How to effectively implement CCS in Poland?

R&D and framework for a CCS cluster.

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CCS PL

demos EUROPA
CENTRE FOR EUROPEAN STRATEGY

British Embassy Warsaw

The report has been prepared within the framework of the project "Carbon Capture and Storage as a preferred technology for mainstreaming the clean use of coal in Poland". The project has been supported by the British Foreign and Commonwealth Office Strategic Program Fund Low Carbon – High Growth, whose objective is to promote a low carbon economy, while maintaining high economic growth.

Cover design:
Michał Polkowski

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The author would like to thank Russell Baker, Cezary Filipowicz, Ewa Gąsiorowska, Dieter Helm, Marek Jarosiński, Daria Kulczycka, Jerzy Majchrzak, Stanisław Nagy, Bogusław Smólski, Eugeniusz Sutor, Zbigniew Szymczak, Paweł Świeboda, Jerzy Tokarski and Magdalena Woźniewska for their help in compiling this report and comments on the report's wording.

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List of abbreviations

AGH	University of Science and Technology
CCS	Carbon Capture and Storage
CO2	carbon dioxide
EEPR	European Energy Programme for Recovery
EU	European Union
EUR	euro
GCCSI	Global CCS Institute
GIG	Central Mining Institute
ICT	Information and Communications Technologies
IGCC	Integrated Gasification Combined Cycle
IEA	International Energy Agency
NCBiR	National Centre for Reasearch and Development
NER 300	New Entrants Reserve
NFOŚiGW	National Fund for Environmental Protection and Water Management
MW	Megawat
PIG	Polish Geological Institute
PPCTW	Polish Clean Coal Technologies Platform
R&D	Research and Development
USD	US dollar
ZEP	The European Technology Platform for Zero Emission Fossil Fuel Power Plants

Executive Summary

This report is the third in the series on "How to efficiently implement CCS in Poland?".[1] It has been prepared on the basis of interviews with representatives of R&D organisations as well as industrial and academic institutions involved in CCS implementation in Poland.[2] The aim of this report is to help with the preparation of the Polish CCS Strategy and, specifically, its R&D elements. The report addresses challenges faced by the Polish R&D in the field of CCS, which were discussed inter alia during a seminar organised by demosEUROPA – Centre for European Strategy on 29 June 2010.[3]

The report argues that if Poland is to fully realise and capitalise on its R&D potential in the field of CCS the country must overcome numerous challenges. These include establishing the legal, political and financial frameworks required for CCS[4]; dealing with technical issues relating to CO2 capture, transport and storage; gaining public acceptance for CCS; mobilising human resources and expertise; and strengthening ties between CCS stakeholders. These challenges could be tackled more comprehensively and effectively if current CCS activities were expanded and better supported - and if they were coordinated in a more strategic way.

The report also argues that the successful implementation of CCS in Poland can deliver commercial benefits not only to CCS stakeholders (government and public administration, industry, academics, R&D organizations, NGOs and others) but also to the broader Polish economy

[1] Previous reports: "How to efficiently implement CCS in Poland? Political and legal frameworks" (http://www.demoseuropa.eu/files/CCSreport_demosEUROPA_en.pdf) and "How to efficiently implement CCS in Poland? Financial framework" (http://www.demoseuropa.eu/files/demosEUROPA_Report2_CCS_en_2.pdf).
[2] See annex.
[3] See: http://www.demoseuropa.eu/index.php?option=com_content&view=article&id=481&Itemid=99 .
[4] These challenges have been deeply examined in the first two report of this series. *Op.cit.*

by increasing its innovativeness, creating new markets and stimulating intellectual capital.

The first chapter looks at the challenges for Poland in fully realising its CCS R&D potential; examines the status of current CCS activities; and presents a set of recommendations for more efficiently implementing CCS in Poland. The key recommendation is to establish a Government Plenipotentiary for Clean Coal Technologies, whose first task would be to coordinate the implementation of EU funded CCS demonstration projects.

The second chapter examines in detail the recommendation to create a Polish CCS Cluster - including proposals for its institutional and financial frameworks. The efforts of different CCS stakeholders can be more effective when properly coordinated. The Polish CCS Cluster could generate a number of benefits for the government as well as for non-government stakeholders. Further, the Polish CCS Cluster could serve as a model for realising the R&D potential of other strategic sectors in Poland.

The report is directed at politicians as well as representatives of public administration, industry and science - especially R&D organisations and NGOs - and creates the basis for further discussion on CCS implementation in Poland. Most of its recommendations can also be applied to the preparation of programmes aimed at realising the CCS R&D potential of other European Union Member States.

An introductory note

Climate change, CCS and global R&D

Dieter Helm, Professor of Energy Policy, University of Oxford

Climate change is a global phenomenon, and so far policy has made very little difference. Over the period of the Kyoto Protocol, emissions have continued to increase, pausing only as a result of the global economic crisis. Behind these increases lies the expansion of demand for fossil fuels, and in particular the burning of more and more coal. Though there is much political rhetoric about the shift to renewables, for the foreseeable future – and over the time period within which emissions have to start to come down – coal and fossil fuels will remain the dominant way of generating electricity, and electricity in turn will grow in importance.

