CCS ROUND TABLE in Russia

Cooperation in carbon capture and storage (CCS):
Demonstration and commercialization of technologies
Moscow, 29 March 2011

Meeting Summary

On March 29 2011, the IEA jointly with the Russian Skochinsky Institute organized a Roundtable on CCS technologies in Moscow, Russia. The roundtable was supported by the Russian Ministry of Energy, The Russian Academy of Geology, and the Siberian Coal Energy Company (OAO SUEK).

The meeting brought together around forty Russian participants representing government, academia, research institutes, private sector oil, gas, coal, energy companies. Several international stakeholders, including representatives from the EC, UK government and Global CCS Institute also participated in the meeting.

The meeting was moderated by **Juho Lipponen, the head of the CCS unit at the International Energy Agency** and **Igor Levankovsky, Director General of the Skochinsky Institute**. The meeting was organized around 5 key themes: (1) Role of CCS in the energy sector development – setting the stage; (2) Technical issues of carbon capture, transportation and storage; (3) Policy, regulation and incentives to make CCS work; (4) Early opportunities for CCS in Russia; and (5) The role of international cooperation in facilitating CCS development and deployment. Each session (organized around each theme) included presentations by Russian and foreign experts and a discussion with the roundtable participants.

Mr. Alekseev from the Ministry of Energy opened the meeting by outlining the important role of Russia in global GHG mitigation and the need for clean technologies to allow Russia fulfil this role and develop its energy sector with a growing share of coal in domestic energy mix (currently 27%). Russian coal production (2008): 247 Mt hard + 76 Mt brown (respectively 4% and 8% of global totals). Currently the key priorities for the Russian energy sector are energy efficiency improvements of power plants, strategy development for the coal sector, and provision of incentives to Russian companies.

The opening session also included presentations by Mr. Plakitkin, deputy director of the Institute of Energy Technologies and Juho Lipponen, head of CCS unit at the IEA. **Mr. Plakitkin, deputy director of the Institute of Energy Technologies** made a presentation on a long-term development of the global energy sector and the role of innovative technologies in this development. Then **Juho Lipponen** presented the IEA analysis that demonstrates that CCS is an important part of the clean technologies portfolio globally and will have to bring around 19% of all GHG emission reductions in the energy sector by 2050 to achieve a 50% reduction in emissions from 2005 levels. He also outlined key challenges that currently cause a very slow development of the technology. These challenges include setting strategic policy drivers and directions that would include CCS, creating incentives for CCS, development of relevant laws and regulations, improving understanding of CO2 storage, addressing technical issues.

CCS Technology Road map could be found at the IEA website:
http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2145

During session 2 presentations and discussions focused on the latest technological developments in the field of CCS. **Mr. Puchkov from the Ministry of Education and Science** presented on the analytical and research work that has been going on in Russia on CCS. One of the programs mentioned by Mr. Puchkov was the assessment of geological capacity for CO2 storage, and another – research into capture technologies. The goals that the Ministry has set for CCS were: assessment of CCS potential for Russia, scientific justification, geological and economic assessment of storage capacity; development of geological models and atlases. Several issues that have already been looked at are: identification of large point pollution sources and links to potential storage sites, risk assessment of geological storage, monitoring of storage sites, and opportunities for the development of a pilot project. In addition, the Russian State University of Oil and Gas is looking into EOR and ECBM opportunities. The Ministry of Education and Science is cooperating with CSLF and GCCSI. However, it is interested in enhancing its international cooperation on CCS. `

Juho Lipponen and Tsukasa Yoshimura of IEA presented an overview of CCS technologies from capture to transport and storage. Carbon Capture and Storage is a chain/group of technologies and applications that enable: capture of CO_2 from large point sources (power plants, steel, cement, refineries, gas processing etc.), its transport (trucks, ships, pipelines) and storage of CO2 in geological formations (e.g., depleted oil and gas fields, saline aquifers, unminable coal seams, etc). A variety of capture routes is under development: Post-combustion; Pre-combustion; Oxy-combustion. For coal-fired power generation, no capture route outperforms alternative routes. An increase in capital costs of about 70-80% on top of the costs of the baseline (super critical coal) power plant without CCS is estimated (this reflects the size of additional equipment required). Substantial variation exists in costs across regions and depending on fuel and power plant types. The IEA's latest publications on the cost of CCS capture technologies, indicating that the cost of electricity production by a plant equipped with CCS could be around 100$ per MW/h.

