is at this point of time difficult to evaluate their chances of success, although it is generally recognized that some of them are likely to perform less well than would be desirable.

Businesses − particularly in the oil and gas sector − have considerable experience with an extension of the 'strategic alliance' model, the so-called '***joint ventures***', where the collaboration actually involves the formation of a new separate and dedicated management entity. One of the best known examples of such a joint venture is that of Sony Ericsson, a firm established in 2001 by Sony Corporation, the Japanese consumer electronics company, and Ericsson, the Swedish telecommunications company, to take over their mobile phone productions. As it happens, a number of countries such as China, and to some extent India, already require foreign companies to form joint ventures with domestic firms, in order to enter the market. This may well be of significance in the present context, given the importance of these two countries with respect to solving the developing country emission problem.

At the 'strategic' (i.e. international political) level, the equivalent of such a joint venture would presumably be something in which member states of the EU have been engaged ever since the Treaty of Rome in 1957. Clearly, it would be unrealistic to think that countries would decide to embark on such a strong strategic joint venture just to pursue climate change aims. However, there are weaker versions, such as the collaboration under the above-mentioned North Atlantic Treaty which, after all, gave rise to the North Atlantic Treaty Organization (NATO) with its own HQ, command structure, and budget.[14]

The key to the success of any such collaboration − be it as a strategic political alliance or joint venture – is its potential to deliver tangible mutual benefits ('win–win' outcomes) for

[14] See, for example: 'North Atlantic Treaty Organization', (2008). In Encyclopædia Britannica. Retrieved 14 July 2008, from *Encyclopædia Britannica Online*:
http://search.eb.com/eb/article-218591

the partners. The more tangible the benefits, the more likely the success. This also holds true at the strategic international level, where 'tangible' means near-term economic benefits, as witnessed in a press article about the 2006 *US–India Peaceful Atomic Energy Cooperation Treaty*. At the time, the deal still needed agreement from the *International Atomic Energy Agency* (IAEA), the Nuclear Suppliers Group − which seeks to curb proliferation by controlling nuclear exports – and crucially from the US Senate (by way of ratification). According to the article, the *Administration may warn Congress that if the IAEA and the group pass the deal but it does not, other countries will get the commercial benefit of selling kit to India*.[15]

While there are already a number of strategic (international political) partnerships dealing with climate change − and specifically with developing country emissions − it is not clear whether they will be able to achieve the enormous task of tackling these emissions in a manner consistent with global environmental and domestic developmental objectives.

While there have been a number of relatively successful strategic international collaborations (e.g. NATO) which have been based on the idea of genuine joint commitments between the partners, this has not yet been true in the climate change domain. Based on the initial argument that mitigating developing country emissions should be treated as a matter of joint commitment between developed and developing countries, it therefore seemed reasonable to consider the possibility of international (bilateral) ***Joint Commitment Framework Agreements*** (JCFAs) as part of a strategic partnership/joint venture to mitigate certain developing country emissions and thereby help to achieve the twin goals of global environmental integrity and national sustainable development in developing countries. Joint commitments might provide sufficient incentives for governments to take seriously the need for constructive collaboration, while the partnership/joint venture model might provide the necessary additional private sector incentives and confidence to carry out the job on a large scale.

These will be discussed in more detail in Part III of this Report.

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[15] Bronwen Maddox, 'Harm done by US–India nuclear pact eclipses benefits', *The Times*, London, 11 July 2008, page 38. See also Glenn Kessler, 'Congress May Not Pass U.S.–India Nuclear Pact: New Delhi Could Turn to Other Nations', *Washington Post*, Wednesday, 9 July 2008; Page A10

Part II. The Case for Large-scale Sino-European Collaboration

This part of the Report makes the case for large scale Sino-European collaboration to promote the expansion of wind generation in China. It has three sections. First, it outlines the reasons for focusing on the Chinese power generation sector in general and the wind power sector in particular, and it identifies the potential benefits of Sino-European collaboration. Second, it examines the past experience of this collaboration in relation to wind power, both between firms and between governments. We refer to these two categories of collaboration as 'bottom-up' (firm-level) and 'top-down' (government-level) collaboration, respectively. Third, it identifies the most promising opportunities for larger scale commercial collaboration to increase the production of electricity from wind, and some of the barriers that must be overcome to take advantage of those opportunities. This part of the report draws on the case study of the Chinese wind power sector contained in the Appendix.

2.1. Potential Benefits of Large Scale Collaboration

2.1.1. Data Relating to the Chinese Power Sector

We have chosen to study the Chinese power sector because of the growing importance of CO_2 emissions from that sector, and the potential of reducing the level of those emissions through large scale Sino-European collaboration.

According to the IEA World Energy Report 2009 (WEO 2009),[16] Chinese energy-related CO_2 emissions in 2007 were 6,071 $MtCO_2$, about 21 per cent of the global energy-related emissions of 28,826 $MtCO_2$. That same report forecasts Chinese energy-related emissions in 2030 to be 11,615 $MtCO_2$, which is 29 per cent of the forecast global figure of 40,226 $MtCO_2$. In view of the volume and growth of these emissions, it is important to ask: from where do these emissions come and what is being done to curb them?

Coal accounts for about 82 per cent of Chinese CO_2 emissions, primarily from the power sector. According to the WEO 2009, China gets about 80 per cent of its electricity output

[16] IEA, World Energy Outlook 2009, pages 622 and 647. These forecasts are for the base case, which reflects business as usual, including legislation that has been adopted. We will refer to this document as WEO 2009.

from coal. In 2007 Chinese coal-based generation emitted 2,997 $MtCO_2$, about 10 per cent of world energy-related CO_2 emissions. That year, the Chinese power sector had about 700 GW of generating capacity, of which about 71 per cent was coal-based. Looking forward to 2030, the IEA forecasts Chinese generation capacity of 1,936 GW, of which 66 per cent would be coal-based. If this forecast proves accurate, it would mean that Chinese coal-based generation in 2030 would be more than double its 2007 levels, accounting for about 6,244 $MtCO_2$, which would be about 15 per cent of global CO_2 emissions.

China has introduced a number of policy measures aimed at slowing the growth of CO_2 emissions. Goals include a 20 per cent reduction in energy intensity (per unit of GDP) by 2020 compared to 2005, and a 15 per cent share of primary energy from renewable sources by 2020.[17] To achieve these medium-term objectives, the Government has promoted increased efficiency of coal-based generation through the decommissioning of inefficient plants and a significant increase in the role of zero-carbon generation technologies. The Government has also introduced policies aimed at improving energy efficiency in end uses, and restructuring the economy towards less energy- and carbon-intensive activities. Since our focus is primarily on the power generation sector, we discuss briefly below the measures taken to lower emissions from coal in that sector, and then turn to the role of renewable energy and wind power in particular.

Within the coal-based generation sector, the main measure has been to shut down small and inefficient coal plants, and to replace them with larger and more efficient (supercritical and ultra supercritical) ones. This policy[18] has lowered average coal consumption and resulted in 60 million tons of avoided CO_2 since the policy was introduced. The plan is to decommission an additional 100 GW of inefficient capacity in the next few years, which could lead to a reduction in annual CO_2 emissions of approximately 200 $MtCO_2$.[19] This policy lowers CO_2 emissions, as well as the unit cost of electricity, hence its popularity. Looking further ahead, the Chinese Government is promoting the development of different

[17] See Appendix.

[18] 'How Does China Reduce CO_2 Emissions From Coal Fired Generation?', Jianxiong Mao, Tsinghua University, Department of Thermal Engineering, Beijing. Presented at World Bank 2009 Energy Week, Washington DC, 31March – 2April, 2009.

[19] A Greenpeace report estimates that decommissioning 100 GW of coal plants by 2012 would reduce CO_2 emissions by 200 million tons of CO_2 annually. *Polluting power: ranking China's power companies*, 28 July, 2009, page 5. Available at www.greenpeace.org/raw/content/china/en/press/reports/power-ranking-report.pdf

Carbon Capture and Storage (CCS) technologies[20] with a view to their introduction after 2030.

The Government is also promoting a significant increase in zero carbon electricity, notably from hydroelectric, nuclear, wind, biomass, and solar energy. According to the WEO 2009,[21] hydro capacity will more than double, from 145 GW in 2007 to 315 GW by 2030, whereas nuclear capacity will increase from 8 GW to 60 GW. However, because of the enormous size and growth of projected electricity demand, the share taken by hydro falls from 21 per cent to 16 per cent of installed capacity, and that by nuclear will only increase from 1 per cent to 3 per cent. The combined capacity of wind, solar, and biomas, on the other hand, is forecast by WEO 2009 to grow from 6 GW in 2007 to 144 GW by 2030. Wind power alone is forecast to grow to 95 GW by 2030, which would be about 5 per cent of capacity. These IEA forecasts constitute a base case and certainly understate the potential role of wind, as we discuss below.

The conclusion is that, in spite of the many measures being taken to reduce emissions growth, projected economic growth in China will continue to drive up coal-based generation and coal-based emissions. It is against this backdrop that we see opportunities for a Sino-European agreement to cut CO_2 emissions growth through an accelerated development of the wind power sector.

2.1.2. The Potential Benefits of Collaboration in the Wind Sector

From the Chinese perspective, economic development that allows for rising living standards for the Chinese population, and for energy security, is a key political objective. There are at least three ways in which the sort of large-scale collaboration we have in mind could support that objective.

- First, keeping energy costs as low as possible is obviously important. As long as coal is the cheapest source of energy, and is domestically produced, it is easy to understand why Chinese economic development is fuelled by coal. Wind power is typically at least 50 per cent more expensive per unit than coal, if CO_2 costs are ignored. However, for a variety of reasons (including concerns about the consequences of serious environmental

[20] Of the different CCS technologies, we understand that post-combustion technologies are likely to come first.
[21] WEO 2009, page 647.

degradation in China), the Chinese Government has adopted renewable energy targets and other measures aimed at reducing CO_2 emissions growth. We assume that the aim is to achieve those targets at least cost. Large-scale collaboration with leading wind power manufacturers, wind park operators, and grid companies (with experience in dealing with large-scale wind power resources) from Europe and around the world is one means of reducing the cost of meeting the targets. Put another way, collaboration of this kind is a means of going as far beyond the targets as possible (in terms of replacing coal), for any given budget.

- Second, the Chinese Government has also supported the development of renewable energy equipment manufacturing in China, to provide a base for successful exports of this equipment and for international expansion by Chinese companies in this sector. Collaboration with European wind turbine and related equipment manufacturers has already been successful, involving technology transfer to China, as well as collaborative technology development between Chinese and European firms. Three of the world's leading wind turbine manufacturers are Chinese companies (Goldwind, Sinovel, and Dongfang) and foreign operators (e.g. Gamesa) now have substantial and state-of-the-art operations in China. Furthermore, Chinese wind park companies are now entering international capital markets.
- Third, the Chinese Government upholds the principle of common but differentiated responsibilities, which is a core principle of the UNFCCC. This ties developing county mitigation efforts to developed countries bearing the incremental costs and providing different kinds of support. Large scale collaboration with European enterprises is a way for developed countries to provide financial and other support to China, for instance through the Clean Development Mechanism (CDM).[22]

From the perspective of European enterprises, the Chinese market for almost all services and goods is among the most important in the world. The size and growth of the market is unparalleled. Large-scale collaboration between European and Chinese enterprises is a way of participating in the growth of that domestic market. China is also now a major exporter of manufactured goods (e.g. turbines, solar panels) and of capital. European firms may benefit as buyers of products manufactured in China, as recipients of Chinese capital (potentially as

[22] Note, however, that if the CERs generated are used as offsets, then the money paid for them is unlikely to be considered to be financial support as envisaged in paragraph 1.b.ii of the Bali Action Plan, and consequently will not be eligible to count towards compliance with financial commitments (by developed countries).

takeover targets) and as joint venture partners in pursuit of global markets.

From a global perspective, the obvious potential benefit is the effect on the environment. As explained above, on a BAU basis, coal-based generation in China could account for 15 per cent of global energy-related emissions in 2030. If large-scale collaboration facilitates the transfer and adoption of power technologies that displace coal in the Chinese power sector, then this is a powerful incentive to encourage such collaboration. According to the World Energy Commission, using one million kWh of wind power will save 600 tons of CO_2 emissions. If 30 GW of wind power were installed in China by 2020 and the annual power generation from wind reached 60 billion kWh, the annual CO_2 emission reduction would be 36 $MtCO_2$.[23] Although this is a drop in the bucket when compared to annual estimated emissions in that year of 3,000 $MtCO_2$ from the power sector, if wind power capacity were to rise to 300 GW, which is within the technical potential, then the CO_2 reductions would become material – more than 10% of the estimated Chinese CO_2 emissions from power in 2020.

If larger-scale commercial collaboration potentially generates substantial net benefits, the question is whether and under what conditions it will occur. We illustrate below that domestic Chinese policies and international agreements can facilitate (but are now limiting) commercial collaboration of the kind we have in mind. The aim of the study is to examine whether and how a JCFA can contribute to making markets work better, and to facilitate even more effective large-scale collaboration, in the interest of lowering CO_2 emissions from the Chinese power sector.

2.2. Wind Power – Sino-European Development and Collaboration to Date

This section briefly introduces the highlights of the Chinese wind power sector's development and analyzes the role of Sino-European collaboration in that sector – first from the perspective of commercial collaboration, and then from the perspective of international agreements that were meant to facilitate that collaboration. We argue that, while collaboration to date represents success in terms of building up a wind power industry, the

[23] China Wind Power Report, 2007, Li Junfeng, Gao Hu, Shi Pengfei, Shi Jingli, Ma Lingjuan, Qin Haiyan, Song Yanqin, plus Greenpeace Coordinators (Yang Ailun, Liu Shuang Niu Jitao) and GWEC Coordinator (Steve Sawyer), page 40. Available at www.greenpeace .org/raw/content/china/en/press/reports/wind-power-report.pdf. Referred to hereafter as *China Wind Power Report, 2007*.

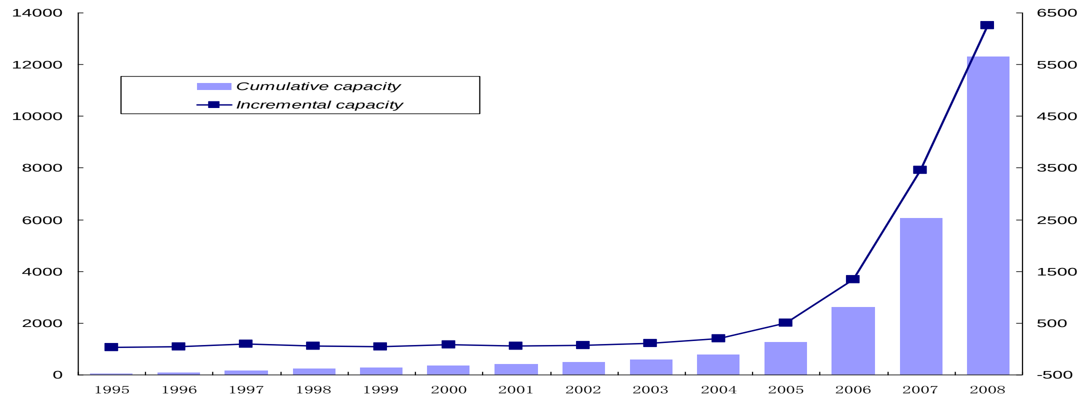
impact on CO_2 emissions reduction has so far been relatively small. The limits of this success point towards areas in which further, larger-scale, collaboration should be encouraged, to drive down costs and substantially increase the penetration of wind power, so that emission reductions can be materially significant.

