BRIEFING PAPER 18/2007

THE EU ENERGY COOPERATION WITH CHINA IN THE FIELD OF CLEAN COAL TECHNOLOGY

Pavel Zástěra

October 2007

Association for International Affairs, Žitná 27, 110 00 Praha 1; tel./fax. +420 224 813 460; www.amo.cz; info@amo.cz

ASSOCIATION FOR INTERNATIONAL AFFAIRS

The Association for International Affairs (AMO) is a non-governmental organization founded to promote research and education in the field of international relations. Our main goal is to increase awareness of international affairs. Thanks to its activities and more than ten-year tradition, AMO has established itself as a preeminent foreign policy think-tank in the Czech Republic.

AMO Strives To:

- publish analyses and research papers;
- organize international conferences, expert seminars, round tables, public briefings;
- promote educational projects;
- provide critical assessment of current affairs for Czech and international media;
- foster development of a new generation of foreign policy experts and scholars;
- encourage interest in international relations among the general public;
- cooperate with Czech and international like-minded institutions;

RESEARCH CENTER

Founded in October 2003, the AMO´s Research Center has been dedicated to carrying out research into and raising public awareness of international affairs, security and foreign policy.

The Research Center strives to identify and analyze issues important to Czech foreign policy and the country´s position in the world. To this end, the Research Center produces independent analyses; encourages expert and public debate on international affairs; and suggests solutions to tackle problems in today´s world. The Center´s activities can be divided into two main areas: First, the Center undertakes research and analysis of foreign policy issues. Second, the Center fosters dialog with the policy-makers, expert community and broad public.

This paper is the independent analysis of the author. Views expressed in the report are not necessarily those of Association for International Affairs.

INTRODUCTION

The technology cooperation in the field of energy is one of the tools available to tackle climate change. Considering the provisions of economic growth in developing countries, introduction of low Greenhouse gas (GHG) emissions' technologies in these countries seems to be of primary importance. Coal, the most polluting fossil fuel, is expected to remain a significant source of energy in the near future. The Clean Coal Technology (CCT) has the potential to reduce negative environmental impacts of coal consumption. The article is aiming to analyse different aspects of the EU-China energy cooperation in the field of clean coal.

Firstly, prospects of energy consumption and technical aspects will be considered. The second part focuses more closely on actual bilateral and multilateral frameworks for CO2 mitigation that can be applied to the introduction of Clean Coal Technology in China and related to the EU interests. Thirdly, different projects using Clean Coal Technology run by European companies both in the EU and China are presented.

1. CHINA'S SPECIFIC NEEDS AND DEFINITION OF CLEAN COAL TECHNOLOGY

1.1. THE IMPORTANCE OF COAL IN CHINA´S ENERGY MIX

If things stay the way they are, around 2010, the non-OECD counties will surpass the OECD countries in terms of energy consumption. The bulk of the trend can be attributed to China's economic take-off with the annual GDP growth estimated at 6% for the period 2003-2030. In 2002, the energy-economy relationship in China was reversed.

Ever since, the energy consumption has been growing more rapidly than the GDP.[1] Despite imprecise statistical data, the fast growing energy demand in China causes concerns at both national and international levels. The security of energy supply to China needs to be achieved without destabilising world energy markets.

Coal represents 69% of China's primary energy consumption, and China is the world's largest producer and consumer of coal. Although coal reserves are relatively evenly distributed around the world in comparison to other fossil energy sources, 67% of the world's coal recoverable reserves are situated in 5 countries. China holds the third place behind the United States (27%) and Russia (17%) with 13% of the total, which accounts for 126.2 billions short tons of coal, followed by India (10%).

Because of the lack of significant reserves of oil and gas, coal is expected to remain the main source of energy in China. Coal use in the electricity sector is expected to increase three fold between 2003-2030 (i.e. at an average rate of 4,2% per year). [2] In addition, China's industrial sector also uses predominantly coal as energy source.

