CCS ROUND TABLE in Ukraine

Carbon Capture and Storage Perspectives in Ukraine

Donetsk, 18 May 2011

Meeting Summary

On May 18 2011, the IEA jointly with DTEK, a private Ukrainian vertically integrated energy company, and regional and city administrations of Donetsk organized a Roundtable on CCS in Donetsk, Ukraine. The roundtable was supported by the Ukrainian Ministry of Energy and Coal Industry.

The meeting brought together around sixty Ukrainian participants representing national, regional and local governments, academia, research institutes, private sector and national coal, energy, metallurgical, cement companies. Several international stakeholders, including representatives from the EC, EBRD, IEAGHG, TNO 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 **Iryna Verbitska,** ***the head of the Environmental Safety Department of DTEK***. The meeting was organized around 5 key themes: Role of CCS in the energy sector development – setting the stage; Technical issues of carbon capture, transportation and storage; Policy, regulation and incentives to make CCS work; Opportunities for CCS in Ukraine; and The role of international cooperation in facilitating CCS development and deployment. Each session (organized around each theme) included presentations by Ukrainian and foreign experts and a discussion with the roundtable participants.

Vladimir N. Ishkov, ***Head of Department of Industry and Infrastructure, Donetsk Regional Administration*** opened the meeting. He said that coal would continue to play a key role in the world and Ukraine. However, the issue of addressing environmental consequences of the use of coal is becoming urgent. Donbass region that is the main producer and consumer of coal in Ukraine is the 27th in environmental hierarchy among 27 Ukrainian regions. The reality today is coal and fossil fuel fired power plants. The dialogue started by this meeting is very important and will contribute to addressing environmental challenges associated with the use of coal. Donetsk region is open for further cooperation. One step in this direction is the 4th international summit that will be held in October and focus on innovation and environment.

Yuriy Ryzhenkov*, Chief Operating* ***Officer, DTEK*** expressed his gratitude for the cooperation with the IEA in organizing this workshop. Clean coal technologies is one of the key areas of interest and future development. However, the priority now is to address local pollutants such as SO2, NOx, particulates. GHG is not currently a high priority, but Ukraine is following the developments in this regard in the EU and will follow in due course. CCS is one of the technologies that will assist in addressing GHG emissions. DTEK is following the progress that is being made on demonstrating and further developing the CCS technologies in the EU and around the world.

Juho Lipponen welcomed the participants on behalf of the IEA. He noted that the goal of the workshop is to learn from each other, identify opportunities and challenges for CCS development in Ukraine, start our partnership in this area and possibly identify areas for future joint analysis.

Keith Burnard, *Senior Energy Analyst at the IEA*, provided an overview of the IEA's World Energy Outlook and the role of clean coal technologies. He framed the CCS issue within a broader context of coal sector development and the global energy outlook. He noted a substantial role of coal in the world's energy consumption. In the last decade coal has been way ahead of other fossil fuels in meeting the growing demand for energy. Half of the growth in the world's electricity generation comes from coal. According to the BAU scenario for the global energy sector, coal consumption and GHG emissions will continue to grow while the goal is to reduce GHG emissions by 50% by 2050. The IEA's Energy Technology Perspectives outline technological portfolio to achieve global GHG emission reductions. CCS is a part of it along with energy efficiency and other measures.

Then **Juho Lipponen** presented the IEA's 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, developing relevant laws and regulations, improving understanding of CO2 storage, addressing technical issues.

Natalia Kushko, *National Agency for Ecological Investment* spoke about CCS in the context of the Kyoto Protocol and outlined perspectives in Ukraine. She highlighted that potentially CCS could be implemented as a JI project. However, the lack of experience, clarity on the future of the Kyoto Protocol and national level legislation regarding CCS activities would constitute the major obstacles. She also stressed that currently Ukraine is considering a draft law on national CO2 trading. While it is still not a near term plan, it could provide impetus to innovation and technology development in GHG mitigation.

During session 2 presentations and discussions focused on the latest technological developments in the field of CCS. **Juho Lipponen, *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 indicate 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).

Neil Wildgust, *IEAGHG* provided an overview of the CO_2 storage: estimates, challenges, needs. 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 there is a 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. Four large-scale projects are currently storing >5Mt CO_2 per year: Sleipner-1Mt, Snohvit-0,7Mt; Weyburn - >2,3Mt; In Salah-1,2Mt. Global estimates suggest much larger storage potential in deep aquifers than in depleted oil and gas fields. However, the uncertainty is also larger due to lack of research on cap rocks of aquifers and the issue of pressure management. There are 4 key elements of storage sites for CO2: capacity to store (potentially large quantities); injectivity (to address economic efficiency); containment (assessment of cap rocks, role of fractures); and monitoring (to monitor storage reservoir and also leakage detection). There is a need of more large scale demonstration projects to improve knowledge and understanding.

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. She highlighted the importance of policy evolution in relation to technology developemment. At early stages of technology development, the current state of CCS, public support plays a crucial role in technology development. International cooperation that allows to share the cost of learning is also important. As technology matures, more technology-neutral tools, like for example, CO2 price, could become more appropriate.

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*.