2.2.1. Background to the Growth of the Wind Power Sector in China

The technical potential for wind power in China is substantial. At a height of 10 metres, the technical potential of onshore wind power resources is about 300 GW, with an annual electricity generation potential of more than 594 TWh, which is more than 18 per cent of the total electricity production of China in 2007. At a height of 15 metres, the potential is significantly greater.[24]

The history of China's wind power sector development can be split into four phases (see Box 2 for a summary of wind power capacity expansion).[25] The first, between 1986 and 1993, involved the building of small-scale demonstration wind farms, using grants from donor countries. The second phase, 1994–2003, saw the development of wind farms connected to the grid, and a set of regulations and subsidies designed to finance wind farms, which sold their energy to the grid. The third phase (2004–2008) saw an accelerated programme of wind power development. Under this system, the goal was to expand the rate of development, improve the local manufacturing capability, and to lower power generation costs. Since 2004 China's wind power industry has been growing at an unprecedentedly

Box 2. Chinese Wind Power Capacity: 1995–2008 (MW)



Source: See Appendix.

[24] See Appendix. Also note that a recent study by MIT and Tsinghua University has estimated that Chinese wind potential could provide seven times China´s current electricity consumption. See www.ccchina.gov.cn/en/NewsInfo.asp?NewsId=19338

[25] See China Wind Power Sector Report, 2007, page 5 for a description of the first three stages.

high rate. The cumulative installed capacity of wind turbines went from 550 MW in 2003 to 12 GW in 2008, with new installations of 6.2 GW in 2007 alone.

The fourth stage began in 2008, when the newly established National Energy Administration highlighted wind energy as a priority for diversifying China's energy mix. The bureau selected six locations from the provinces with the best wind resources, and decided that each would have more than 10 GW of installed capacity by 2020. In 2009, China became the world's largest market for new installed wind power capacity. We understand that wind power capacity at the end of 2009 is about 26 GW. Added to the existing base and to wind power projects in other parts of China, the additional large projects being planned suggest that China will have more than 100 GW of installed capacity producing 200 TWh per year by 2020.[26]

What explains this significant growth? Both domestic policy and international collaboration have played a role. We focus first on a few key domestic policies, notably the combination of legislation on renewable energy, the wind power concession programme, and renewable targets. Later we examine the role of China–EU collaboration.

2.2.2. Domestic Legislation Favouring Wind Power

RENEWABLE ENERGY LAW

China's Renewable Energy Law was passed by the People's Congress on 28 February 2005, and took effect on 1 January 2006. The law recognizes the strategic role of renewable energies in optimizing China's energy supply mix, mitigating environmental pollution, and promoting rural social development. It also relates renewable energy development and utilization directly to China's energy system transition. The law has largely shaped an integrated renewable energy policy framework by providing a set of directives encouraging and enabling renewable energies. Wind power development has been listed as a priority technology and was highlighted by the law. More importantly, the law has laid a legal foundation for wind energy investments and government intervention in China.

[26] GWEC website, www.gwec.net/index.php?id=125

WIND CONCESSION PROGRAMME

In China the development of any wind power project over 50 MW needs to go through a concession tendering procedure that is coordinated by the National Development and Reform Commission (NDRC).[27] In order to improve cost-effectiveness through competition, potential developers are invited to join a public bidding process. Those who offer the 'best price' under certain terms will win the concession, and thus have the right to build wind farms on the concession sites. The wind power developers selected by the concession programme will also have the right to sell the electricity under the agreed tariff to the grid, which is guaranteed by the government through a Power Purchase Agreement (PPA). From 2003 to 2008, five rounds of concession biddings were implemented, and a total of 49 wind farms were approved with a total capacity of 8,800 MW. Most of them are located in Guangdong, Jiangsu, Inner Mongolia, Jilin, Gansu, and Hebei provinces.

The programme has been modified in the process of implementation. In order to strengthen the role of local wind turbine manufacturers, a 70 per cent of domestic content rule for wind turbines has been required since the second round of bidding.[28] To avoid the excessively low prices that sometimes resulted during the first two rounds of bidding, and subsequently prevented effective implementation, a comprehensive evaluation method has been introduced since the third round of bidding. With the new method, the selection of the concession developers is based not only on the energy price bid by the developer (long-term power purchasing agreement) but also on the technological proposals.

MANDATORY RENEWABLE MARKET SHARE

A mandatory target has been introduced, to increase the share of renewable energies in national energy supply. Renewable energies have to account for 10 per cent of the total energy consumption by 2010, and 15 per cent by 2020 respectively. The share of renewable power capacity (excluding hydro) in the main electricity grids should reach 1 per cent by 2010 and 3 per cent by 2020. Those electricity companies with an installed capacity of more than 5 GW are 'requested' to have a share of renewable power (excluding hydro) in their electricity generation capacity of more than 3 per cent by 2010 and 8 per cent by 2020.

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[27] Provincial development and reform commissions approve projects of less than 50 MW and negotiate the terms and conditions for these installations.

[28] This requirement no longer applies, but we have been told by European companies that the Chinese Government has introduced new measures to favour equipment whose technology has been developed in China.

Wind power has been identified as a priority renewable energy technology. According to the Plan, the installed capacity of wind power should reach 5 GW by 2010. Since the cumulative installed capacity of wind power surpassed 6 GW in 2007, the NDRC increased the wind power target for 2010 from 5 GW to 10 GW. Based on the current momentum of development, the total installed capacity of wind farms could exceed 30 GW by the end of 2010.

This last point serves as an illustration of the importance of quantitative targets, which is at the heart of the proposal put forward in Part III of this Report.

POWER SURCHARGE FOR RENEWABLE AND PREMIUM

The Chinese Government has implemented a surcharge of 0.2 cent RMB/kWh of electricity sales to subsidize renewable power including wind power. In January 2006, a policy document named 'Interim Measures of Renewable Energy Tariff and Cost Sharing Management' was released by the NDRC. For wind power, a public bidding process is required for projects with a capacity over 50 MW. The difference between the long-term contract price for wind power and that of the local coal-fired power is covered by a fund.

Although these and other domestic policies have been central to the development of wind power, there is also evidence to suggest that Sino-European collaboration has played an important role in the manufacturing of wind turbines and, to some extent, in the development of wind parks. The analysis below explores this collaboration, and highlights some of the limits, especially as far as the environmental benefits (reduction of CO_2 emissions) are concerned. It also suggests new methods of collaboration, to achieve more significant CO_2 reductions.

2.2.3. Varieties of International Collaboration

'BOTTOM UP' COLLABORATION

Sino-European company collaboration has in many respects been successful in transferring technology that has enabled Chinese companies to develop their own wind turbine and related manufacturing capabilities.

Such collaboration has taken various forms. It has progressed in stages: from importation of European turbines in the late 1980s, such as by Goldwind in 1988–9; to licensing of

European technology from the mid 1990s to the mid 2000s, such as the agreement between Goldwind and German Jacobs in 1997; to joint development of technology between European and Chinese firms since the mid 2000s, such as the agreements between Sinovel and German Fuhrlander in 2003 and Austria Windtec in 2007; and finally to acquisition by Chinese firms of European firms, such as the acquisition of German Vensys by Goldwind in 2008.

The share of domestic and joint venture wind turbine manufacturers in new turbine installations climbed from 25 per cent in 2004 to 75.6 per cent in 2008. The two biggest domestic wind turbine manufacturers, Sinovel and Goldwind, shared 40.6 per cent of the newly installed capacity in 2008, while their foreign counterparts, Vestas and Gamesa, jointly installed 17.7 per cent. In terms of the cumulative installed capacity, domestic and joint venture manufacturers accounted for 61.8 per cent while foreign companies accounted for 38.2 per cent. It is generally acknowledged that Chinese manufacturers are now major global competitors for the foreign companies and that they will take an increasingly large share of the Chinese market for wind turbines.

The evolution of collaboration between European and Chinese manufacturers of wind turbines reflects the policy of localization and the successful development of a significant domestic wind energy manufacturing industry in China in recent years. There are now over 20 domestic wind turbine manufacturers in China, most of which have the capability of manufacturing wind turbines with a generating capacity of 750 kW, and some of which are in the process of developing megawatt-scale turbines.[29] As mentioned above, three Chinese turbine manufacturers (Sinovel, Goldwind, Dongfang) are among the world's top ten, and other leading companies (e.g. Gamesa) have major manufacturing operations in China.

If bottom-up collaboration in manufacturing has involved both European and Chinese operating enterprises, the situation is somewhat different for wind parks. There, all of the wind parks connected to the grid have been awarded to state-owned electricity companies. European collaboration in this part of the business has been primarily in the financing of the projects. Thus far, bottom-up collaboration among operating companies has therefore been confined largely to the manufacturing end of the wind power business in China.

[29] J. Han et al, *Energy Policy* 37 (2009), p. 2948

‘TOP DOWN’ COLLABORATION

There are two types of top-down collaboration which deserve mention: high level international agreements, and more specific agreements directly aiming to facilitate bottom-up commercial collaboration in the wind power sector. Of the latter, we have identified two types that are relevant to this study: bilateral agreements between China and a Member State of the EU promoting wind power technology transfer; and financing mechanisms, such as the Clean Development Mechanism (CDM), and specifically the European policy of accepting offsets from CDM projects under the EU Emission Trading Scheme (ETS).

HIGH LEVEL INTERNATIONAL AGREEMENTS

There are many international agreements, frameworks, and organizations, which aim to promote renewable energy and climate change mitigation at a regional or global level, but these are mostly broad and aspirational.[30] At the bilateral level, in 2005 the EU and China established a framework for cooperation on climate change known as the ‘EU–China Partnership on Climate Change’.

It is too early to say whether these broad agreements have succeeded or will succeed. However, we see limitations. First, they were not designed to target a specific quantified reduction in CO_2 emissions. Second, there is scope for collaboration at significantly greater scale than these agreements envisage. Also, the agreements do not really tackle the problems impeding large-scale collaboration. Nonetheless, as explained in Section III, a JCFA focusing on the wind power sector in China could constitute a concrete instance of enhanced cooperation within the context of the EU–China Partnership on Climate Change.

BILATERAL AGREEMENTS

There has been a range of initiatives by European governments to promote collaboration between European and Chinese wind energy firms. Some of these initiatives were in the early days of wind power sector development, before 2000. For instance, the Danish Government supplied US$3 million in grant support to Goldwind for the purchase of turbines manufactured by Danish firms in October 1989. Using this support and 6.7 million RMB of its own funds, Goldwind purchased 13 sets of 150 kW wind turbines from Bonus

[30] These include the Asia–Pacific Partnership on Clean Development and Climate, the Renewable Energy Policy Network for the 21st Century (REN21), the Renewable Energy and Energy Efficiency Partnership (REEEP), and the International Renewable Energy Agency (IRENA), which is in the process of being established.

and one set of 100 kW turbines from Wincon. Similarly, in 1996 the Danish Government gave US$50 million of mixed credit to construct the Huitengxile Wind Farm.[31]

The German Government also provided support to collaborating European and Chinese firms. In 1996, the German Government helped Goldwind to install and operate 600 kW wind turbines, which were the most advanced technology in China at the time, provided a loan for Goldwind to enlarge the Dabancheng wind farm, and gave a direct subsidy to a German turbine manufacturer to support their joint ventures. Other governments, such as those of Spain, the Netherlands, and Belgium, have provided support for collaboration, in the form of concessionary loans, with the aim of promoting their own exports to China.[32]

How effective were these agreements in promoting development in the wind power sector? Success should be judged by what could reasonably have been expected. The early agreements succeeded in creating an embryonic wind power manufacturing industry based in China. Some critics argue that the availability of subsidized loans from foreign governments reduced Chinese willingness to pay full cost for commercial machines and may have initially stifled the development of a sustainable commercial market because wind power installations were limited to those obtained with concessionary finance.[33] On the other hand, wind power has received public subsidies and strong regulatory support in all countries where it has developed successfully; so China is not unusual in that respect. A commercial market only started after the introduction of a feed-in tariff. Nevertheless, the early development of the sector was valuable in creating a technological base from which to grow. We therefore conclude that international collaboration in promoting technology transfer did make an important early contribution.

THE CLEAN DEVELOPMENT MECHANISM

A more recent form of top-down collaboration (based in this case on the Kyoto Protocol), has been the CDM, which has been a significant factor in the development of wind energy generating capacity in China. By the end of 2009, wind farms accounted for 141 of the 673 registered Chinese projects and 244 of 1162 projects that were under preparation. Registered

[31] J. Han et al, *Energy Policy* 37 (2009), p 2945

[32] Debra Lew and Jeffrey Logan, 'Energizing China's Wind Power Sector', p. 4; Debra J. Lew, 'Alternatives to coal and candles: wind power in China', *Energy Policy*, Volume 28, Issue 4, April 2000, pages 271–86.

[33] Debra Lew and Jeffrey Logan, 'Energizing China's Wind Power Sector', p. 4; Debra J. Lew, 'Alternatives to coal and candles: wind power in China', *Energy Policy*, Volume 28, Issue 4, April 2000, pages 271–86.

Chinese wind power projects are projected to result in annual reductions of 78 $MtCO_2$ in 2012 (about 12 per cent of total Chinese Certified Emission Reductions' (CERs)), and those under preparation for an additional 111 $MtCO_2$ (18 per cent). Wind farm investors get an average economic incentive of approximately 10 cents RMB/kWh from CER income.

To date, the CDM has been very significant in the development of Chinese wind energy capacity: as of October 2008, 90 per cent of wind energy projects in China have applied for CDM registration.[34]

Under the 'Linking Directive' of 2004, European firms, which are covered by the ETS, are permitted to purchase CDM credits, or CERs, as an alternative to reducing their emissions in line with their allocated emission allowance, or to purchase extra allowances within the EU. During the second phase of the ETS (2008–12), which coincides with the first commitment period of the Kyoto Protocol, companies participating in the ETS are able to buy emission credits from CDM and Joint Implementation (JI) projects equivalent to 1.38 billion tonnes of CO_2, and the planned inclusion in the EU ETS of the aviation sector from 2011 will boost further the demand for CERs.

Several EU Member States have also set up programmes to buy emission reduction credits from CDM projects, either directly or through government-financed 'carbon funds'. Member State governments plan to buy CDM and JI credits equivalent to around 550 million tonnes of CO_2 and have budgeted some €2.9 billion for these purchases.[35] For example, the Netherlands and China signed a CDM contract in 2002 under which the Netherlands buys CERs, associated with the Huitengxile Wind Farm project, from China at a price of 54 RMB/t of CO_2 reduction. Until 2020, 514000t of CO_2 emissions would be reduced, providing Huitengxile with roughly 28 million RMB of Dutch funding.[36]

2.2.4. Evaluation of Wind Sector Performance and Existing Collaboration

For this study, in order to evaluate the benefits of collaboration to date, we shall use the yardstick of whether the wind power sector has helped to cut CO_2 emissions by displacing coal in China compared to business as usual development, and whether Sino-European

[34] Global Wind Energy Council, 2008, *Global Wind Energy Outlook 2008,* p. 54. www.gwec.net/fileadmin/documents/GWEO08-graphs/GWEO_A4_2008_54.jpg

[35] European Commission, 2005, EU action against climate change: Working with developing countries to tackle climate change. Available at http://ec.europa.eu/environment/climat/pdf/brochures/asia_en.pdf

[36] J. Han et al, *Energy Policy* 37 (2009), p. 2946; UNEP Risø (2009) CDM pipeline.

collaboration has played a part in that success. We argue that both performance and China-EU collaboration to date have been successful, but that the environmental benefits so far are minor. We will look first at evidence that successful collaboration has reduced CO_2 emissions. We end with some concerns that need to be addressed in order to achieve a more substantial impact on CO_2 emissions.