As for the transportation of the captured CO2, it can be transported by pipeline, trucks and ships. CO_2 can be transported by pipelines in liquid or gaseous form, but the main option is compressed gas at 10-80 Mpa pressures. Approximately 5600km of CO_2 pipelines exist (mostly in the US) and they are currently handling some 50Mt of CO_2 per year. The following issues exist in relation to CO2 transport: pipeline economics, permitting, planning, risks associated with potential high concentrations of CO2 in low-lying areas in case of rupture (however excellent safety record to date).

Storage solutions include deep saline formations, oil/gas fields, CCS with enhanced oil recovery (EOR). While a massive storage capacity is identified at a general global level, there is a significant uncertainty at national and local levels, and lack of harmonized estimation methods. Standardization for CO2 storage capacity estimation is a key task for the near future. Other challenges include analysis of potential leakage mechanisms and development of safety regulations and criteria. Five large-scale projects are currently storing >5Mt CO_2 per year: Sleipner-1Mt, Snohvit-0,7Mt; Weyburn - >2,3Mt; Rangely-1Mt; In Salah-1,2Mt. There are 72 other integrated large-scale projects around the world in various stages of development. More information on storage could be found on the following websites: http://www.co2crc.com.au/dls/pubs/08-1001_final.pdf
http://www.netl.doe.gov/technologies/carbon seq/refshelf/BPM-SiteScreening.pdf
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0114:0135:EN:PDF

Session 3 focused on policy incentives, finance mechanisms and regulatory frameworks that support CCS. **Ellina Levina, Energy Analyst at the IEA** highlighted a critical role that policy and regulations play in facilitating development and deployment of CCS. She outlined four levels of policy intervention: (1) Strategic vision and defining the role of CCS that would enable CCS as part of energy portfolio; (2) Development of a legal framework that would make CCS a legal activity and clarify responsibilities, and ensure safety and environmental viability of operations; (3) Provision of incentives for demonstration and deployment through policy instruments, development of business models & financing of projects; and (4) Provision of information, education, and stakeholder consultations to contribute to public acceptance.

For further information on current CCS regulatory practice please see the 2010 *IEA CCS Model Regulatory Framework* - *www.iea.org/ccs/legal/modelframework.asp*. For further information on current national or regional CCS regulatory development please see the *IEA CCS Legal and Regulatory Review* - *www.iea.org/ccs/legal/review.asp*.

Olli Pirkanniemi from the EU Delegation to Russia presented on the regulatory developments and financial allocations in the EU in support of CCS. He talked about the EC Storage Directive (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0114:0135:EN:PDF) and financial commitments of 26% of the Eeuropean Energy Programme for Recovery and about setting aside 300 million allowances in the New Entrants' Reserve of the European Emissions Trading Scheme for subsidising installations of innovative renewable energy technology and carbon capture and storage (CCS). The allowances will be sold on the carbon market and the money raised - which could be as much as 4.5 bn EUR if each allowance is sold for 15 EUR - will be made available to projects as they operate. He highlighted the goals of the European industrial initiative to have large demos, engage public and private funds, and invest in R&D. The highest possible quality of demo projects and geographical balance are the key criteria.

James Godber, from the UK government provided an overview of the UK government's rational and support for CCS. He highlighted that the UK government is keen on seriously addressing the problem of climate change and it understands that all opportunities should be employed. However, the UK contributes only 2% of global GHG emissions, so global effort is important. Even though CCS is expensive it is still part of the low cost mitigation strategy. According to the Stern review, climate change mitigation would cost around 2% of global GDP, however, if we do not act, adaptation to the consequences of climate change will cost significantly more. First CCS demo in the UK was launched in 2007. Recently there was a competition for the governmental support of 1 bln pounds for another CCS demo. The government has also set up a national roadmap for CCS to 2050.