[1] IEA, Energy Outlook for China: Focus on Oil and Gas, 2005, in http://www.iea.org/textbase/speech/2005/jl_china.pdf
[2] EIA, International Energy Outlook 2006, in http://tonto.eia.doe.gov/FTPROOT/forecasting/0484(2006).pdf

Many Chinese cities are listed among the most polluted towns in the world. In the short run, the energy efficiency improvements and the increase of renewable energies' use are of the primordial importance. China has decided to reduce the part of coal used for electricity production from 74% to 63% until 2020 and to increase the share of renewable energies up to 18%.[3] However, coal will still remain an important source of energy for decades.

Firstly, the Chinese government is interested in the dissemination of clean coal technology for domestic environmental and health reasons. Secondly, this technology is becoming an important tool for China's CO2 emissions´ mitigation.

1.2. CLEAN COAL TECHNOLOGIES AND THEIR MATURITY

The term "clean coal" is used to describe a whole range of technologies that facilitate the diminution of polluting emissions during the electricity and heat production. The reduction of such emissions can be achieved by improving power plant efficiency, reducing waste, air pollution and C02 emissions. This term also denotes a range of technologies with different characteristics and maturity.

There are three different types of coal power plants to which corresponds one different combustion technology each: the Pressurised Pulverised Coal Combustion (PPCC), the Pressurised Fluidised Bed Combustion (PFBC) and the Integrated Gasification Combined Cycle Generation (IGCC). While the supercritical cycle[4] can be integrated into existing coal power plants by adding better performing technology and new materials, the IGCC is a new power plant concept that cannot be integrated into previously established plants. Therefore, it is also more expensive to invest in this technology.

[3] China Energy Research Society, Energy Policy Research, 2003
[4] Combustion technology associated with the first two types of coal power plants: the Pressurised Pulverised Coal Combustion Plants, the Pressurised Fluidised Bed Combustion Plants.

Coal consumption causes considerable pollution and contributes to the greenhouse effect, which is on rise. Capture and storage of CO2 emitted by coal power plants seems to be a possible solution to this problem. In this context, we could envisage using zero emissions power plants that are able to collect the CO2. The capture by post-combustion is the most mature and has been tested in the European project CASTOR. The transportation of CO2 and storage in the emptied petroleum and gas reserves, or salt aquifers are all viable. High costs at the industrial level are the principal obstacle that has prevented the rapid development of a capture-transport-storage chain.

According to Gaz de France, supercritical pulverised coal power plants are more dependable and mature in the short and middle term. The IGCC process should be used for the poly-generation[5] (electric/hydrogen) and the capture of CO2. In the long term, the IGCC will compete with the supercritical pulverised cycle.[6] This analysis correlates with EDF's strategy that has tested all of the previous technologies and played an active role in the development of the ultra-supercritical cycle and the fluidised bed cycle.

[5] Poly-generation is an energy supply system delivering more than one form of energy to the market, e.g. electricity and hydrogen.
[6] Ibid

2. FRAMEWORKS FOR GREENHOUSE GAS EMISSIONS MITIGATION FACILIATING THE INTRODUCTION OF CLEAN COAL TECHNOLOGY

2.1. THE ADVANTAGES OF THE CLEAN DEVELOPMENT MECHANISM

Today there exists a potentially advantageous system for foreign firms to invest in the developing countries in projects reducing greenhouse gas (GHG) emissions: The Clean Development Mechanism (CDM). In 1997, many industrialized countries ratified the Kyoto Protocol and agreed to restrict their greenhouse-gas emissions (Annex 1 Parties). The member countries of the Organisation for Economic Co-operation and Development (OECD) and the countries of Eastern Europe have committed to globally reduce their carbon dioxide emissions by 5.2% between 2008 and 2012. These industrialized nations selected 1990 as a year of reference to establish an annual emissions quota that cannot be surpassed.

Besides emissions trading, The Kyoto Protocol also authorises two other mechanisms that allow member countries to attain their objectives for the 2008-2012 period: the Joint Implementation (JI) and the Clean Development Mechanism (CDM). Through the application of the CDM, industrialized countries finance projects that reduce or prevent the production of greenhouse gases in developing countries. These countries are subsequently awarded emissions credits that can be used to obtain their emissions quota. The CDM fixes/sets the same price for emissions in developing countries and industrialized countries. Developed countries consequently benefit from relatively lower costs and a favourable profitability to manage the equivalent quantity of greenhouse gas. Emerging countries benefit from investment in new technology.