SUCCESSFUL COLLABORATION IN MANUFACTURING

Based on discussions with European investors in the Chinese wind power sector and with Chinese experts, we find evidence that collaboration was important in helping to establish a competitive and technologically advanced wind power manufacturing industry. By helping to establish a local manufacturing base and driving down the overall cost of wind turbines (per kW), collaboration assisted in raising the potential for wind power to gain market share.

Firstly, early bilateral agreements with EU Member States involved technology transfer that enabled China to establish pilot programmes and to begin to develop wind power manufacturing companies, such as Goldwind. Without that technological and financial support, wind power development in China would probably have been delayed. Secondly, licensing, joint ventures, and mergers between Chinese and European companies enabled Chinese companies to adopt and develop new, larger, and more efficient turbine designs. Thirdly, European companies decided to locate large state-of-the-art manufacturing facilities in China. Finally, the Chinese Government considered that a combination of foreign technology and local manufacturing costs was the key to lowering the overall cost of wind power, as suggested by these quotes from the 2007 report on Chinese wind power.

> '*Investment in the wind turbine accounts for 70 per cent of total investment in a project. Reducing the cost through domestic production is a necessary pre-condition of large-scale development… The current strategy is to gradually improve domestically made turbines by adopting mature foreign technologies, in the meantime making efforts to produce major parts and accessories domestically. This could lower the price by 10-20 per cent compared to imported units. In order to improve domestically made equipment, the National Development & Reform Commission has organised four rounds of wind concession tendering specifically designed to provide market opportunities for*

domestic enterprises.'[37]

A calculation of the comparative costs of wind power and coal is very complicated, not least because of the intermittency of wind power (and the need for back-up capacity), the cost of building transmission grids (to bring the wind power to market) and the need also to take account of the hidden CO_2 costs of coal-based generation. Nevertheless, we conclude that by helping to transfer technology and drive down the costs of wind power, collaboration with EU companies and governments has contributed to the process of displacing coal and thereby reducing CO_2 emissions.

SUCCESSFUL COLLABORATION IN WIND PARK DEVELOPMENT

Collaboration in the development of wind parks has been primarily of a financial nature, funnelled through the CDM. There has been little collaboration in the siting, development, and operation of the wind parks themselves, in the extension of the grid to connect the wind parks, or in system operations to integrate growing wind power production.

CDM financing has played a role in supporting the growth of the wind power sector[38]. According to the Global Wind Energy Council (GWEC), over 13 GW of existing or future wind power projects had benefited from the CDM by August 2008, and the total value of CDM credits for wind power projects in China has been between €70m and €100m since 2005.

SHARED CONCERNS OVER PERFORMANCE OF THE WIND SECTOR TO DATE

The rapid growth of installed wind power capacity has helped to reduce CO_2 emissions in China, but the potential is far greater than has been achieved to date. Although China is now one of the world's largest producers of wind energy, there are a number of general problems acknowledged by most people in the industry with whom we spoke.

- The first is that installed wind power is still a very small percentage of Chinese generating capacity. Although the capacity has now grown to about 26 GW, that is less than 2 per cent of the Chinese total capacity, and wind-based output accounts for less than 1 per cent of total electricity generation. This can be viewed as a problem in the performance of the wind power development programme, but it is probably better to see it

[37] China Wind Sector Report, 2007, page 12.

[38] As discussed in Section III, there is a debate over whether the CDM projects are additional as that term is defined by the UNFCCC.

as a sign of the significant potential ahead and the need to prepare to support that growth.

- A second set of concerns has to do with the grid. A significant share of wind power capacity is not connected to the grid and is therefore not available to contribute to reducing the emissions from coal-based generation. Citigroup estimated that 30 per cent of wind power capacity was not connected to the grid at the end of 2008.[39] There are a number of reasons for this. Firstly, grid companies appear to have weak incentives to extend their grids, partly because this connection (and the intermittency of wind) causes difficulties for normal system operations. Secondly, since wind power capacity is often at a distance from where the demand is located, new transmission capacity is required to bring it to market – financial and other incentives are needed. In particular, China needs to develop high voltage direct current (HVDC) lines in order to overcome the problem of long distances between generation and demand.[40] Thirdly, large state-owned electricity companies have obligations to own renewable capacity (3 per cent of their total in 2010) but do not have strong incentives to operate these plants efficiently. Finally, beyond these specific concerns about the grid, there is a more general one: namely the lack of transparency with respect to the development of the grid, making it very hard to plan or finance new generation facilities.
- A third concern is that the wind power plants perform at capacity factors that are well below international norms and anticipated levels. This appears to be due to the fact that original wind power resource assessments have not been very good, so that some sites are poorly chosen and under-perform. We understand from foreign companies active in the Chinese wind turbine market that poor performance is also the result of the selection of wind turbines that have low initial capital cost, but higher maintenance and running costs, and hence higher lifetime costs.
- A fourth concern has to do with the central dispatch (by the system operator) and the local operation of wind farms, and with the provision of back-up supplies to deal with the intermittency of wind. Once the wind farms are connected, their intermittency will cause problems for the grid and the system operator. This is not a major concern when wind power capacity is a very small share of total capacity, but it will be a growing concern when this share grows. Some foreign companies have told us that generators are

[39] The website Energy Tribune, 30 July 2009, refers to data from the China Power Union, which says that 72 per cent of China's wind capacity was not connected to the grid... A European engineering company active in China confirms this number and claims that wind parks often have to wait between 3 and 12 months to be connected, and face frequent outages and unreliable technology.

[40] We understand that Siemens is to build a 5 GW HVDC line in China.

disconnected without economic compensation when wind power causes bottlenecks on the distribution or transmission network. This is just the start of a problem that Europe has been addressing now for a number of years, especially in Germany and Spain. From that experience, we think it will be necessary in China to develop new system operational requirements (e.g. to require voltage and frequency limits, active and reactive power control) for wind parks, as well as to work out the legal, economic, and technical basis for providing the back-up power that will be needed.

- A final concern has to do with doubts over the CDM as a financing mechanism. The Executive Board of the CDM has recently rejected some wind power projects and questioned their "additionality."[41] The implication is that Chinese and foreign investors are far from certain that the CDM will continue to be a source of financing for new wind power projects in China. We discuss this concern in Part III of our report.

All of the concerns listed above are shared by the representatives of Chinese and European companies with whom we have spoken. Both sides favour resolving the issues. Below, we identify some additional concerns that were expressed either by the Chinese or by the Europeans companies (or officials) with whom we spoke. These too will need to be addressed in order to achieve large-scale commercial collaboration in the wind power sector.

BARRIERS TO FURTHER LARGE SCALE COLLABORATION

It is important to register the concerns that have been expressed by the Chinese and by the international companies, with respect to collaboration and more generally with respect to the development of the wind power sector.

From the Chinese side, those with whom we spoke expressed three main concerns about collaboration.

- They maintain that the turbine and related technology being transferred was appropriate for European wind conditions and was not always appropriate in China. It is often very difficult for the Chinese to know this until it is too late. European companies may also be the losers if they transfer inappropriate technologies.
- They argue that it is very difficult to absorb the technology and to adapt it to local conditions. This is partly because, in their view, foreign companies often do not transfer the 'know how' that was expected under the agreement.

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[41] Note the response of Steve Sawyer of the GWEC in a letter to the Financial Times, 4 December 2009, 'China has not lowered subsidised tariffs for wind projects'.

- They complain about high costs of imported technologies (including intellectual property fees). This lies behind the localization policy, which has helped to drive down costs.

European companies have expressed concerns to us on at least four matters.

- Manufacturing companies are concerned about protection of intellectual property, and in particular the loss of economic value if their Chinese partners do not follow technology transfer agreements and the laws of intellectual property protection. They argue that the lack of legal redress when property rights are infringed is a serious inhibitor of technology transfer.
- European wind park developers and manufacturers consider that the regulatory environment for wind parks discourages foreign investment in that business and, thereby, raises the lifetime cost of wind power in China (discouraging its expansion). Firstly, they maintain that the requirement for a Chinese company to own 51 per cent of the wind park to qualify for CDM status makes foreign investment unattractive. This is because, with a minority stake, the foreign company is unable to manage the business efficiently. Secondly, they argue that the tendering process organized by government for development rights or turbine selection needs clearer rules and procedures, and a more extensive involvement from all stakeholders. In particular, they are concerned that the concession rules focus on the initial capital cost of the equipment, rather than the lifetime electricity generation cost of the project; this, they argue, favours less reliable equipment. Thirdly, the European companies argue that the wind power targets are not clearly defined and that this discourages investment. Fourthly, they point to different leverage requirements (33 per cent for foreign companies and only 20 per cent for Chinese companies) as evidence of protectionism. Finally, they are concerned that the tendering process tends to favour the state-owned electricity companies, which are in a position to subsidize their wind power operations. This, they argue, leads to unrealistically low prices that discourage investment by leading foreign-owned wind power groups, and eventually increases the overall cost of expanding wind power in China, because the state-owned companies have weak incentives to operate the wind parks efficiently or to invest in the turbines with the lowest lifetime costs.
- European companies have expressed the view that investors lack signals of a political

commitment that will build investor confidence in the wind power sector. This is partly a matter of defining longer-term wind power targets, but also of indicating an interest in the participation of foreign wind park developers in new concessions.

- A number of companies expressed concern over a preference to buy from Chinese turbine manufacturers, even though a number of the European companies had established significant manufacturing operations in China to meet the criteria for being ‘local’.[42]

In conclusion, our assessment of the development of the Chinese wind power sector and of Sino-European collaboration is that both have contributed to a reduction in CO_2 emissions from coal, but that much remains to be done. There is substantial potential to increase the capacity and to improve the performance of the wind power sector. Furthermore, there is significant potential for additional collaboration between Chinese and European companies, provided the barriers can be overcome. In the next section, we identify the areas where we think collaborative efforts in the wind power sector should focus.

2.3. Opportunities for Further Collaboration

This section considers the areas of collaboration in the wind power sector that seem most promising from the perspective of lowering CO_2 emissions in China. We will argue that Sino-European collaboration should now shift towards wind park siting, development and operations, and to grid expansion and system operations.

The analysis above and in the case study in the Appendix illustrates that, in recent years, a strong and internationally competitive domestic wind energy manufacturing industry has developed in China, helped by a set of supportive domestic policies and collaboration with foreign firms and governments, notably from the EU. Without ruling out further collaboration (or mergers) in manufacturing, we do not think that a focus on technology transfer between Chinese and European wind power technology manufacturers will lead to significant additional price reductions for wind power, since the gap in terms of technological development or capability in this area has narrowed significantly. Furthermore, large European firms are less likely to engage in further technology transfer to

[42] Keith Bradsher, ‘China builds high walls to guard energy industry’, *New York Times*, 14 July 2009. One foreign investor in the wind turbine business informs us that the Chinese Government has informed them that a future selection criterion for choosing wind turbines and related equipment will be that the patents are Chinese.

Chinese firms, because the latter are nowadays seen as serious global competitors.

We believe that to reduce the cost of wind power generation in China, the most promising collaborative efforts would be in the siting, development and operation of wind farms, the extension and management of grids, and the improvement of system operations to cope with the intermittency of wind.

2.3.1. Grid Expansion and System Operations

The geographical distribution of wind resources in China does not match that of demand. Coastal regions have most of the load and few of the wind resources, whereas northern areas have abundant wind resources but limited demand. The grid network is relatively weak, and grid extension and reinforcement is needed to connect to distant wind resources. It also appears that the main grid companies (e.g. State Grid Company and the China Southern Grid) face weak incentives to extend their grids at the pace necessary to connect a growing wind power industry. There is a need to extend the grids, including the development of HVDC grids, in order to cope with the long distances to market.

From experience in other countries, notably in Europe, grid extension is only the beginning of the necessary transformation. Other issues relate to connecting multiple wind sites to the transmission and distribution grids, deciding who should pay what share of the costs, and addressing issues of system stability, dispatch, and back-up to cope with the intermittency of wind.

The European experience with integration of wind power, especially in Germany, Denmark, and Spain, is more extensive than in any other region of the world. For those reasons, we think there are at least three kinds of expertise that would benefit China. One is the operating expertise of transmission system operators, like REE of Spain, which are used to integrating wind into their electricity systems. A second is the technology required to address the specific problems of HDVC grid extension for wind parks; Siemens is an example of the type of company active in this area, including in China. Finally, regulators (and the regulated companies themselves) in Europe are familiar with the sort of incentives that are required for grid companies, system operators, and wind parks to coordinate effectively.

2.3.2. Siting and Wind Resource Assessment

The economics of wind farms and the selection of the sites of wind farms are very much based on wind resource assessments. There has been a lack of sufficient and accurate wind resource assessments in China. As a consequence, a number of wind farms built in China cannot generate as much electricity as expected, resulting in economic losses. Currently, there is a shortage of advanced wind survey technology expertise in China. This is another area where collaboration with European experts would be of great value. As noted earlier, knowledge of local wind conditions is not only an important determinant of the optimal siting of wind parks; it will also influence the choice of turbine technology and use. This is an area where European and Chinese experts could fruitfully collaborate.

2.3.3. Wind Park Development and Operations

The large grid-connected wind park concessions are currently in the hands of the main publicly-owned electricity companies, including Huaneng, Datan, Guodian, Huadian, and CPI as the five largest. These and other large power companies face a renewable portfolio obligation, requiring renewable power capacity to make up 3 per cent of their capacity in 2010 and 8 per cent in 2020. Of the renewable energy options open to them, wind power is the least expensive and offers a relatively straightforward way of meeting their quotas. We understand that these companies have quoted very low prices when bidding for concessions in order to meet their quotas. According to a study by Greenpeace, it is unlikely that some of them will achieve their 3 per cent targets by 2010, with only Guodian having already achieved more than 3 per cent[43].

Unfortunately, even if these companies do achieve their quotas, they do not have good incentives to operate the plants efficiently, or even to connect to the grid. They also lack operating experience in wind parks. The result is a waste of resources that could be used to further develop the wind power sector.

European operating companies are recognized world leaders in wind park development and operations. They are enthusiastic about the opportunity to participate in the growth of the wind power sector in China, but for reasons explained earlier have found it difficult to justify investing.

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[43] 'Polluting Power: Ranking China's Power Companies', Greenpeace, July 2009, page 6. Available at www.greenpeace.org/raw/content/china/en/press/reports/power-ranking-report.pdf

2.3.4. How to Promote Commercial Collaboration

From the Chinese perspective, the central issues are that collaboration must drive down the cost of wind power and increase its output. For the European companies, the key issues are those related to the regulatory regime and having a clear long term target to provide investor confidence in the development of wind parks. Both sides share a set of overlapping concerns related to the financing of wind power expansion, intellectual property, the effective extension of the grid, and improved system operations.

We are convinced that there is room for a larger scale Sino-European collaboration that builds on the success to date, provided the barriers can be overcome The next part of the report explains how that collaboration could work in the context of a JCFA.