Igor Kozhukovsky, Director General, Russian Energy Forecasting Agency focused on national priorities for reducing GHG emissions in Russia. He mentioned that 45% of GHG emission reductions in Russia could be realised through energy efficiency and another 10% by employing renewable energy. He also highlighted that the Russian energy strategy focuses on nuclear, hydro, renewables, and coal: supercritical and IGCC plants. CCS plays only a marginal role in this strategic thinking. However, there are opportunities for CCS in Russia and they could be realized in the timeframe to 2020 under the conditions of international cooperation, availability of financial resources and state policy support. Right now the priorities should be in increasing technical competence, identifying and hosting pilot CCS projects, improving quality of coal fuel.

Mr. Yuvonin, Federation Council, highlighted the role of the UNFCCC flexible mechanisms and in particular Joint Implementation under the Kyoto Protocol in stimulating investments in CCS. He emphasised that Russia has finally made all national level arrangements so that JI projects could be implemented. He stressed that current priorities are energy efficiency, renewables and coal mine methane. However, it is not that difficult to imagine that CO2 prices could go up to $100 per ton by 2050 and CCS could become a viable option then.

The goal of session 4 was to discuss early opportunities for CCS in the Russian coal sector. **Mr. Linev** from the **Institute for the Enrichment of Solid Fuel** talked about the Clean Coal Energy Programme and the role of standardized coal fuel in its realization. He emphasized the role of coal in Russian TPES coal's share is 22.1% and there are plans to increase this share further by 2030. Siberian coal basin is the largest supplier of coal in Russia. Implementation of CCS on coal-fired power plants would allow to reduce GHG emissions which otherwise will continue to grow with increased coal consumption. However, the focus areas in the coal sector now are improvement of the quality of coal and addressing the issue of large quantities of ash sludge.

Mr.Ryabov, All Russia Heat Technical Institute (VTI) provided his perspectives on opportunities and conditions for CCS in Russia. He noted that CCS is a rather long term opportunity. The priority today is energy efficiency. The next issues that needs to be addressed in the coal sector is coal quality and reduced costs for transport. However, it is important to engage in research work on CCS, and FASI is already financing some research projects, including capture of CO2 with chemical cycles, and storage of CO2. According to some preliminary estimates, CO2 reductions from CCS could cost around 20-30 Euros per ton of CO2 in Russia: capture cost of a pilot project would be around 20 Euros /ton CO2, while for an industrial scale project – 12-15 Euros/ton of CO2; transport cost for a pilot project could be in the scale of 5-7 Euros/ton of CO2, while for a large commercial scale project – 3-5 Euros/ton of CO2, and estimated storage cost would be between 3-5 Euros/ton of CO2 for a pilot project and 0.7-3 Euros/ton of CO2 for a industrial scale project. He mentioned that one of the most cost-effective options for CCS could be in enhanced oil recovery. Mr.Ryabon also reported that some work of storage mapping has been done on the territory of Russia, and analytical work done on methodologies for monitoring CO2 under the ground. He emphasised that priorities for the near future should be on: development of capture technologies, launching demonstration projects, distributing information about technologies, establishing technology networks, developing research on reducing cost of CCS technologies, building government-industry-private sector partnerships, establishing international cooperation.

Mr. Gitarsky, Institute of Climate stressed that exchanges like this workshop are very useful in addressing key issues of technology understanding, cost estimates and defining priority areas. Russia is actively looking for opportunities to reduce GHG emissions and it is important to discuss CCS in this context. It is also important to analyse further environmental safety of this technology, its cost-effectiveness, and transport issues.

Mr. Butenko, SUEK, provided private sector perspectives. SUEK is Russia's largest coal producer and the world's 7th largest (after Peabody, Shenhua, Rio Tinto, Arch, BHP Billiton and Anglo American). It is the 5th largest coal exporter (22% of EU coal imports came from Russia in 2008, compared with

just 6% in 2000). SUEK is particularly strong in domestic steam coal supply for power generation, taking 43% of the market. He emphasised the need for economic incentives in order to develop and deploy new technologies such as CCS. Mr. Butenko also talked about international climate negotiations and how a future post 2012 climate regime should be designed to include incentive mechanisms for development and deployment of CCS and new bio fuels, including algae. He noted that both coal users and coal producers will have to work together to address environmental concerns of coal use.