However, investment in JI and CDM projects is conditioned by their additional nature with regard to the domestic action. Parties must demonstrate the relative contributions of the mechanisms respect the so-called “supplementary principle”.

The CDM is the only mechanism from the Kyoto Protocol that indirectly incites developing countries to approve projects that are designed to reduce greenhouse gas emissions. China has become the top country to host CDM projects and counts approximately 40% of the world's projects. India and Brazil are ranked second and third respectively.

As an active member of the UNFCCC[7], China ratified the Kyoto Protocol in August 2002. The central government later designated the National Development and Reform Commission as a national authority for the CDM. In June 2004, China instated temporary measures to follow CDM projects. These measures also establish the conditions and the criteria concerning the acquisition and the implementation of each project. In addition, all of the CDM projects must be validated by the National CDM Board, an ensemble of seven governmentally appropriated agencies. CDM projects are approved at the central government level because local authorities are not qualified to approve the projects independently. The government stipulated that the transfer of environmental technology must be assured as well as the obligation that companies realising CDM projects should be Chinese. In the case of market capitalisation, this condition is not fulfilled. Then, Chinese people must detain at least 50% of the companies' shares. [8]

The latest statistics on the number of projects are as follows: 39 projects were approved with partners in the United Kingdom (12), the Netherlands (6), followed by Sweden and Luxembourg. In addition, eight non-objection letters were granted and over one hundred projects are in preparation. The majority of these projects are to be accomplished in renewable energies. [9]

[7] In 1992, China has signed the United Nations Framework Convention on Climate Change (UNFCCC).
[8] Agence française de développement, Agence de Pékin, *"Les grandes lignes de la politique énergétique en Chine"*, Septembre 2005, in http://www.afd.fr/jahia/webdav/site/myjahiasite/users/administrateur/public/Portail%20Energie/pdf/2005%2009%20Les%20grandes%20lignes%20de%20la%20politique%20%C3%A9nerg%C3%A9tique%20en%20Chine.pdf
[9] Office of National Coordination Committee on Climate Change, Newly Approved projects by DNA of China, in http://cdm.ccchina.gov.cn/WebSite/CDM/UpFile/File1229.pdf

Nevertheless, China could potentially host more CDM projects. For the present China has not fully taken advantage of its full capacity. As long as China has no commitment to diminish its GHG emissions, the lack of incentives reduces the development of CDM projects. According to recent previsions, coal will be abundantly used in Chinese thermal and electric power plants. CDM projects that specialise in clean coal technology could represent an important part of the total CDM projects.

According to the EU, the growth and the stability of the Chinese market is intrinsically correlated to the favourable European economic performance. Growth of the Chinese economy should be "sustainable" taking into account negative impacts on health and environment. In this light, the EU is detaining technologies that China is willing to acquire enabling the reduction of GHG emissions, including the promising Clean Coal Technology.

Furthermore, the CDM can increase the availability of private investment for Clean Coal Technology dissemination in the developing countries. Thus, this project-based mechanism is complementary to existing or future bilateral agreements having for objective the technology transfer to developing countries for climate change mitigation.

2. 2. THE PARTNERSHIP BETWEEN THE EU AND CHINA AND ITS IMPLICATIONS

The EU and China have signed a Partnership on Climate Change on the China-EU Summit in 2005 with the aim to strengthen cooperation and dialogue on climate change and energy. The Partnership has two concrete cooperation goals that should be achieved until 2020. The first is to develop clean coal technology and realise demonstration of advanced "zero emissions" coal technology based on carbon dioxide capture and storage, thus avoiding CO2 emissions in the atmosphere. The UK has decided to commit 6 million Euro for the first phase targeting the construction of a demonstration power plant in

China having capture and storage technology.[10] The second goal concerns the significant reduction of the cost of technology in the field of energy and its dissemination.

In addition, the efforts of China and the EU are directed towards energy efficiency. China have set a target to reduce energy intensity of the economy by 50% until 2020 and the EU has propose to reduce energy consumption of its economy by 20% over the same period. The Partnership covers two The China-EU Action Plans, one on clean coal and the other on energy efficiency and renewable energies.