Part III. Large-scale Wind Power Collaboration under a Sino-European Joint Commitment Framework Agreement

The first Part of this Report introduced the idea of bilateral 'joint commitments' and its conceptual background. Part II, in turn, looked into the potential for collaboration between European and Chinese enterprises in activities that would result in a significant mitigation of greenhouse gas emissions from the Chinese power sector by way of ***large-scale displacement of coal by wind power***. It also gave an account of existing strategic (i.e. intergovernmental) collaborative efforts with respect to the Chinese power sector in general, and wind power in particular. The aim of this final Part is to investigate if and how a framework agreement involving joint commitments could unleash the potential of the above-mentioned large-scale substitution of coal by wind power in the Chinese power sector.

3.1. Forms of Joint Commitments

A joint commitment in the sense envisaged here is meant not only to 'focus the mind' of government officials, but also to provide a clear political signal to all concerned – particularly investors – that China and the EU will take all the measures necessary to achieve compliance. For this to be effective, such a commitment has to go beyond qualitative generalities ('we want to enhance collaboration'). It has to be a commitment to achieve a ***quantitative target*** within a ***specified time-frame***.

There are many different ways in which such a quantitative target could be formulated. One might consider an electricity ***sector-wide carbon target***, be it in absolute terms – either as a cap, or as a reduction relative to some agreed baseline – or as a carbon intensity target (in terms of kg CO_2 per kWh). Alternatively, one might wish to focus on the ***performance of wind power*** relative to coal power, say by committing to a certain share of the power mix to be taken by wind power by a certain date, by committing that additional wind power will reduce a certain number of Mt CO_2 from coal fired power generation in China by a certain date, or alternatively by committing to make wind power economically competitive with respect to coal by a certain date.[44]

[44] Note that it is unlikely that wind will ever become competitive without introducing measures that internalize the carbon externalities into the coal power price.

The choice of target will ultimately rest on the overall purpose of the agreement. If it is to mitigate emissions from the Chinese power sector, then a sectoral target might be appropriate. However, in that case it might not be useful to have an agreement pertaining to wind power alone. If one opts for a wind power agreement, it would seem to be more appropriate to define the target in terms of wind power performance, that is kWh from wind, rather than kW of wind power capacity. Given the recent unilateral (domestic) commitment by China *to increase the share of non-fossil fuels in primary energy consumption to around 15 per cent by 2020*,[45] a target for ***an additional wind share*** of say *x* per cent (implying a combined non-fossil fuel target of 15+*x* per cent) would seem to be politically the least problematic option, at least from the Chinese point of view.

Some form of ***absolute mitigation target*** – e.g. ***x*** $\boldsymbol{MtCO_2}$ ***of emissions reduced*** – may be preferable for the European side, depending on the choice of implementation instrument (i.e. CDM or NAMA support, see Section 3.2)

3.2. Sample Implementation Options

How might the partners contribute towards achieving such a target? As mentioned above (Section 2.2), historically the strongest factor in delivering the growth in installed capacity in the Chinese wind power sector has been a ***renewable obligation*** for utility companies imposed by the Chinese Government, coupled with a ***feed-in tariff*** and ***local content requirements***, and an additional ***carbon subsidy*** in the form of CER purchases by actors from Annex I countries. These measures have helped to jump-start the growth of a local wind turbine manufacturing industry and of installed wind power capacity.

However, the only efficient and lasting way towards a displacement of coal power by wind power on a large scale is by making wind power economically competitive relative to coal power. It is possible to reduce the difference in power generation cost by providing external subsidies (such as the CER revenue), but ultimately the best way forward is to ***reduce the generation cost of wind power*** *per se* − the cost of generating a wind power kWh – to below that of a coal power kWh, once CO_2 externalities have been taken into account, even if only on a 'shadow' price basis. In the meantime, the goal should be to drive down the typical cost of (newly installed) wind power generation, and therefore the cost differential with coal.

[45] President Hu Jintao to the United Nations General Assembly, Tuesday 22 September 2009.

We have argued (Section 2.2 and 2.3) that enhanced collaboration will by itself bring down the generation cost differential, but only if wind power is supported in some way or other to harness certain benefits of scale. In particular, we argued that collaboration (in wind park development, grid extension, and system operation improvement) has the potential to substantially lower the lifetime cost of generation from newly-installed wind power capacity. The key to implementing the sort of JCFA envisaged here is therefore to provide the incentives for relevant enterprises to collaborate, which, *inter alia* means to provide support for overcoming the effects of cost differentials between coal and wind power.

To overcome these remaining coal–wind power cost differentials, one could use direct levies on coal and/or subsidies for wind power (including feed-in tariffs). Alternatively, price-based mechanisms, which raise the price of carbon-based energy, such as a carbon tax or a cap-and-trade system could be considered. One could equally go down the regulatory path, say by using renewable (wind) portfolio standards, which require utility companies to supply a mandated share of electricity from renewable (wind) sources,[46] or mandate the use of CCS (carbon capture and storage) technologies. All these instruments would be available to the Chinese authorities, while the EU can really only provide (financial and technical) support to reduce the cost of wind power generation. Similarly, it is only the Chinese side which can alter the regulatory framework to remove disincentives for foreign companies to invest, operate, and collaborate in China/with Chinese companies. This Report ***focuses on (the existing Chinese) feed-in tariffs and the Kyoto Protocol Clean Development Mechanism (or NAMAs) as delivery tools for subsidies required to cover the residual wind/coal generation cost differential.*** However, it must be emphasized that this is simply for expository purposes, and not meant to rule out the use of other instruments[47] − either as alternatives, or as complements − especially since the feed-in tariffs have not been able to provide the necessary support for siting, grid development, and system operations.

3.2.1. Feed-In Tariffs: Background

FITs have been used for over two decades and are currently employed in over 45 countries and states/provinces. Among the many variants, the one that has received the most favourable attention is the Advanced Renewable Tariff (ART) which requires priority access

[46] We refer here to a percentage of the electricity generated or sold to final customers, not simply to the percentage of capacity built, as at present.
[47] Such as the IPR Insurance idea propagated by Project Catalyst and alternative offset mechanisms, such as sectoral crediting mechanisms.

to the grid, priority purchase of generation from renewable resources, and differentiated tariffs based on the cost of generation plus a reasonable profit.

According to the recently published *World Economic and Social Survey 2009*[48], a major problem in the use of FITs in developing countries *stems from the fact that the costs of most renewable options are far higher than the average retail price of electricity, which in turn is held down by reason of the fact that there is a proportion of lower-income groups that can afford electricity only at a cost under $0.06/kWh. This creates a disincentive for producers, who fear future policy changes in case of large-scale uptake of renewable energy generation. In this regard,* ***a FIT option can be successful in developing countries only if it***

Box 3. Feed-in Tariffs – A Brief History

Feed-in Tariffs (FITs) were first developed in the USA under the aegis of the Public Utility Regulatory Policies Act (PURPA), a part of the National Energy Act of 1978, which allowed connection of renewable generators to the grid and specified that they should be paid for the cost of generation that they avoided. In response, different States developed contractual arrangements, called 'standard offer contracts', which were offered to renewable generators. Specifically, in 1984, the California Public Utility Commission instituted Standard Offer No. 4, which fixed the amount to be paid per kilowatt-hour for a long period (generally 10 years, over a 30-year contractual period). This fixed tariff was estimated on the basis of the long-term avoided cost of conventional generation. For this reason, Standard Offer No. 4 is often perceived as representing the first instance of a successful FIT. It resulted in the establishment of 1,200 MW of new wind power generation plants by the mid to late 1980s, which have consistently contributed about 1 per cent of California's consumption for more than two decades. However, Standard Offer contracts were offered only up until 1984, before the collapse of oil prices.

Germany had implemented its *Stromeinspeisungsgesetz* (StrEG), literally, the law on feeding in electricity to the grid, in 1991. Germany based its tariffs upon a fraction of the retail rate (that is to say, the price at which electricity was sold to consumers), not the wholesale rate (that is to say, the cost at which utilities purchased electricity from other generators). In Germany, consumption taxes constitute a large fraction of the ultimate retail price of electricity. Wind energy and solar energy were paid 90 per cent of the retail rate and hydroelectric plants were paid 80 per cent of the retail rate. However, these rates were not sufficiently stable to attract adequate financing. This was corrected in Germany in 2000 by the stipulation that renewable sources of electricity would have priority access to the grid for a host of environmental, social, and economic reasons. It also set different tariffs for different technological options (based on the respective cost of generation plus a reasonable profit) and guaranteed them for 20 years.

Many developing countries have followed this model, comprising so-called Advanced Renewable Tariffs, since it corresponds with standard practice in respect of other private electricity plants. In the case of residential rooftop solar photovoltaic (PV), for example, Germany's 2004 law offers € 0.57/kWh (~US$ 0.75/kWh), which is a much higher figure than that for other sources. The Canadian Province of Ontario recently revised its laws for the purpose of offering standard contracts differentiated by technology, size, and application, including, for example, Can$ 0.80/kWh (US$ 0.62/kWh) for residential rooftop solar PV. In most cases, although tariffs are expressed as a percentage of the retail rate, they are in effect based on the cost of generation plus profit.

Source: UN DESA 2009

[48] UN DESA, *World Economic and Social Survey 2009*: *Promoting Development, Saving the Planet*, 2009, pp.56–9. Available at www.un.org/esa/policy/wess/wess2009files/wess09/wess2009.pdf

is backed by an international guarantee, and internationally funded subsidies for low income consumers.[49]

For this reason, the World Economic and Social Survey 2009 (WESS 2009) proposes a ***global feed-in tariff programme*** to provide guaranteed purchase prices to producers of renewable energy in developing countries over the next two decades. According to the WESS, such a mechanism would lead to an automatic drawdown of subsidies over time as production and incomes increase. The same idea has also entered into the current international climate change negotiations with Pakistan proposing the establishment of *a global fund to support a global-feed-in-tariff programme, providing guaranteed purchase prices, over and above the retail energy price in the developing countries, of energy from renewable sources including wind, solar PV, concentrated solar, geo thermal, hydro and others, to the producers of such energy in the developing countries for a period of 20 years. The Global Fund shall aim at both inducing a shift to renewable energy without compromising the development momentum in the developing countries, and the realization of economies of scale and sustained reduction of costs of generation of renewable energy*.[50]

In other words, the provision of subsidies to support feed-in tariffs as a means of stimulating the growth or renewable energy in developing countries clearly has some traction in the current debate on how to address developing country emissions. From a European perspective, the idea of a bilateral scheme would have the added attraction that it would allow the targeting of subsidies to those wind power operations that involve the sort of collaboration between European and Chinese entities that are meant to be encouraged by the envisaged JCFA.

3.2.2. The China Wind Additionality Issue

Chinese wind park developers have in the past been successful in using CDM finance as an additional income stream for their investments, and renewable energy sources – such as wind power – are the focal areas of Chinese CDM development according to the relevant national regulations. The fact that nearly all new wind park investments have registered (successfully for the most part) as CDM projects in recent years – and CDM use is thus factually ‘common practice’ – has led to some debate about whether Chinese wind power developments can be considered additional. The CDM Executive Board has continued to

[49] Op. cit.; emphasis added.
[50] UNFCCC, Notes on sources for FCCC/AWGLCA/2009/INF.1

view these projects as adhering to the CDM rules, and has so far not rejected registration of Chinese wind power projects on these 'common practice' grounds.

In December 2009 the Executive Board did, however, reject the registration of a number of Chinese wind power projects after sending them for review three months earlier, because 'the tariff [used for the proof of additionality] is lower than tariffs previously issued for similar projects in the same region, and this lower tariff may result in the reduction in the incentives for investment in renewable energy which may create a comparative advantage for more emissions intensive technology'.[51] Lowering the income accrued from feed-in tariffs may result in more wind power projects meeting the CDM additionality requirements. The Chinese government in turn maintains that CDM revenue has never been taken into consideration in the process of tariff-setting and that the individual project-based activities have applied all rules accurately.

This episode shows how highly politicized the Chinese (wind power) additionality issue has become internationally. It is therefore far from certain whether Chinese wind park developers can continue to count on classical CDM income in the future. Below, nevertheless, we will assume that CDM or other offset mechanisms will be available to supplement the FIT.

3.2.3. European Contributions

Having chosen to focus on the CDM and the existing Chinese wind power feed-in tariffs as 'subsidy delivery mechanisms', there remains the question of how these subsidies would be raised by the European side. There are a number of options, ranging from using (Member States') tax revenue, to obliging the private sector to pay for the subsidies. What would be the incentives and disincentives for these subsidy-raising alternatives?

OPTION 1: PURE PRIVATE SECTOR CDM.

The private sector, for example, could provide the required subsidy through the CDM. While this might in many ways be the preferred option − particularly from the point of view of European treasuries – it would not really be possible for the European side alone[52] to ensure that this 'CER subsidy' flows to the targeted operations, certainly not to the extent which

[51] CDM Executive Board, EB49, par.48.
[52] The Chinese Government, by contrast, has the means to channel private sector CDM projects towards its own policy priorities (see Section 3.2.4 Chinese Contributions).

would make any sort of bilateral (joint) commitment a realistic option.[53] The fact is that − although private sector CDM has been a significant factor in the development of Chinese wind energy capacity thus far (see Section 2.2) − it has not led to the required large scale operations, and is unlikely to do so, given in particular the external political/regulatory risk reflected in the recent decision on Chinese wind additionality by the CDM Executive Board.

OPTION 2: PUBLIC SECTOR FIT SUBSIDIES.

At the other end of the spectrum would be the option of using (EU Member States') tax revenues to pay the subsidy to the Chinese Government for the targeted Sino-European operations included either in the existing FIT scheme or in a new, purpose-built one. As with all public sector finance, the advantage of this would be the ***ability to steer the subsidies to the targeted operations***. It is, however, unlikely that such a scheme would be politically feasible, even if one could demonstrate that European firms are benefiting from it, because of what has been termed the 'domestic revenue problem', referring to the difficulties of sending domestic tax revenue abroad. In the present context, the problem would be aggravated by the fact that China is seen by many to be a chief commercial competitor in the wind turbine and related businesses.

OPTION 3. PUBLIC SECTOR CDM.

One way of overcoming this domestic revenue problem could be to use the CDM as public sector delivery mechanism, i.e. to ***purchase CERs from the targeted operations with public funds***. This would retain the general targeting ability of public finance, while providing the treasuries with the argument that the funds are being used to achieve compliance with their domestic/international mitigation targets. However, depending on the cost of these targeted CER purchases, the perceived benefit might be outweighed by the fact that compliance could be achievable more cheaply by purchasing CERs from other sources.

OPTION 4. INNOVATIVE PRIVATE/PUBLIC SECTOR CDM/OFFSETTING

This cost issue, in turn, could be addressed by turning to carbon derivatives, in particular to offering ***Certified Emission Reduction Put Options*** (CERPOs, see Box 4) as suggested in Müller (2007).[54] In particular, the EU counterparty to the envisaged JCFA could undertake

[53] It is unlikely that anyone would adopt a commitment if they were not sure that they had the tools to ensure compliance.

[54] For more on the idea of CERPOs, see Benito Müller, 'Bonn 2007: Russian Proposals, Policy CDM, and 'CER Put Options' (CERPOs)', *OIES Energy and Environment Comment*, July 2007. Available at

to issue a series of put options for emission reductions achieved by the targeted wind power operations which would guarantee them a price floor (strike price) that would cover the residual generation cost differential. In line with the feed-in tariff concept, this strike price would presumably be ***diminishing over time (along with the FIT)***, and given the site-specific nature of the cost differential, it might also be appropriate to issue ***site specific put options***.