Yuriy Trofymenko*, National Joint Stock Company "Energy Company of Ukraine" (NJSC ECU),* presented on the key environmental challenges for NJSC ECU's Thermal Power Plants. NJSC ECU was founded in 2004; it includes 11 fossil fuel power plants. Coal is the main fuel on these power stations, representing 96%. According to the Energy strategy of Ukraine up to 2030 that is being drafted now, this share will remain. The main environmental problem of these power plants is the lack of pollution control equipment for criteria pollutants SO2, NOx and PM. Emission levels are more than ten times higher than requirements in the EC Directives. Modernization of the existing stock and installation of flue gas treatment equipment are the key priorities right now. The challenge is the lack of industrial facilities capable of producing this equipment domestically. Another big problem is high ash content of local coal and as a result, large quantities of waste. Ukraine intends to follow the EU environmental requirements for power plants and participate in the integrated European Energy Systems. New sources of financing are needed to achieve this ambition. The following options should be considered by the government: change the current electricity tariff

system, improve investment climate, provide for transparency and long-term strategy of the tariff system.

Hans Rhein, ***Head of Operation Section Energy, Transport and Environment, Delegation of the European Union to Ukraine*** 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 European 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 collected - 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. He also emphasised the importance of Ukraine in the global energy and climate mitigation outlook as a large consumer of energy and producer of coal. The EC is funding two projects in Ukraine to address clean coal technologies, including CCS.

The goal of session 4 was to discuss opportunities for CCS in Ukraine. **Igor Volchin** from the ***Institute of Coal Energy Technologies*** described the situation with fossil fuel power plants in Ukraine and presented options for modernization and addressing pollution. He noted that most plants exceeded the planned life time long time ago. He also pointed out that compared to 1990 the structure of the energy balance has changed significantly yielding a much higher share of coal than before. The newest power block was launched in 1988. The actual efficiency of the majority of power plants is around 30%. That is why the first priority for Ukrainian electricity and heat sector is to improve energy efficiency. CCS is currently at the research phase.

Nikolay Shestavin from the ***Donetsk National University*** presented on the CCS research project funded by the EC and implemented jointly with the French geological survey BRGM. The project focuses on analyzing CO2 storage options in industrial areas of Ukraine and matching storage maps with maps of major sources of pollution. BRGM brings geological experience and also its experience with conducting similar assessments in France and in Europe.

Frank van Bergen, TNO Energy – National Geological Survey presented on the potential of using CO2 storage for enhanced coal bed methane recovery (ECBM). Many Ukrainian stakeholders are interested in this option given very large reserves of coal bed methane in deep coal reserves that may never become economically minable. However, Frank stressed that there were still many limitations for using this technology. The key problem is injectivity. Some countries, like Canada, US, China have positive experience testing this technology. However, Ukrainian coal seams are of a different quality. Horizontal drilling could potentially resolve the problem of injectivity but it is not yet at the stage of implementation. ECBM is still at the stage between theoretical capacity assessment and realistic capacity assessment. More research and testing are still needed.

Iryna Verbitska, *DTEK* highlighted the importance of innovation, environmental and social responsibility for DTEK. She noted that the priority today is the fulfillment of European requirements on SO2, NOX, PM. CCS is a longer-term strategy for Ukraine and its energy companies.

Session V focused on the importance of international cooperation on CCS. **Bob Pegler** 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 Institute collects information on active and planned CCS activities and accounts for 234 active and planned CCS projects in various sectors and at varied lifecycle stages, 77 projects among them are integrated large scale projects. The observations by the GCCSI 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, and 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.

Demetris Koufos*, Energy Efficiency and Climate Change, European Bank for Reconstruction & Development (EBRD)* outlined EBRD's views on CCS and its current related activities in the region. EBRD considers CCS to be a key technology for the low-carbon future. It believes that eventually carbon market could be a solution for incentivizing this technology. Right now EBRD is interested in financing CCS activities and leveraging other private investments. Current projects are of technical assistance type and involve local and national authorities; however EBRD is interested in moving into private space later. EBRD's CCS objectives are:

1. Assess the technical and economic feasibility of the transport and storage of CO2 as a solution for future development of the electricity generation sector,
2. Assist countries in formulating a sustainable position at the EU level, focused on the opportunity of CO2 transport and storage development,
3. Participate in financing certain projects with good potential to demonstrate the technological potential and economic viability based on the sound banking principles that the Bank uses in every project: *Sound Banking, Transition Impact & Additionality*.

Then Mr. Koufos presented the results of a recent case study CCS project in Bulgaria. The project identified technical options for CCS implementation in Bulgaria and how CCS could be integrated into the national energy strategy. The project also included the assessment of storage capacity and cost and investments needs. EBRD would be interested in conducting similar activities in Ukraine if there is an interest from the national and local/regional governments and the private sector.

Conclusions from the workshop:

- Coal is important and will continue to play an important role in Ukraine;
- Current priority is modernisation of the power production;

- Economic aspects are more pressing right now than CCS development;
- Ukrainian participants are aware of the CCS technologies and their challenges. Ukrainian negotiators are following the development of JI and CDM. If CCS is approved as CDM activity, it could have positive effects on proposing CCS for JI. At the national level the priority would be to develop policy and regulatory frameworks conducive to CCS development;
- Starting points for developing CCS in Ukraine would be research into storage sites, their location and proximity of large emission sources. Use of enhanced coal bed methane recovery with CCS could be an interesting area to research. However, as far as coal sector is concerned, the priority now is improvements in coal extraction technologies. Capture-ready power plants was not mentioned often at the workshop, but was brought up a couple of times. It could be interesting to do some analysis on this issue;
- International cooperation is very important. We have heard from the GCCSI on its learning sharing network and assistance with individual projects. Ukraine was invited to join as a member and benefit from information exchange and other opportunities; EBRD presented on its interesting work on CCS opportunities in Bulgaria. Ukraine could potentially benefit from a similar study and analysis;
- IEA is ready to continue dialogue with Ukraine on CCS and clean coal technologies. IEA also has a number of research/technology networks, - for example, IEAGHG, Clean Coal Center. It may be interesting for Ukraine to consider joining some of them.

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