The Joint Declaration states that the EU and China "will 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."[11]

The partnership should promote projects realised in the framework of the CDM and establish a platform for a dialogue on its development and modifications for the "post-Kyoto" period. Both partners have been discussing the establishment of a global carbon market enabling cost-efficient reduction of GHG emissions and the functioning of the CDM in the light of Nairobi and Bangkok Conferences.[12]

The Memorandum of Understanding signed by Energy Commissioner Andris Piebalgs and Chinese government in Shanghai[13] can be seen as prove of Parties' commitments to promote the CO2 mitigating technologies. It encourages the development of capture and storage of CO2 emitted from coal-fired power plants. According to A. Piebalgs, the cooperation between the EU and China in the

[10] CE, Climate Change: EU-India and EU-China workshops demonstrate commitment to concrete cooperation, 2005, in http://ec.europa.eu/environment/climat/pdf/infonote_china_india.pdf
[11] Joint Declaration on Climate Change between China and the European Union, 5 September 2005, in http://ec.europa.eu/external_relations/china/summit_0905/index.htm
[12] 12th Conference of Parties to the UNFCCC and the parallel 2nd meeting of Parties to the Kyoto Protocol were held in Nairobi in December 2006 and they resulted in a number of new initiatives to support developing countries which are vulnerable to climate change. The next event should take place in Bangkok from 3-14 December 2007.
[13] Signed in February 2006 at the EU-China Summit

field of clean coal technology using capture and storage "is a key element in enhancing [EU´s] energy security, promoting new technologies and address the challenge of climate change."[14]

3. DEVELOPMENT OF PROJECTS USING CLEAN COAL TECHNOLOGY

3. 1. PROJECTS IN THE EU

Directed by the EU, CASTOR is the largest existing project, enabling the capture and storage of 10% of the C02 emissions in Europe, which corresponds to approximately 30% of CO2 emitted by European power and industrial plants. Except improving existing technologies, its target is to finance the research and development of new technologies for the capture of CO2 and its geological storage.

Main objectives are to reduce the post-combustion capture costs, enhance storage security and environmental acceptability, and search for possible capture, transport and storage locations in Europe. Funded by the EU, Castor is planned for the years 2004-2008. More than 30 European companies have created the project consortium. Elsam in Denmark built the greatest pilot plan for post-combustion capture on coal. Four storage performance and risk assessment studies are organised: The Casablanca off-shore field situated near Tarragora (Spain), Atzbach-Schwanenstadt gas field (Austria), Snohvit aquifer (Norway), K12B gas field (The Netherlands).

Recently, the Czech Republic has showed its interest for hosting another CO2 storage feasibility project. Coal provides around half of its primary energy and is used to produce around two third of the country's electricity. "The European Union should understand that the Czech Republic is dependent on coal power plants. (…) It would be logical to place a pilot project in the Czech Republic" said the

[14] EC, Speech, Andris Piebalgs, "*Towards closer EU-China cooperation in the field of energy*", 20 February 2006, in http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/06/105&format=PDF&aged=1&language=EN&guiLanguage=en

Minister of industry and commerce Martin Říman.[15] The Ministry and the Czech power producer ČEZ have already chosen the power plant in Hodonín and the storage in the nearby oil reserve in South Moravia.

The investments in research and development targeting the low cost of CO2 capture and storage are essential for making the "true" clean coal technology viable. Capture of 1 tonne of CO2 costs at least twice as much as the CO2 allowance in the EU Emission Trading Scheme.[16]

The International Energy Agency (IEA) considers the prospect for the development of CCTs in the Czech Republic to be good in the long term, when the old coal plants will be retired. In the short and middle term, the introduction of new clean coal plants is dependent on the outcomes of the first pilot project. Apart from the capture and storage projects, the first coal-fuelled IGCC plant is situated in Vřesová.

3.2. INTRODUCTION OF THESE DIFFERENT TECHNOLOGIES IN CHINA: ADVANTAGES AND DISADVANTAGES

In China, the dominant technology used for electricity generation is pulverised coal combustion with a subcritical vapour cycle. Still in construction, these plants have very low efficiency and cause high pollution.