The advantage of issuing such CERPOs for the European (public sector) counterparty compared with a simple purchase agreement is that, depending on the CER market price, the ***subsidy payments can be passed on to the private sector***: if the market price is higher than the CERPO strike price, then the holder of the option (the wind power operator) would presumably sell to the market and not exercise the option.

Indeed, given that it is uncertain whether the issuing European public sector counterparty will have to pay anything, public sector exposure can be further diminished by ***sharing the payment risk with the private sector*** through insurance.

Box 4. CER Put Options (CERPOs)

The idea of CERPOs is that Annex II Parties would be giving developing countries ***the right to sell a certain number of CERs at a certain price*** ('strike price'). A couple of points are important in this context. First, developing countries are not forced to exercise this right. They can try and realise a more favourable price. Also, they are *not* legally bound to generate any such CERs at all, even if they enter such put option agreements. Second, Annex II countries are not asked to finance projects or programmes, but only their performance, in terms of greenhouse gas reductions, albeit possibly at a premium, which in turn would seem to be justifiable, particularly in light of the obligation they have taken on under Article 4.1 of the Framework Convention.

There are a number of reasons why the spot price of CERs may collapse, and hence why it would be rational for DCs to exercise their CERPO rights. There could be an over-supply of CERs due to 'import barriers', i.e. domestic Annex B limits on the maximum allowed number of CERs. Or it might simply reflect a general collapse of the carbon price, due to a lack of environmental stringency of Annex B targets. In the case of the latter, the CERPO scheme could also be used to improve the overall stringency simply by retiring the policy CERs acquired under it. Indeed, the scheme could be designed so as to *ex ante* provide incentives for Annex B governments to adopt more stringent targets.

Source: Müller 2007

However, as with all uses of the CDM, there remain the above-mentioned 'external' political risks. The option described thus-far depends on factors which are not in the (direct) control of the government counterparties, namely whether the CDM will continue to exist post-2012, and if it does, whether the emission reductions of the targeted operations are deemed

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www.oxfordenergy.org/pdfs/comment_0707-1.pdf to be additional (cf. ‘Chinese wind additionality issue’). How, if at all, might this be addressed?

The only way of doing this is to internalize the relevant decisions, for example, by switching from the CDM to the European Union Emission Trading Scheme (EU-ETS) as reference regime. That is to say by subjecting emission reductions of the relevant Sino-European wind power operations to some form of ***EU-ETS offset certification***,[55] independent of the CDM.

OPTION 5. PUBLIC SECTOR NAMA-SUPPORT

Purchasing offsets – be it under the CDM or the EU-ETS − to meet mitigation commitments is not the only way in which European policy makers could justify the use of public sector funding to their tax payers in order to reduce their ‘domestic revenue problem’. The Bali Action Plan, which provides the framework for the current international climate change negotiations, envisages – paragraph 1.b.ii − measurable, reportable, and verifiable (MRV)

Box 5. What are NAMAs and how are they measured?

NAMAs can be considered to be actions proposed by developing countries for financing by the international community and comprise government actions, which aim at achieving emission reductions and other benefits in line with the development plan of the respective country. These actions will in many cases be of a programmatic nature, including a set of individual activities including capacity building, the set up of appropriate institutional structures, and the establishment of the required political framework to enable concrete mitigation action or to trigger private investment in the desired area. These characteristics are very similar to policy-based or programme-based approaches used by international financial institutions (GEF, World Bank, regional development banks etc.). Three types of NAMAs are currently discussed: unilateral NAMAs that developing countries propose to undertake, independent of outside support; supported NAMAs that developing countries propose to implement conditional on developed country support, for example in the form of finance, capacity building, or technology transfer, but not conditional on the GHG impact of these measures; credited NAMAs for which support is provided in the form of carbon credits equivalent to the GHG reduction achieved. Whether this latter form of NAMA will exist in its offset-generating form, is still up for debate.

NAMAs differ in how directly they influence emissions, and financing for supported NAMAs is likely to be provided in phases linked to certain MRVable milestones, based on performance-based indicators. Compared to project based CDM, this opens up additional activities like ***(smart) grid extension*** for international support, as these entail great benefits for wind power development, but no directly correlated emission reductions that could be credited under the CDM.

Nationally Appropriate Mitigation Actions (NAMAs), meant to be supported by MRV ***finance, technology transfer, and capacity building***, which, in turn, is to count towards ***financial commitments*** by developed countries under the future international climate change regime. In other words, if the targeted activities – in the present context Sino-European wind

[55] The idea here is that the emission reductions in question would be certified as EU-ETS offsets. As such, they could be used for EU-ETS compliance, but not (necessarily) for Kyoto Protocol compliance, as the EU-ETS certification would not have to apply all the CDM certification rules.

power operations – are eligible for NAMA status, then it is possible to justify the use of (European) taxes to support them on grounds of compliance with financial commitments.

One of the advantages of NAMA support over a (CDM/EU-ETS) offset route is that NAMAs need not be tied to specific emission reductions. The route of using offsets to subsidize the targeted activities is only available if these activities can be associated with a particular emission reduction figure. NAMAs, by contrast, need not be measured in tonnes of carbon. They could, for example, be measured in terms of shares in the domestic power mix, which in turn could have implications as to the choice of joint commitment format. NAMAs would also allow the EU to finance smart grid developments, as well as advisory and other services related to the siting of wind parks and the necessary adaptations to system operations to integrate the growing share of intermittent renewable energies.

OPTION 6. INNOVATIVE PRIVATE/PUBLIC SECTOR OFFSETTING/NAMA-SUPPORT

One of the (potential) problems with the NAMA-support route is that it is – at least to this date – essentially tied to public sector finance, and it is difficult to see how this could be changed, i.e. how the cost of NAMA support could be offloaded to the (European) private sector. In particular, it is uncertain whether standard offset generating activities would be eligible to count as NAMAs (see Box 5).

However, this could change if the offsets generated were used against an ***additional dedicated EU 'target budget'*** – i.e. over and above what is internationally agreed otherwise – to be achieved through CERs from the targeted Sino-European wind power operations. This would in essence be tantamount to an ***obligation to retire the amount of CERs*** in question (as discussed in Müller and Ghosh 2008[56]) and, in contrast to the mere purchase of offsets, could count as support for a NAMA, i.e. could be credited towards compliance with EU (Member State) financial commitments, if and when they are adopted.

Indeed, the idea of ***Retirement CERs*** (R-CERs), combined with that of issuing ***insured CER Put Options*** – provides for a very cost-effective and flexible subsidy delivery instrument:

Whatever the (CDM/EU-ETS) market price for CERs, the cost of the subsidy is carried by

[56] For more on the concept of 'Retirement-CERs' see Benito Müller and Prodipto Ghosh, 'Implementing the Bali Action Plan: What Role for the CDM?', *Oxford Energy and Environment Comment*, October 2008. Available at http://www.oxfordenergy.org/pdfs/comment_1008-2.pdf

the (European) private sector, be it through purchasing offsets (if the strike price of the put option is lower than the market price), or through insurance cover (otherwise). The European public sector counterparty/ies will simply be paying the insurance premium.

Should the put options be exercised by the targeted wind power operators − i.e. should they make use of the right to sell the CERs to the European public sector counterparty/ies at the relevant strike price (with a possible volume ceiling) − then it would be up to the counterparty/ies to decide whether to use them as offsets ***to count towards their mitigation commitments*** or to retire them and to ***count the purchase cost towards their financial commitments*** (if and when they are adopted).

SUMMARY

The main implementing contribution by the European counterparty/ies to our sample JCFA would be ***the provision of subsidies*** to make the targeted activities economically viable (by closing the generation cost gap between the targeted wind power operations and competing coal-fired power generation) and leveraging large-scale private sector investment. The ***subsidy delivery*** could be done through payments directly to the operations, or to the Chinese government, as subsidy to a feed-in tariff.

As to ***sourcing*** the required funding, there are a number of options, involving public and/or private sector sources in the context of offset generation and/or NAMA support. The choice between them depends on the assessments by the counterparties of the risks involved (e.g. the regulatory/political risks of CDM and NAMA support, the risk of non-compliance), and the European judgment of the severity of the domestic revenue problem (in this case the 'sending taxpayers money to China' problem).

Box 6 illustrates potential costs and benefits of supporting the development of wind power in China. These figures are approximate, but generally reveal that the potential benefits in terms of avoided CO_2 emissions are somewhat lower than the current cost of emission allowances being traded in the EU[57].

[57] The calculation assumes (a) 1€=9.25RMB, (b) a wind-coal emission factor of 1.0069 tCO2/MWh and (c) that wind is operating 30% of the time (which is much higher than currently the case, partly because capacity is not connected to the system and also because of siting and operating inefficiencies.).

Box 6. Example estimating the cost and the benefit of supporting wind power in China

Here is simplified example of how the EU could contribute to a significant increase in wind-based generation in China, along with estimates of how much CO_2 could be saved and how much it would cost. At the end of 2009, Chinese wind power capacity was about 26 GW. Let us examine the implications of reaching the goal of 100 GW of wind-based generation.

First, we estimate that the additional unit cost of wind-based generation (i.e. the difference between the average cost of a kWh from wind compared to coal) is about 0.1 RMB. If 74 GW of new wind power plants ran 30 percent of the time, that would amount to an additional 194 TWh of wind-based generation per year at an annual cost of about €2.15 billion. If the EU were to contribute 50 percent of the additional cost, that would be approximately €1.1 billion per year.

Second, assuming this wind power displaces coal, we estimate an annual reduction in emissions of about 196 $MtCO_2$. Dividing the additional cost by the avoided CO_2 emissions works out to an average abatement cost of about €11/tCO_2. Current annual CO_2 emissions from the Chinese power sector are about 3,000 $MtCO_2$, so the implied reduction in emissions would be about 7 per cent of that total, which is a substantial volume of emissions at a cost that is below the current price of emission allowances in the EU-ETS.

3.2.4. Chinese Contributions

As discussed in Part II and in the case study in the Appendix, China has already successfully employed a number of tools − such as a ***renewable obligation*** for large utility companies and a ***feed-in tariff*** − to promote renewable energy in general, and wind power, in particular. We assume that these instruments will continue to be used by the Chinese Government to achieve their domestic targets regarding the renewables/wind power share in Chinese electricity generation.

However, to date, wind generates less than 1 per cent of Chinese electricity, with coal continuing to generate close to 80 per cent. This is partly due to the relatively small capacity for wind power generation, which at 26 GW is less than 2 per cent of Chinese generation capacity. However, it is also due to the fact that about 30 per cent of the existing capacity is not connected to the system, and that operating efficiency is relatively poor.

With the Chinese Government having signalled the intention of reaching 100 GW of installed wind power capacity by 2020, and studies suggesting that China could install at least 300 GW of wind power capacity, the central question is how best to achieve the potential for wind power to replace coal at the lowest possible cost. Since we are proposing EU financial support for the Chinese wind power sector, the aim is to achieve the maximum displacement of coal by wind power for any given budget.

To achieve these objectives, it is important to reduce the overall cost of wind power and the cost disadvantage with respect to coal. Ultimately, it is required that:

(i) manufacturers of wind power technology reduce costs and/or increase the reliability of turbines and other equipment (and hence lower the investment cost per kWh over the operating life);

(ii) operators and designers of wind farms reduce the cost of wind power generation, through improved siting, choice of technology, and performance; and

(iii) grid and system operators successfully extend their grids to connect wind parks and adapt their grids and operations to operate effectively in the conditions that will apply when many intermittent sources of power generation are connected.

We have argued earlier that international collaboration could help to accelerate the fulfilment of these requirements. We have explained that we do not see significant potential for collaboration in wind turbine manufacturing, but that we do see it in the areas of (a) improved wind park siting, development, and operations, (b) in the extension of grids and (c) improved system operations to integrate intermittent wind. Moreover, while the desired results might occur in the wind parks where collaboration occurs, the beneficial effects will in time spread throughout the sector, thus contributing also to the achievement of more ambitious targets for the sector.

Given the envisaged European subsidies to overcome the residual generation cost differentials, one of the remaining key obstacles to collaborations is, according to our survey of potential collaborators from the European wind power sector, the current regulatory system governing such collaborations and operations.

REGULATORY REFORM

In their *Joint Memorandum on Realising the Opportunities and Potential of the Chinese Wind Market* (October 2009)[58] which was presented recently to senior Chinese policy makers, international and Chinese wind power associations identify a set of conditions that they consider vital to encourage wind power development in China (see Box 7). The Global Wind Energy Council (GWEC), the Chinese Wind Industries Association (CREIA), and the Chinese Wind Energy Association (CWEA) proposed a number of areas for cooperation. These included ambitious national targets for wind power, improved transmission networks and access, and a level playing field for international and domestic players, both in manufacturing and in wind park development. We have reproduced the text of their

Box 7. Chinese Wind Power Market Joint Memorandum

A coherent policy framework is the key driver for the healthy development of the wind power industry, through market competition on a clear and level playing field. The paper identifies the following areas that need to be part of such a framework:

1. Setting appropriate national targets for wind energy

Ambitious national targets build investor confidence and send out positive signals of political commitment, and are thus key for industry development. An appropriate target for China's wind energy development should be based on the country's tremendous potential and the industry's growing manufacturing capacity. GWEC and its partners are calling for a more ambitious target, saying that 100 GW by 2020 will easily be reached and possibly exceeded. In addition, the target should focus on electricity production rather than installed capacity, which would encourage maximum efficiency of wind farm development.

2. Ensuring better access to the Clean Development Mechanism (CDM)

The Chinese wind power industry is currently heavily reliant on financing through the Kyoto Protocol's Clean Development Mechanism. However, the authorities administering the CDM are increasingly questioning the 'additionality' of wind energy projects in China, which is one of the key criteria for granting carbon credits under the CDM. To date, several projects have been put on hold by the CDM Executive Board. Much work is needed to ensure that carbon markets will continue to play a role for the wind power industry in China in a post-2012 climate agreement.

3. Improving transparency of administrative rules and procedures

Tendering organised by government for development rights or turbine selection needs clearer rules and procedures, and a more extensive involvement from all stakeholders. GWEC and its partners encourage broader selection criteria, which take into account the lifetime electricity generation cost of a project rather than just the initial capital cost of the equipment.

4. Enhancing transmission networks and operation, and grid access

Due to the boom of wind energy in China, the planning of grid construction has been outpaced by the development of wind farms, creating bottlenecks which are now leading to considerable connection problems. Grid access and the operation of the transmission and distribution system are some of the key challenges for wind energy development in China. Unfortunately, grid operators are given little incentive to create a power grid which can accommodate large amounts of wind energy.

In addition to the issues referring to a policy framework, the paper calls for a strengthening of national Chinese research and development programmes, as well as a better protection of Intellectual Property Rights (IPR), in order to stimulate technological innovation.

Source: www.gwec.net/uploads/media/China_memorandum_final.pdf

[58] www.gwec.net/uploads/media/China_memorandum_final.pdf

published memorandum in the inset.

All of these proposals have been echoed by the companies with whom we have spoken. They are as important for manufacturing companies, as they are for companies involved in the development of wind parks and their financing.

In addition to the above proposals, European companies with expertise in wind park development and operations have told us that wind park development in China would be enhanced substantially by two specific measures: (a) allowing foreign companies to have effective control over wind park siting, development, and operations; and (b) enabling foreign operators to compete effectively, or to collaborate, with the publicly-owned generators which face renewable obligations.