Prof Harchenko, Moscow State University noted that traditionally the Russian government addressed important problems through creation of a specific targeted program tasked to address the issue. He suggested that a CCS targeted program could be created and led by Skochinsky Institute.

Session V focused on the importance of international cooperation on CCS. **Derek Taylor** from the **Global CCS Institute** presented on the role of GCCSI in fostering international cooperation and learning sharing on CCS projects. The GCCSI membership now includes 277 members from industry, governments, NGOs, research and finance institutions. The Institute currently provides support to several CCS demonstration projects: 3 in North America, 2 in Europe, 2 in Australia. The observations from the European scene are that there is a robust number of projects, UK and Netherlands are the most active, onshore storage faces significant public acceptance issues, political support for CCS is limited to a small number of countries partly also due to the renewed interest in using gas for electricity generation, there is also too little effort on industrial plant CCS. There is significant under-representation of projects in developing countries. Key challenges remain –financing, policy uncertainty, public acceptance. Knowledge sharing allows collecting and analyzing information across projects, providing status update on project development, delivering knowledge sharing reports, collecting and sharing data.

James Godber from the UK outlined the UK government's approach that aims at providing strategic direction to the UK government, aligning actions in the UK, EC and world, identifying what industry and government should be doing, measuring progress, making government publically accountable, adjusting tracks if needed, assuring alignment with the UK energy policy, but not prescribing technology. He also emphasised international cooperation of the UK government at bilateral (in particularly with China) and multilateral (Clean Energy Ministerial, CSLF) levels. He noted that several areas require priority work to facilitate CCS development: closing financial gap, providing support to developing countries, developing legal frameworks, addressing marine treaty, engaging in knowledge sharing, enhancing understanding of storage, facilitating CCS in industry. Regarding the work with China, Mr. Godber underscored the work on research, biomass and CCS, and CCS readiness. He noted that China is moving quickly on initial CCS-related research. The focus is on improving energy efficiency, and in this context there is some scepticism to CCS which brings efficiency penalty. Right now the Chinese Ministry of Science and Technology (MOST) is working on CCS, however, there is a lack of internal governmental dialogue and coordination to address CCS challenges. Currently there are two demonstration CCS projects in China. One project captures 3000 ton of CO2 per year and sells it to a coca cola company. The second project involves capturing 100000 ton of CO2 with the price of 30$ per ton of captured CO2. China is keen on developing IGCC

technology. So, in the CCS technology family the focus is on developing capture technologies (IGCC, coal to liquid), and there is much less investment in storage.

Mr. Solovies, GE commented from the technology producer point of view and stressed that CCS could be looked at as part of a big investment project. Big companies like GE could assist Russia in structuring such big projects and bring experience of working with banks, investors, state agencies. Assistance is also needed on technical operating of the project to facilitate return on investment. He noted that post combustion and oxyfuels technologies are still pilot projects while IGCC has been a complete integrated CCS experience. Separating CO2 could be useful for making hydrogen. There are already enterprises producing hydrogen with the help of CO2. Mr. Soloviev also highlighted the important role of government in providing support at this early stage of CS technology development to facilitate the take off of the technology.

Conclusions from the workshop:

- The workshop provided an opportunity for initial exchange of information and views and should be viewed as the beginning of the dialogue;
- International cooperation is an important prerequisite for enhanced CCS actions in Russia;
- The meeting covered a lot of ground from technical issues to policy and financial incentives;
- The meeting noted that CCS technology is there but it is too costly to be widely deployed;
- In addition to cost there are other regulatory, policy, geological challenges, but they are similar across countries - another reason for working together;
- While CCS is not a priority in Russia, it is being discussed and analysed to some extent. The IEA is happy to assist Russian with the analysis; National technical expertise and learning are very important. Technology development is also important as Russia may be interested in exporting the technology in the future;
- More opportunities for further discussions and analysis should be explored, focusing on cost, policy, storage estimates, involvement of companies. Possible joint IEA-Russia research projects could include:
    - Storage capacity assessment and development of regional and national atlas;
    - Capture technologies (additional data, e.g., costs);
    - Exploring opportunities for underground coal gasification with CCS;
    - Exploring opportunities for enhanced coal bed methane recovery with CCS;
    - Policy and financial incentives.

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