In cooperation with EDF, China has invested in the supercritical process that has provided an increased efficiency from 37% to 45%-46%. Four 1000MW power plants have been constructed in Shanghai and others have been built in Tianjin. Within the framework of a program that includes the construction of

[15] R. Brestan, *"Cesko chce ukladat emise pod zem"*, Hospodářské noviny, in http://ihned.cz//c6-10001595-21416810-000000_d-cesko-chce-ukladat-emise-pod-zem

[16] The EU ETS allowance for 1 tonne of CO2 costs approximately 24 Euro.

300MW PFBC power plants, consultations or communal pilot projects have been created (PFBC pilot project 2x300 MW of Baima in Guizhou is a good example). [17]

European companies have hesitated to participate in projects that attempt to increase the productivity of the low-capacity power plants because of relatively high investment cost, even if these plants are the most polluting ones. For instance, Alstom Energie realises retrofitted coal plant projects for more than 200 MW. [18] EDF has worked on increasing of old coal power plants in the province Shandong (3000 MW) or Guangxi (720 MW). Nevertheless, the application of the most efficient clean coal technologies at existing plants (such as IGCC) is not possible.

Using the coal gasification process, electricity can be generated by IGCC or poly-generation power plant. The latter seems to be economically more attractive for China, especially in the long term. The advantages of IGCC plants are gasification, production of hydrogen and combined cycle. Taking into account Chinese interest in developing capacities for combined electricity/hydrogen production, and CO2 capture and storage, China may privilege IGCC technology. However, IGCC technology is not yet completely mature even in developed countries and it still engender additional costs and risks.

According to the IEA, the production cost of electricity generated by the IGCC plant is 20% higher compared to traditional plants. In China, costs and risks would be amplified due to the construction delays and production shortfalls would be amplified. The risk factor would increase by nearly 25%. These concerns explain partially why there is only one demonstration IGCC power plant in China situated in Yantai.[19]

[17] Agence française de développement, Agence de Pékin, *"Les grandes lignes de la politique énergétique en Chine"*, 2005.
[18] Ministère des Affaires étrangères, Mission coopération décentralisée et développement durable en Chine, 2006, in http://www.diplomatie.gouv.fr/fr/IMG/pdf/chine_rapport_mission_gerbert_gaillard.pdf
[19] International Energy Agency, *"International Energy Technology Collaboration and Climate Change Mitigation. Case Study 4: Clean Coal Technologies"*, 2005, in http://www.oecd.org/dataoecd/22/38/34878689.pdf

Unlike IGCC, the poly-generation allows the production of synthetic fuels from coal and significant reduction in investment costs. Thus this technology seems to be attractive for China in the longer run, especially from economic perspective. In fact, poly-generation plants produce simultaneously electricity and synthetic fuels, which results in the reduction in the fuels' production costs and CO2 emissions. [20] Chinese companies are participating in the Future Gen initiative lead by the US, having as an objective the construction of "zero-emissions" poly-generation coal power plant.

Supercritical power plants should be used for electricity production, due to high efficiency. Nevertheless, given high research and development expenses, the Chinese government should actively participate in Clean Coal technology projects.

[20] Task Force on Energy Strategies and Technologies to the China Council, *"Transforming Coal for Sustainability"*, 2003, in www.emrg.sfu.ca/EMRGweb/pubarticles/2003/CoalChina.pdf

CONCLUSION

In the light of fast GDP growth and thus rapidly increasing energy consumption of major developing countries, the North-South energy cooperation has been increasingly important. Recently, besides concerns of energy security, the dimension of climate change mitigation has been added. Despite high pollution it causes, coal is expected to remain dominant in China's energy mix in the future. The EU detains technologies, that China is willing to acquire, enabling better efficiency and GHG emissions reduction.

The CDM is potentially advantageous for China and the EU's companies. It facilitates technology transfer to China and investment in new projects helping to tackle climate change. Through this project-based mechanism, European companies can receive tradable emission allowances at lower cost. Capture and storage of CO2 emissions still represents excessively high additional costs, but is seems to be very promising technology in the longer run both in the EU and China. IGCC correspond better to EU's needs, China could prefer poly-generation plants.