EFFECTIVE CONTROL

Currently, 51 per cent Chinese control is needed to get a wind park registered as a CDM project. CDM wind power projects have lower 'costs' and can offer lower power prices than other projects because they can add in CER income. Wind park concessions have been awarded via reverse auction bidding, i.e. the lowest per kWh prices get the concessions. Since only Chinese controlled wind parks can factor in CDM income, they can regularly bid lower than foreign competitors. European companies could be minority partners in projects, but they have chosen not to do so. They argue that they could achieve higher efficiency and lower costs if they were permitted to control decisions such as micro-siting, the selection of turbines, and the operating regime – which is not possible if they are minority partners. They seek the right for their projects to be registered as CDM projects without 51 per cent Chinese control, or mechanisms which would enable them effectively to manage wind farms in a way that fully exploits their expertise – for instance with a suitable Chinese financial partner which would allow the foreign company to control operations.

EFFECTIVE COMPETITION OR COLLABORATION

A second condition for effective participation of foreign operators is that the regulation be designed so as to enable foreign operators either to compete directly with the main publicly-owned Chinese generators, or to collaborate with them in a way that minimizes the system's costs of expanding wind power generation. To our knowledge, all the important wind power concessions have been awarded to the large state-owned electricity companies, which have made aggressively low bids. The evidence reported in Part II of this Report illustrates that these companies have not been very effective in connecting or operating these wind parks. A number of reports have argued that the publicly-owned Chinese generation companies are willing and able to operate wind parks at a loss for two reasons: their ability to subsidize wind power projects from their monopoly operations, and the fact that they face a renewable energy obligation that requires them to own renewable capacity, even if it is not operating.[59]

If the aim is to expand wind power generation as efficiently as possible, it makes sense from the Chinese perspective to choose the operator which will be able to carry out the work most effectively. One way to achieve this objective would be to enable the publicly-owned generators to meet their renewable obligation (a) either through the purchase of renewable energy (or renewable energy credits) supplied by other companies, (b) or by owning and generating from their own renewable power assets. These companies should have incentives to choose the lowest cost alternative.

WHY AN INTERNATIONAL AGREEMENT?

The principal aim of the JCFA idea is to provide incentives for enhanced (Sino-European) private sector collaboration at a scale appropriate to the problem of addressing large developing country (Chinese) emissions. The fact is that most of the above proposals on how the Chinese and European public sector could contribute to such an enhanced collaborative effort could be carried out without an international agreement. The Chinese authorities do not need to have an agreement with a foreign power to carry out the proposed regulatory reform, nor do European governments need an international agreement to offer CERPOs to their national wind farm operators for their Chinese operations.[60]

The reason why we believe that an international (Sino-European) agreement is nonetheless essential to achieve the envisaged large scale private sector cooperation, is simply ***the private sector demand for political and regulatory 'certainty'***. This is not to say that China is seen to be particularly risky. On the contrary, according to the World Bank, for example, CER 'buyers continue to cite the economies of scale, the reliability of business partners, the ***predictability of regulatory processes*** and what they considered higher, but still fair, prices

[59] China Wind Power Report, 2007, pages 33–4.
[60] The one implementing option which presumably would need a bilateral agreement is the provision of FIT subsidies to the Chinese government.

for contracts'[61] as the reasons for investing in Chinese CDM projects. Nor would political risk be an issue only with regard to the Chinese side: as mentioned above, one of the key issues with the envisaged European contributions is the domestic revenue problem – i.e. the real risk that the European governments involved would cease to provide the required subsidies because of domestic pressures.

The existence of a government-to-government agreement reduces the political risks involved considerably, certainly more than if the agreements were 'merely' between the private sector operators and the governments in question: the fact is, governments tend to be extremely hesitant to renege on agreements with their peers.

3.3. Institutional Arrangements

What sort of institutional arrangements would be best suited for the envisaged JCFA? Who would be the most appropriate public sector counterparties for such an agreement?

While it is always intellectually interesting to come up with brand new designs, from a practical point of view it is better to try and see whether there already is an institutional arrangement which could be used for the purposes of a JCFA.

While there may indeed be a multitude of existing Sino-European agreements which could subsume the envisaged JCFA, there is clearly one candidate that stands out: The ***EU–China Partnership on Climate Change*** (ECP).[62] The ECP, agreed in 2005, consists of a political agreement to develop and strengthen cooperation on climate change. It comprises an ***overarching political agreement*** along with more specific ***memoranda of understanding*** involving both the EU and a member state (UK) as contracting parties with China.

3.3.1. The ECP Political Agreement

The ECP was established by a 'Joint Declaration on Climate Change between China and the European Union', which was endorsed at the 8th EU–China Summit in Beijing on 5 September 2005.[63] It represents a broad political commitment by the EU and China to *strengthen practical co-operation on the development, deployment and transfer of low*

[61] World Bank 2008, *State and Trends of the Carbon Market 2008*, Washington, D.C., May 2008, p.32; emphasis added.
[62] http://ec.europa.eu/environment/climat/china.htm
[63] http://ec.europa.eu/environment/climat/pdf/china/joint_declaration_ch_eu.pdf

carbon technology, to enhance energy efficiency and promote the low carbon economy.

However, even more important, in the present context, is that − in order *to reduce significantly the cost of key energy technologies and promote their deployment and dissemination* by 2020 – China and the EU commit themselves to

- *take strong measures to encourage low carbon technology development, deployment and dissemination and will work jointly to ensure that the technologies become affordable energy options.*
- *explore financing issues including the role of the private sector, joint ventures, public private partnerships, and the potential role of carbon finance and export credits.*
- *co-operate to address barriers to the development, deployment and transfer of technology.*

Given our discussion of the possible implementation options for the envisaged sample JCFA, it is clear that the ECP could very easily be the institutional home for such a Framework Agreement, given the perfect fit with these Partnership commitments.

Note, however, that the envisaged JCFA would mean a departure from the ECP as it is currently framed, since there are no quantitative targets associated with the overarching political key aims of the project for 2020, although there are targets and timetables for the implementing bilateral MOUs.

3.3.2. Bilateral ECP Memoranda of Understanding (MOUs)

The political agreement of the ECP is implemented through a range of mechanisms,[64] including the use of bilateral MOUs between the Chinese Government, on the one hand, and either the European Commission or a (at the moment just one) Member State, on the other. At present, implementation is focused on the political cooperation goal *to develop and demonstrate in China and the EU advanced, near-zero emissions coal technology through carbon capture and storage* (CCS) by 2020. This goal has been divided into three phases: Phase I, which ran until autumn 2009, comprised a number of projects conducting initial research into options for CCS in China; Phase II, running from 2010 to 2012, will examine the requirements for, and define the details of, a demonstration plant; and Phase III will see

[64] The commitment to consult on climate change policies is implemented through a 'bilateral consultation mechanism' which has met six times. There is also a CDM facilitation project which is scheduled to run from February 2007 to January 2010, and workshops have been held on energy efficiency in buildings and adaptation.

the construction and operation of a commercial-scale demonstration plant in China before 2020.

Two bilateral implementing MOUs were signed for the purpose of implementing Phase I of the project.

In February 2006, the European Commission and the Ministry of Science and Technology of China signed an MOU on ‘Cooperation on Near-zero Emissions Power Generation Technology through Carbon Dioxide Capture and Storage’. This MOU initiated the COACH project (Cooperation Action with CCS China–EU) which is funded by €1.6 million from the European Commission, provided in part under the EU’s 6th Framework Programme for research. The aims of the COACH project were:

- the enhancement of knowledge sharing and capacity building;
- the preparation of the implementation of large scale clean coal energy facilities by 2020;
- addressing the cross-cutting issues, e.g. societal anchorage, legal, regulatory, funding, and economic issues; and
- the coordination of activities performed under the EU–China MoU.

In December 2005, the UK (represented by the Department for Environment, Food and Rural Affairs and the Department for Business, Enterprise and Regulatory Reform) and China (represented by the Ministry for Science and Technology) signed an MOU on *Cooperation on Near-zero Emissions Power Generation Technology through Carbon Dioxide Capture and Storage* – referred to as the NZEC (Near Zero Emission Coal) project – with £3.5 million UK funding.[65] The objectives of the UK’s NZEC Initiative under Phase I of the project were to:

- enable knowledge transfer between Chinese and UK parties (academic, industrial, and other),
- model the future energy requirements of China, taking CCS technology into account,
- produce case studies of potential carbon dioxide capture technologies,
- build capacity in China for evaluation of storage potential for CO_2 and undertake preliminary screening of potential sites suitable for geological storage of CO_2.

[65] www.nzec.info

Both projects reported their results to an international conference on 'EU–China Co-operation on Near Zero Emissions Coal: Phase I results and next steps', held in Beijing in October 2009.

Phase II of the ECP started in November 2009 with a new MOU between the European Commission and the Ministry of Science and Technology of China, in which the European side 'considers to support the financial activities in Phase II up to the amount of €7 million'.

3.3.3. The ECP as Institutional Home for a Sino-European JCFA

There are a number of reasons why the ECP model would be institutionally appropriate for a JCFA as envisaged above. Apart from the mentioned perfect fit of the JCFA aims with the overall political goals of the political ECP agreement, there is the fact that the purse strings in the EU are still largely held by the Member States, who also have particular incentives to strengthen the role of their national (wind farm operating) firms in the envisaged large scale cooperation with China. Accordingly it would make sense to have bilateral implementing MOUs with individual Member States with respect to the provision of the required operating subsidy.

At the same time, there would be a need for an overarching framework agreement between the EU and China, not only in order to achieve the envisaged scale of the operations, but also because some of the Implementing Options (Section 3.2) could require certain amendments to the EU-ETS, which is not in the remit of individual Member States.

3.4. Conclusions – Why Joint Commitments?

To conclude, there are two central features of the proposed joint commitment agreement. Firstly, the JCFA would involve explicit quantitative targets agreed by both sides − for instance for wind power to displace *x* MWh of coal-based generation and thereby cut CO_2 emissions by *y* tons by, say, 2020. The evidence in China to date is that a quantitative target will provide a powerful signal to all participants.

Secondly, the agreement would explicitly recognize that for wind power to displace coal without subsidies, wind power must be competitive with coal, at least when CO_2 externalities are taken into account. For some years to come, ignoring CO_2 externalities, wind power is likely to cost more than coal, especially due to the need to provide back-up power to deal with intermittency and to make the significant transmission investments required to bring wind power to market. The JCFA should help to drive down the cost of wind power relative to coal, and to provide financial support while wind power continues to be at a cost disadvantage.

Beyond these two key features, the JCFA would establish conditions that allow both parties to benefit as they cut CO_2 emissions. China would receive financial support from the EU (e.g. through an enhanced CDM programme, through NAMAs or in other ways) and increased investment and technology transfer by European companies, especially in wind park siting, development and operations, transmission system development, and system operations for wind power-intensive networks. These are all very important areas for China, in which European expertise is recognized. In return, European companies would receive improved access to opportunities in wind park development and management, a reasonable expectation of profitability in a potentially enormous market, and improved protection of intellectual property.

Although the JCFA can be signed by the European Union and China, it would support other bilateral agreements (between individual Member States and China) to promote wind park and related investments, joint research and development, and increasing contacts among researchers and policy makers from China and the EU. Indeed, we would expect to see countries like Spain, with their substantial wind power expertise, establishing bilateral MOUs with China, or with regions of China, to promote wind power research, development, and investment, possibly through pilot programmes.

We have encountered a high level of scepticism among European companies and officials concerning the willingness of the Chinese Government to move in the directions we are proposing. On the other hand, our view is that the European Union, its Member States, and European companies in the sector are potentially very attractive partners for China in the wind power sector, provided China sees genuine political support from the EU.

Indeed, there is a recent development that would favour the sort of collaboration we have in mind: the spinning off (via Initial Public Offerings) of wind park operators by major Chinese electricity companies, specifically Longyuan (an affiliate of Guodian).[66] From the perspective of European companies, this development is potentially promising for two reasons. Firstly, this process will create new, privately-owned companies with a greater interest in the profitability of Chinese wind parks. Secondly, the Chinese companies will be seeking markets for wind parks around the world. European companies are potential competitors in Chinese and global markets, but also potential joint venture partners and even merger candidates. It seems to us that a joint commitment agreement at this stage would be very well-timed to take advantage of these developments, or at least to prepare a defensive strategy.

As mentioned earlier, there is nothing in the scheme for large-scale collaboration described in this part of the Report which could not be introduced in the absence of joint commitments. What, therefore, is gained by adopting joint commitments over and above the sort of commitments already undertaken in, say, the EU–China Partnership on Climate Change?

The chief purpose is to ***provide an additional assurance to the relevant private sector companies*** that the government counterparties to the agreement are ***fully committed to the scheme at the envisaged scale***. Furthermore, targets and timetables envisaged in the joint commitments not only provide the means for assessing the progress of the collaboration, but also allow for improved forward planning, particularly by the private sector. The legal format of the joint commitments in this case is of secondary importance; what counts is that there is a timetable with quantitative targets.

Finally, we recommend that the ideas from this study on the case for joint commitments be considered for other large developing countries and for other low-carbon technologies, including other renewable energies, nuclear energy, CCS, and energy efficiency projects and programmes.

[66] The news story is available on the internet at: www.reuters.com/article/idUSHKG24080920091204

Appendix: Wind Power Case Study[67]

A.1. Introduction

China's energy consumption and GHG emissions have recently become a focus of most global energy, environment, and security talks. As a result of its sheer size, the way in which China's energy system develops will not only have important implications for global energy investment, energy market restructuring, and local environmental protection, but also for the chances of avoiding dangerous climate change. Increasing the share taken by renewable energy sources is an important element of China's energy system transition.

Wind power not only supplies renewable energy, but also mitigates CO_2 emissions, so its deployment benefits the whole world. China is a rich country in terms of wind energy resources. The technical potential of onshore wind resources is estimated at 297 GW, at a height of 10 metres,[68] with annual electricity generation being more than 594 TWh, which would amount to more than 18 per cent of China's total electricity production in 2007.

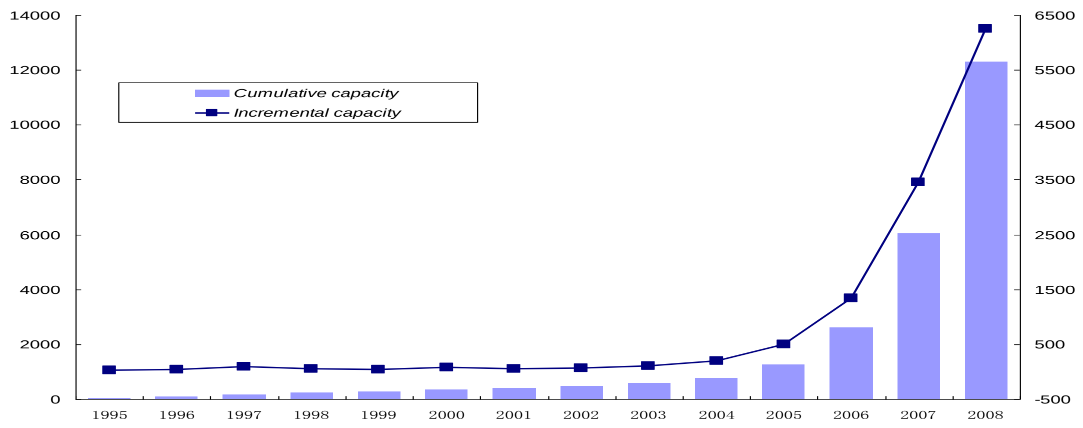

Figure 1. Installed and incremental wind power capacity 1995–2008 (MW)

Since 2004 China's wind power industry has been growing very rapidly (see Figure 1). The cumulative installed capacity of wind turbines went from 550 MW in 2003 to 12 GW in

[67] This Appendix is largely based on an article written by the Chinese contributors to our report, in part based on Zhang Xiliang, Wang Ruoshui, Chang Shiyan, Huo Molin, *China's wind industry: policy lessons for domestic government interventions and international support*, Climate Policy, Volume 9, Number 5, 2009, pp. 553-564(12).