BIBLIOGRAPHY

[1] Agence française de développement, Agence de Pékin, *"Les grandes lignes de la politique énergétique en Chine"*, September 2005, Available [online]: 23.02.2007 on: http://www.afd.fr/jahia/webdav/site/myjahiasite/users/administrateur/public/Portail%20Energie/pdf/2005%2009%20Les%20grandes%20lignes%20de%20la%20politique%20%C3%A9nerg%C3%A9tique%20en%20Chine.pdf

[2] BP Statistical Review of World Energy, 2006, Available [online]: 20.06.2007 on: http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/publications/energy_reviews_2006/STAGING/local_assets/downloads/spreadsheets/statistical_review_full_report_workbook_2007.xls

[3] Brestan R., *"Česko chce ukládat emise pod zem"*, Hospodářské noviny, Available [online]: 18.06.2007 on: http://ihned.cz//c6-10001595-21416810-000000_d-cesko-chce-ukladat-emise-pod-zem

[4] European Commission, Speech, Andris Piebalgs, "*Towards closer EU-China cooperation in the field of energy"*, 20 February 2006, Available [online]: 27.05.2007 on: http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/06/105&format=PDF&aged=1&language=EN&guiLanguage=en

[5] European Commission, *"Climate Change: EU-India and EU-China workshops demonstrate commitment to concrete cooperation",* 2005, Available [online]: 14.05.2007 on: http://ec.europa.eu/environment/climat/pdf/infonote_china_india.pdf

[6] European Commission, COM(2006) 843 final, *"Sustainable power generation from fossil fuels: aiming for near zero emissions from coal after 2020"*, 10 January 2007, Available [online]: 12.03.2007 on: http://ec.europa.eu/energy/energy_policy/doc/16_communication_fossil_fuels_en.pdf

[7] Gaz de France, La filière charbon propre pour la production d'électricité. M.DU.COGV.2006-238, 2006

[8] International Energy Agency, *"Act locally, Trade globally",* 2005, Available [online]: 03.06.2007 on: http://www.iea.org/textbase/nppdf/free/2005/act_locally.pdf

[9] International Energy Agency, Energy Outlook for China: Focus on Oil and Gas 2005, Available [online]: 15.04.2007 on: http://www.iea.org/textbase/speech/2005/jl_china.pdf

[10] International Energy Agency, International Energy Outlook 2006, Available [online]: 13.05.2007 on: http://tonto.eia.doe.gov/FTPROOT/forecasting/0484(2006).pdf

[11] International Energy Agency, *"International Energy Technology Collaboration and Climate Change Mitigation. Case Study 4: Clean Coal Technologies"*, 2005, Available [online]: 05.06.2007 on: http://www.oecd.org/dataoecd/22/38/34878689.pdf

[12] Joint Declaration on Climate Change between China and the European Union, on 5 September 2005, Available [online]: 16.05.2007 on: http://ec.europa.eu/external_relations/china/summit_0905/index.htm

[13] Maosheng D., Haites E., *"Implementing the Clean Development Mechanism in China"*, in: International Review for Environmental Strategies, Vol.6, No.1, 2006

[14] Ministère des Affaires étrangères, Mission coopération décentralisée et développement durable en Chine, 2006, Available [online]: 07.04.2007 on: http://www.diplomatie.gouv.fr/fr/IMG/pdf/chine_rapport_mission_gerbert_gaillard.pdf

[15] Office of National Coordination Committee on Climate Change, Newly Approved projects by DNA of China, Available [online]: 08.06.2007 on: http://cdm.ccchina.gov.cn/WebSite/CDM/UpFile/File1229.pdf

[16] Task Force on Energy Strategies and Technologies to the China Council, *"Transforming Coal for Sustainability"*, 2003, Available [online]: 02.05.2007 on: http://www.emrg.sfu.ca/EMRGweb/pubarticles/2003/CoalChina.pdf

[17] World Bank, Clean Development Mechanism in China: taking a proactive and sustainable approach, 2004, Available [online]: 01.04.2007 on: http://siteresources.worldbank.org/INTCC/817372-1110879250911/20557087/cdm-china.pdf

Pavel Zástěra

Pavel did his undergraduate Area Studies at Charles University in Prague. In 2006, he integrated the Master of International Relations, specialisation International Economic Policy at Sciences-Po Paris, from which he is expected to graduate in 2008. He has been a member of the East European Programme of the Research Centre of the Association of International Affaires (AMO) in Prague since 2006, specialising on energy and commerce.

■ ■ ■