[68] China Meteorological Administration, 2006. China Wind Resource Assessment Report, Beijing: China Meteorological Press.

2008, with new installations of 6.2 GW in 2007 alone. By the end of 2009, capacity was about 26 GW.

Nevertheless, high costs make an even larger scale deployment of wind power difficult. A high proportion of these costs originate from the investment in the actual wind turbine equipment. Chinese experience is that the development of a domestic turbine manufacturing industry leads to a decline of the overall costs of wind power deployment. Compared to overseas companies, prices have fallen through domestic production because of competition, an abundant supply of labour, and lower transportation costs.

China has become a global leader in wind power technology deployment and manufacturing capacity. How was such a marked progress made? What was the effect of domestic renewables/wind power policy? What has been the role of international support? What is impeding the development of wind power on an even larger scale? Is the focus of the current development model still adequate? China's wind energy development has long been a research subject.[69] However, so far these questions have not yet been fully answered. In particular, there is a dearth of literature examining China's wind power industry development from the combined perspective of domestic policy and international support.

A.1.1. Development

The Chinese wind turbine manufacturing industry has developed quickly in recent years. Domestic 750 kW turbines entered mass production in 2005, while domestic 1.5 MW wind turbines have been in mass production since 2007, when domestic 2 MW wind turbines were also tested and improved. Sinovel, Goldwind, and Dongfang Electric have become the three biggest domestic manufacturers. Goldwind had a share of 25.1 per cent of the market in 2007, while Sinovel's and Dongfang Electric's shares stood at 20 per cent and 7 per cent respectively in that year.

[69] Lema A. Ruby K., 2007. 'Between fragmented authoritarianism and policy coordination: creating a Chinese market for wind energy', *Energy Policy*, 35 (2007), 3879–90. Lewis, J. I. 2005. 'From Technology Transfer to Local Manufacturing: China's Emergence in the Global Wind Power Industry', Ph.D. Dissertation in Energy and Resources, University of California Berkeley, Fall 2005. Liu, W.Q., Gan L. and Zhang X.L. 2002. 'Cost-competitive incentives for wind energy development in China: institutional dynamics and policy changes', *Energy Policy*, 30 (2002), 753–65. Zhang, X.L., Gu, S.H., Liu, W.Q., Gan, L. 2001. 'Wind energy technology development and diffusion: A case study of Inner Mongolia, China', *Natural Resources Forum*, 25 (2001): 33–42.

All these companies initiated manufacturing capability and started to enter the turbine market by making use of technology transferred from overseas. All their current technologies have been gained by way of technology transfer as well. A number of achievements in wind technology development are listed below.

CAPACITY INSTALLED AND ELECTRICITY PRODUCED

The growth in total installed capacity of wind farms is an important measure of the effectiveness of domestic policies. The cumulative installed capacity of wind turbines went from no more than 38 MW in 1995 to 12,153 MW in 2008 (see Figure 1). By the end of 2009, capacity had reached 26 GW. Note that most of the increase in installed capacity has occurred since 2005 when the Renewable Energy Law was passed by the Chinese People's Congress. This is also closely related to the implementation of such wind power policies as the wind power concession programme, the mandatory renewable market share, and the power surcharge for renewables.

Chinese wind turbines generated a total of approximately 12 TWh of electricity in 2008. This relatively low output of electricity compared to installed capacity can be explained by the challenge of connecting all of the newly-installed capacity to the grid. The grid connection rate remained low in 2008 and 2009, due to the prevailing incentive structure that supports the increase of wind power capacity, but not electricity production itself.

Most of the investment in wind park projects has been undertaken by the major publicly-owned Chinese electricity operators. Foreign investors have found it difficult to justify investment in wind parks. This is largely due to the regulatory environment, and in particular to: (a) the requirement for 51 per cent Chinese ownership of the wind park operating company in order to obtain CDM credits; (b) the incentive (due to their obligations to own renewable capacity) and the ability (through cross subsidization from their monopoly businesses) of the main Chinese power companies to bid aggressively for wind park concessions; and (c) the uncertainty about grid connection.

LOCALIZATION OF WIND TURBINE MANUFACTURING

Localization of wind turbine manufacturing has been viewed as an important method of reducing the cost of wind turbines and thus the cost of wind power in China. It can also make a contribution to increasing the competitiveness of the Chinese wind turbine industry. The share of domestic and joint venture wind turbine manufacturers in new turbine installations climbed from about 25 per cent in 2004 to 75.6 per cent in 2008. The two biggest domestic wind turbine manufacturers – Sinovel and Goldwind – shared 40.6 per cent of the newly installed capacity in 2008, while their foreign counterparts – Vestas and Gamesa – jointly installed 17.7 per cent. In terms of the cumulative installed capacity, domestic and joint venture manufacturers accounted for 61.8 per cent and foreign companies for 38.2 per cent.

LOCAL ECONOMIC AND SOCIAL DEVELOPMENT

The majority of wind farms are built in underdeveloped areas of China, such as Inner Mongolia, Xinjiang, Zhang Jiakou District of Hebei Province, and Gansu Province. Wind farm development serves as a new engine of local economic growth and provides a new fiscal revenue source to local governments. It also brings new job opportunities for local residents. The electricity generated from wind farms in 2008 led to revenue of more than 7 billion RMB from electricity sales.

REDUCTION IN WIND TURBINE COST AND FEED-IN TARIFF

There has been a decline in the cost of wind turbines and in the feed-in tariff of wind-generated electricity since 2004. The average feed-in tariff of wind power under the Wind Concession Programme in Inner Mongolia decreased from approximately 0.6 RMB/kWh in 2004 to 0.5 RMB/kWh in 2007.

INCREASED TECHNOLOGY R&D CAPABILITY

The focus of research and development (R&D) in China's wind technology has been on large-sized wind turbines, variable speed technologies, variable screw distance, offshore turbines, and wind farm designs. Before 2000, Chinese companies were not able to manufacture wind turbines of more than 600 kW. Currently, the major Chinese wind turbine manufacturers such as Goldwind and Sinovel already have the capability of manufacturing wind turbines of 1.5 MW. Domestically-made wind turbines of 2 MW are being tested on site. Government support for R&D has made an important contribution to increasing the technological capabilities of Chinese wind power equipment manufacturers.

A.2. Domestic Policy

China has passed a number of domestic policies and measures that have contributed to the rapid development of the wind power industry in recent years. They are summarized below.

RENEWABLE ENERGY LAW

China's Renewable Energy Law was passed by the People's Congress on 28 February 2005, and took effect on 1 January 2006. The law recognizes the strategic role of renewable energies in optimizing China's energy supply mix, mitigating environmental pollution, and promoting rural social development. It also relates renewable energy development and utilization directly to China's energy system transition. The law has largely shaped an integrated renewable energy policy framework by providing a set of directives encouraging and enabling renewable energies. Wind power development has been listed as a priority technology and was highlighted by the law. More importantly, the law has laid a legal foundation for wind energy investments and government interventions in China.

WIND CONCESSION PROGRAMME

In China the development of any wind power project over 50 MW needs to go through a concession tendering procedure that is coordinated by the National Development and Reform Commission (NDRC). To achieve improved cost-effectiveness through competition, potential developers are invited to join a public bidding process. Those who offer the 'best price' under certain terms will win the concession and thus have the right to build wind farms on the concession sites. The wind power developers selected by the concession programme will also have the right, guaranteed by the government under the terms of a Power Purchase Agreement, to sell the electricity under the agreed tariff to the grid. From 2003 to 2008, five rounds of concession biddings were implemented, and a total of 49 wind farms were approved with a total capacity of 8,800 MW. Most of them are located in Guangdong, Jiangsu, Inner Mongolia, Jilin, Gansu, and Hebei provinces.

The programme has been modified in the process of implementation. In order to strengthen the role of local wind turbine manufacturers, a 70 per cent of domestic content rule for wind turbines has been required since the second round of bidding.[70] To avoid the excessively low prices that sometimes resulted during the first two rounds of biddings – preventing an effective subsequent implementation – a comprehensive evaluation method has been introduced since the third round of biddings. With the new method, the selection of the concession developers is based not only on the energy price bid by the developer, but also on the technological proposals.

[70] We understand that this requirement no longer exists, but that there are other measures that favour technologies which have been developed in China.

MANDATORY RENEWABLE MARKET SHARE

The Chinese Government issued and released the Middle and Long-term Renewable Energy Development Plan in September 1997. A mandatory target was introduced to increase the share of renewable energies in national energy supply. Renewable energies have to account for 10 per cent of the total energy consumption by 2010 and 15 per cent by 2020, respectively. The share of renewable power, excluding hydro, in the main electricity grids should reach 1 per cent by 2010 and 3 per cent by 2020. Electricity companies with installed capacity of more than 5 GW are required to have renewable power (excluding hydro) capacity that accounts for more than 3 per cent of their total capacity by 2010 and 8 per cent by 2020. Wind power has been identified as a priority renewable energy technology. According to the Plan, the installed capacity of wind power should reach 5 GW by 2010. Since the cumulative installed capacity of wind power surpassed 6 GW in 2007, the NDRC increased the wind power target for 2010 from 5 GW to 10 GW. However, with installed capacity of 26 GW at the end of 2009, the total installed capacity of wind farms could well reach more than 30 GW in 2010.

POWER SURCHARGE FOR RENEWABLES AND PREMIUM

The Chinese Government has implemented a surcharge of 0.2 cent RMB/kWh on electricity to subsidize renewable power including wind power. In January 2006, a policy document named 'Interim Measures of Renewable Energy Tariff and Cost Sharing Management' was released by NDRC. For biomass power generation projects, a subsidy of 0.25 RMB/kWh applies. For wind power, a public bidding process is required for projects with a capacity over 50 MW. The difference between the long-term contract price for wind power and that of the local coal-fired power is covered by a fund.

RELIEF OF VAT AND CUSTOMS DUTY

The value-added tax (VAT) rate for investment projects is 17 per cent in China, but no VAT is levied on fuel costs. This creates a disadvantage for wind turbines – which have high investment and no fuel costs – relative to coal power stations.[71] To mitigate this distortion and increase the competitiveness of wind power, the Central Government allows for a 50 per cent VAT rebate for wind farm developers.

To enhance domestic innovation and manufacturing capacity, the Ministry of Finance issued

[71] Liu, W.Q., Gan L. and Zhang X.L. 2002. 'Cost-competitive incentives for wind energy development in China: institutional dynamics and policy changes', *Energy Policy*, 30 (2002): 753–65.

a new regulation on import tax and duty for wind turbines and key parts of wind turbines on 14 April 2008. Before the new import tax and duty regulation, there had been no import tax and duty for importing wind turbines. The Ministry confirmed that when Chinese turbine manufacturers import key components and resource material to develop high-power turbines, the customs duty and value-added tax from import will be refunded after collection. Regarding components that domestic companies cannot produce, there is no customs duty. This policy encourages overseas turbine companies to transfer their manufacturing to China, and benefits domestic producers since the cost of components is lowered.

TECHNOLOGY RESEARCH AND DEVELOPMENT

The Chinese Government has made substantial efforts to support wind technology R&D. The National Basic Research Programme ('973 Programme'), the National High-tech R&D Programme ('863 Programme'), as well as the National Key Technology R&D Programme, are the three key programmes in this area. Wind energy technology research and development has been an important focus of these programmes. Other programmes and projects have also largely supported the demonstration and industrialization of wind energy technologies, such as Bi-Emphasis Projects, National Debt Investments for Wind Power, and international cooperation projects. Some experience has been gained in terms of wind power resource surveying and evaluation, wind farm operation and management, and wind power turbine design and manufacture.

The National Ministry of Science & Technology (MOST) has subsidized wind energy R&D expenditure, beginning most notably in 1996 with the establishment of a renewable energy fund. MOST and its subdivision in Xinjiang province funded the research and development of Goldwind. These funds facilitated the absorption of transferred technology, and led to the development of domestic intellectual property for its turbine technologies,.

The National Wind Power Technology Research Center (NWTC) was founded with the approval of the National Ministry of Science & Technology. It is a professional institution, which works on new technology R&D and the promotion of engineering standards and solutions for large-scale wind turbine generator systems. It also provides integrated consulting services for the wind power industry.

ANALYSIS

Demand-pull policies provide long term and stable market demand to manufacturers, and thereby act as an effective incentive to develop and deploy technologies. The Chinese Government has committed itself to a target for long-term renewable energy development, and plans a specific target for wind power development in the next five years. Concession programmes are supposed to give manufacturers the confidence to invest in technology development, which in turn reduces costs and provides increasing benefits for the domestic market.

Goldwind and other Chinese manufacturers have benefited from this government-led focus on R&D and on demand pull. They are increasingly focusing on the development of turbines that are appropriate for Chinese wind conditions, and on controlling the quality of turbines and components.

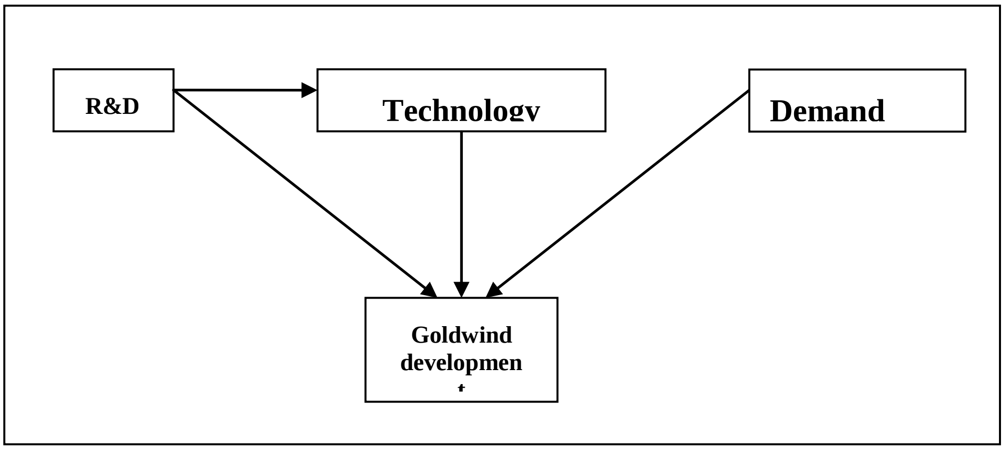

Figure 2. The influence of R&D, Technology Transfer, and Demand-Pull policies on Goldwind.

A.3. International Support

In addition to its favourable domestic policies, international support has played an important role in helping the Chinese wind power industry reach the current level of development. This has happened in a number of ways, which are outlined below.

A.3.1. Technology Transfer

All major wind turbine technologies deployed in China today originated in foreign countries. The role of technology transfer should therefore not be underestimated in China's wind power technology development and deployment.

The development of four generations of turbine technologies is summarized in Table 1. All these technologies have been developed with one form or another of technology transfer, and this has evidently played an important role in the development of all the major Chinese wind turbine manufacturers.

Table 1. Technology transfer mechanisms of the three largest wind turbine manufacturers.

Manufacturer	Technology list	Technology transfer		
		Time	Collaborator	Mechanism
Sinovel	1.5MW	2003	German Fuhrlander	Jointly develop
	3MW	2007	Austria Windtec	Jointly develop
	5MW	2007	Austria Windtec	Jointly develop
Goldwind	660kW	1997	German Jacobs	Licensing
	750kW	2001	German REpower	Licensing
	1.5MW	2005	German Vensys	Jointly develop
	2.5MW, 3MW, 5MW	2008	German Vensys	Purchasing the foreign company
Dongfang Electric	1.5MW	2004	German REpower	Licensing
	2.5MW	2005	German Aerodyn	Jointly develop

Goldwind bought licenses from the German wind turbine manufacturers Jacobs and REpower, and co-designed with Vensys, which is a German wind turbine designer. The license fees were paid for each machine that was manufactured. The license included component specifications and information on the assembly of turbines, but not the knowledge of how to design a turbine. Co-design includes sharing of intellectual property. Technology transfer helped Goldwind to build their manufacturing capability quickly and also to improve its research capacity.

Going a step beyond these concrete examples, below we explain how the technology transfer happened.

TECHNOLOGY TRANSFER MECHANISMS

Sinovel, Goldwind, and Dongfang Electric are the three biggest domestic manufacturers in China. Sinovel accounted for 22.45 per cent of the total increase in the wind turbine market of China in 2008, while Goldwind and Dongfang Electric had 18.12 per cent and 16.86 per cent of the market, respectively. All of them started to build their manufacturing capabilities by technology transfer. The main technology transfer mechanisms are licensing, joint development, and purchasing the foreign company (Table 1).

STAKEHOLDER ANALYSIS

We can approach the issue of technology transfer through a stakeholder analysis based on a wind technology transfer survey. An important lesson learned thereby is that the substantive involvement of the governments of both developed and developing countries in the technology transfer process can play a catalytic role in the international transfer of environmentally sound technologies, particularly in the early stages of the technology transfer. Taking Goldwind as an example: it gained R&D funds not only from the research programmes of MOST, but also by way of financial support from the German government.

The analysis and examples of technology transfer presented here focus on wind turbine manufacturing capacity. This has indeed been the dominant area of collaboration so far. It has to be noted, however, that technology transfer must not (and should not) be limited to the transfer of manufacturing capacity. For example, other important areas are technology and capacity of wind park siting and management. However, to date, most technology transfer has occurred in the area of wind turbine manufacturing.

Table 2. A stakeholder analysis of the technology transfer process in the Chinese wind industry

Stakeholders	Motivations/Objectives	Actions
Domestic Companies	Technology leapfrogging Increased intellectual property More market share Brand recognition	Licensing Jointly develop Joint venture
Foreign companies	More profit from licensing sales Increased market share in China Lower labour cost in China More financial return Understand China's wind conditions	
Chinese government	Lower cost of wind turbine manufacture Address energy crisis and climate change Economic development of wind power industry Technology leapfrogging More job opportunities	Value-added tax reduction Guaranteed grid connection Premium R&D Customs duty relief Favourable loan

Foreign governments	Improved reputations in fulfilling their UNFCC financial and technology obligations under UNFCCC Assisting the wind power companies in occupying more Chinese wind power market	Financial support for purchase of foreign wind turbines Protecting intellectual property Joint R&D

A.3.2. Financing

GRANTS PROVIDED TO CHINA BY NORTH EUROPEAN GOVERNMENTS FOR IMPORT OF TURBINES

The experience of Goldwind is of particular interest in understanding the motivation of different actors in the transfer of technology.

In the early stages of Chinese wind power development, the Danish government gave financial support to China to finance the import of Danish turbines. In October 1989, Goldwind gained a free grant worth US$3 million from the Danish Government for the purchase of turbines. Using this support and 6.7 million RMB of its own funds, Goldwind purchased 13 sets of 150 kW wind turbines from Bonus and one set of 100 kW turbines from Wincon. This enabled Goldwind to build the Dabancheng wind farm in Xinjiang, which was the largest wind farm in Asia at the time. In this way, Goldwind laid a solid foundation for future turbine research and development.

The German Government also provided financial support to Goldwind, in their case to import German turbines into China. In 1996, because Goldwind had participated in the China–Germany Science and Technology Cooperation project, the German Government helped Goldwind install and debug 600 kW wind turbines, which were the most advanced technology in China at the time. It also provided a loan to Goldwind to enlarge the Dabancheng wind farm, making Goldwind the first company to install and operate 600 kW-sized wind turbines in China. The German Government gave direct subsidies to German turbine manufacturers to support them in forming wind farm joint ventures in developing countries, on condition that they install German turbines. This international aid project of the German Government was used to test the performance of Germany turbines in different wind conditions through cooperation with China.

In conclusion, the Danish and German governments provided financial support and technical assistance to Goldwind to facilitate their own wind turbine industries' development, specifically to encourage their manufacturers to enter the Chinese market and to improve their technologies in different wind conditions. Their activities indirectly facilitated wind power technology transfer to China.

THE CLEAN DEVELOPMENT MECHANISM

A more recent method of financing wind power projects has appeared through the Clean Development Mechanism (CDM) under the Kyoto Protocol. China signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and ratified the Kyoto Protocol on 30 August 2002. In the first quarter of 2007, China became the biggest supplier of certified emission reductions (CERs) not only in terms of CER volume, but also in terms of the number of CDM projects.

In the Chinese CDM regulation, priority areas for CDM projects in China are identified as energy efficiency improvement, development and utilization of new and renewable energy, and methane recovery and utilization. (Teng and Zhang, 2009).

At the end of 2009, 141 of the 673 registered Chinese projects were wind farms, as were 244 of 1162 projects that were under preparation. Registered Chinese wind power projects are projected to result in annual reductions of 78 $MtCO_2$ in 2012 (about 12 per cent of total Chinese CERs), and 111 $MtCO_2$ (18 per cent) for those under preparation (UNEP Risø). The CO_2 emission reductions from all CDM projects approved in China would reach approximately 1.57 billion tons by 2012. Wind farm investors get an average economic incentive of approximately 10 cents RMB/kWh from CER income. We can therefore see that CDM has played an important role in China's wind power industry development.

It has to be noted that the financial income from the CDM is limited to project development companies with a Chinese majority investment share. Foreign-led developers have therefore effectively been excluded from profiting from this mechanism.

EU GOVERNMENT CO-FUNDED GRADUATE EDUCATION AND RESEARCH

On the research side of the wind power industry, the Chinese Department of Commerce signed an agreement for a 'China–EU Clean and Renewable Energy Institute' with the European Union on 30 March, 2009. The European Union will supply 10 million Euros to the project, which is an important cooperation project in the environmental area. The project aims to build a platform for graduate education and research for PhD students. A professional training centre of the China–EU Clean Energy Institute will be established to train people working in the industry. The project enhances research and education in this field and facilitates higher-level cooperation.

A.3.3. Research and Development

As the previous paragraphs have shown, research and development (R&D) has been an important area of government-funded financial support. Besides the above-mentioned initiative, international support of R&D has been an important area of collaboration between European and Chinese companies.

THE GOLDWIND EXAMPLE

Goldwind grew out of the Wind Power Research Institute, so it has had an important advantage in the area of research and development. Its business model has been to design and assemble technology-intensive turbines. The company, in turn, outsources component manufacturing, which is labour-intensive and capital-intensive. The reason why Goldwind's share of the turbine market has grown so quickly is its cost competitiveness. Since turbine manufacturing is a high technology industry, R&D capability is the most important driver of cost competitiveness, while cost reduction opportunities from transport, labour, and maintenance are limited. The company has always sought greater control over intellectual property. If its R&D capability were weak, the company could not have developed its intellectual property, and would have had to pay high licensing fees to other wind turbine manufacturing companies. Furthermore, it could not have provided good maintenance for its wind farms, which would have been a big disadvantage in bidding for concession projects.

Goldwind has invested consistently in its R&D capacity. In 2006 its investment in turbine R&D was 88.47 million RMB and in 2007 its investment in R&D grew to 130 million RMB – accounting for 5 per cent of annual revenue. Here is other evidence of Goldwind's commitment to research and development.

- Goldwind has research centres in Xinjiang, Beijing, and Germany. It established The National Wind Power Technology Research Center in 2004. Its research base in Yizhuang, Beijing was launched in 2007.
- Goldwind collaborates and communicates on R&D with international wind power institutions and companies, such as the Danish RIS national laboratory, the Danish wind turbine design

company NORWIN, UK wind power consulting company Garrad Hassan, the German wind turbine design company Aerodyn, the wind turbine manufacturer REpower, and the Dutch Delft University of Technology.

- Goldwind works on R&D with Chinese universities and research institutions, such as North Jiaotong University, North China Electric Power University, Xinjiang Agriculture University, and Xinjiang University.
- Goldwind draws on a pool of external consultants who are experts in China and other countries. There are about 30 Chinese experts and 15 experts from Denmark, Germany, and the UK.
- Goldwind is very concerned about the skill level of its technicians. It employs a steadily increasing number of highly-educated university graduates, including foreign graduates. Up to the end of 2007, there were 24 foreign personnel from five countries taking an internship or job in the company.

LIMITS TO SUPPORT IN R&D

As in the case of financing, most international support and cooperation has so far concentrated on turbine manufacturing. Chinese companies and institutes have dramatically expanded their capacity in this area, but are still falling behind western competitors in wind park siting, management, etc. Little cooperation in research and development has concentrated in these important fields, or in the areas of grid development, integration, and management.

A.4. Challenges and Recommendations

A.4.1. Analysis of Barriers and Challenges, Risks and Uncertainties

INAPPROPRIATE STANDARDS AND AUTHENTICATION

Turbine technology transferred to Chinese manufacturers mostly adheres to European standards, which are mostly based on European environmental and wind conditions. The Chinese environment and wind conditions, however, are quite different from those in Europe, so the European standard system is, in part, inappropriate for China. It is difficult for Chinese manufacturers to select the right turbine technology to be transferred. At the same time, this has hindered European manufacturers from developing their business in the Chinese market through technology transfer, or by turbine exports from Europe.

Weak trust in intellectual property right protection

Both foreign and Chinese companies are concerned over intellectual property right protection. On the one hand, foreign companies care about losing business and potential profits if Chinese companies do not follow technology transfer agreements, or regulations and laws of intellectual property rights protection. On the other hand, Chinese companies are worried that foreign companies abuse the argument of intellectual property rights, for instance, to refuse to transfer something even though it has been included in an agreement, or to demand extremely high and unfair intellectual property fees.

Weak absorption and adaptation capability

Chinese manufacturers must absorb technologies after the transfer, in order for technology transfer to be cost-effective in the long term. Chinese manufacturers have to adapt and re-develop technology, because foreign turbines are mostly inappropriate for Chinese wind conditions. However, domestic R&D capability is very limited, while foreign companies have decades of experience. This weak domestic R&D capability has already hindered the development of the Chinese wind power industry.

Competitiveness

The lowest feed-in tariff accepted by potential investors is an important measurement of the competitiveness of the different power-generating technologies. The lower the feed-in tariff of the technology, the higher the competitiveness of the technology. The competitiveness of wind power varies significantly with the wind turbine cost, wind turbine performance, and the wind resource endowment. Although China's wind power industry has made marked progress since 2004, there are still a number of risks and uncertainties needing to be addressed to translate China's great wind power development potential into market reality.

Resource uncertainty

The assessment of the economics of wind farms and the selection of the sites of wind farms are very much based on wind resource assessment. There has been a lack of accurate wind resource assessments in China. As a consequence, a number of wind farms built in China cannot generate as much electricity as was expected before the wind farm construction, resulting in economic losses. Currently, there is not only a shortage of funds for sufficient and accurate wind power resource surveys, but also of wind power survey technologies in China. Since Chinese manufacturers do not yet have the technology to manufacture low-wind-speed turbines and high-axis wind turbines, there is a possibility that a large amount of

China's wind power resource will not be utilized effectively or in a timely way.

TECHNOLOGY RISK

All of the wind turbine design systems used by Chinese manufacturers are transferred from foreign companies. Foreign companies often transfer the design system to their Chinese partners, but not the data basis and know-how associated with the design systems. The design system transferred is therefore largely a black box for Chinese manufacturers. However, the climate and wind conditions in China are often quite different from those in the countries where the wind turbine design systems are developed. As a consequence, the wind turbines designed with the foreign design systems do not operate as well as expected in some locations.

MARKET UNCERTAINTY

In China it seems that the installed capacity of wind turbines runs ahead of the grid capacity. With more wind farms being built, there are increasing concerns about the capacity of the grids to integrate wind-generated electricity in China. The wind farms built are often located in underdeveloped areas of China, where there is not enough demand for electricity. As a result, wind-generated electricity has to be transmitted over long distances to the developed areas of China. Transmission, dispatch, and management of wind-generated electricity have already become a major barrier to expansion of the wind-generated electricity market. The Chinese grid companies have not yet got command of advanced technologies for wind-generated electricity transmission, dispatch, and management. Furthermore, the development of grid technologies for wind-generated electricity transmission, dispatch, and management will need significant additional funding.

A.4.2. Recommendations for North–South Cooperation on Wind Power Technology Transfer in China

PROVIDE TECHNICAL SUPPORT AND CAPACITY BUILDING FOR PUBLIC SERVICE

Establish Chinese standards

Chinese standards for wind turbines are needed for both foreign and Chinese manufacturers and wind farm investors, in order for technology transfer and innovation to be more appropriate for Chinese conditions.

Support wind resource assessment

Current wind resource assessment in China mostly depends on foreign technologies, whose precision is not sufficiently high to improve wind power development planning and turbine standards. The Chinese meteorological bureau needs advanced technologies to make more precise assessments of wind resources, so as to provide a scientific reference for mid- and long-term wind farm development planning, and the establishment of appropriate turbine standards.

Support intellectual property right protection

Both foreign and Chinese companies need intellectual property right (IPR) protection to further the trust required for successful collaboration. Information which would help companies to understand foreign IPR systems and patents more clearly would help to avoid theft of IPR and misunderstandings.

Support policy making

Chinese policies for wind power development have proven to be successful. However, there are still some potential problems, such as excess manufacturing capacity. It would be helpful for foreign governments and the Chinese Government to communicate, in order to learn from each others' experiences and to improve policies.

ENCOURAGE PROFESSIONAL EDUCATION AND R&D

The number of technical professionals in the wind power industry cannot meet the fast-increasing need for services at this early stage of the new industry in China. Since wind power development in China is in its primary stage, demand for technical professionals will keep growing. Education and training of technical professionals and encouragement of R&D is a very urgent matter, for which various forms of support are possible.

- Visiting and joint research among public research institutions, including universities, NGOs, and public research institutes.
- Communication and study visits of graduate students, especially PhD students.
- Communication and joint research between public and private sector.
- Joint foundation of public research institutions.

A.4.3 Financial Support

The Chinese Government provides substantial financial support to the wind power sector, since, without such support, wind energy is still not competitive with alternative fuels (e.g. coal) under market competition. Manufacturers, power generators, and grid companies receive incentives and subsidies from the Chinese Government to pay for investments in

R&D, infrastructure, and employment. The Chinese Government must at the same time still deal with poverty and the problems of adaptation to climate change. China therefore still needs financial support from developed countries. Mechanisms for providing such support could include loans on favourable conditions, special funding, and grants.