So climate change policy needs to address an increasing coal burn. Although there are considerable efficiencies to be made in coal-fired power stations, the main policy option is Carbon Capture and Storage (CCS). The main components are already well known: how to separate out the carbon dioxide, how to transport it, and how to store it. Separation, transportation and storage of gases is very much a twentieth century technology.

The problems are therefore not at the technology frontier, but rather in the practical applications to new and existing power stations and in terms of storage and storage management. It is also about public acceptability, existing pipeline rights, clusters and costs.

Piecemeal policy so far

In Europe, policy makers have been pursuing both national and European CCS projects. The EU has pushed through a directive on the carbon storage regulatory framework, and has earmarked funds from the proposed auction of EU ETS permits. Individual countries – notably Germany, the Netherlands, the UK and Norway – have developed their own projects too, and a number of large energy companies have been trying out various technologies.

Such progress has been helpful, but it has been piecemeal and without a thought through linkage to global efforts and, in particular, the climate change challenge. The issues at stake include: the "public good" nature of the knowledge gained as part of technology transfer; the coordination of CCS systems; the relationship to emissions performance standards and international competitiveness; and the role of gas.

Public goods and R&D

The objective of CCS policy is to encourage the technology so that it can become widely available to capture emissions and hence help to mitigate climate change. The knowledge is therefore a public good, and needs to be made as widely available as possible so we can all benefit from the reduction of emissions. However public goods are notoriously problematic for private companies: investing in R&D which then becomes freely available leads to costs but not rewards. Everyone has the incentive to let others spend the money on developing the technology and then to copy the results.

The solution tends to be patents: the rewards come from the monopoly rights conferred by the superior technology. The parallel is pharmaceuticals and the development of new drugs: only if a patent is granted can the costs be recovered. In policy terms this means that subsidy is inevitable: private sector incentives will not deliver the results quickly enough. But what form should the subsidy take? One approach is to offer "prizes". The UK, for example, has embarked on a CCS Competition – a competition for a subsidy, with bidders offering the level of subsidy they need to capture a proportion of CCS for existing and new plants.

The obvious drawback is that the incentive remains one for the private gains to the company of the technological advances, and we are back to the patenting problem. The alternative is to have publically funded projects where companies are paid to deliver an outcome, which is then freely available. The problem with this is that since there are no private gains to capture, the costs of subsidy are much higher.

Coordination

CCS is not really about single emitters and single sinks. It is much more about a system of coordinated emissions from power stations, through a

common network, to a portfolio of storage facilities. The analogy with the development of interconnected electricity and gas systems is a close one. Such systems do not tend to arise spontaneously: they need an element of top-down planning and the creation of new companies and institutions to develop the systems and networks. In the electricity and gas cases, it makes sense to give a lead role to existing transmission companies.

Emissions standards and competitiveness

Even if particular technologies are developed, they will only be deployed if required by regulation. No electricity company would voluntarily fit CCS and hence raise their costs unless forced to do so. Such an obligation makes sense only if others have to follow the same path. Otherwise international competitiveness is damaged and more energy intensive industries simply move to those countries where CCS is not required.

The loss of international competitiveness is a serious problem. It has happened already with the EU ETS. Europe's production of carbon has indeed gone down against business as usual. But its consumption of carbon has not – reflecting the fact that carbon intensive goods are imported from places like China which is not carbon price constrained.

The way in which CCS may be made compulsory is through emissions standards imposed on power stations and large industrial facilities. The more international these standards, the more credible the CCS policy and the more incentive there is to invest in CCS technology.

The role of gas

Almost all discussion of CCS has been about coal. Coal is much more polluting than gas, and coal is the dominant fuel for electricity generation. But attention is now turning to gas. The coming of shale gas has transformed its potential for electricity generation. Indeed, it is possible to envisage in the next few decades the electrification of transport, and that electricity coming in large measure from gas. There would be a significant improvement in emissions just by the switch from coal to gas. But in the longer term, the carbon from the gas would need to be tackled.

CCS for gas would be the natural solution. There would be more time, as the substitution of gas for coal first would make a big difference to emissions on its own, especially in shale gas rich countries like the US and

China – and perhaps in Poland and elsewhere in Europe too. Whilst this transition process is taking place, R&D could focus on CCS for gas.

In principle, gas CCS ought to be easier than coal. In a pre-combustion form, coal needs to be gasified first before CCS is applied. Gas comes ready gasified by definition. It is easier to handle. There are also interesting opportunities to gain hydrogen from natural gas without burning it in power stations, and such projects can be located near the gas source.

International cooperation

CCS faces formidable practical rather than theoretical problems. It is an essential part of any serious global decarbonisation process. Without CCS, the chances of winning the battle against global warming are slim (indeed even with it they are not good). Yet it requires new public policy initiatives, public subsidies and international coordination.

Rather than engage in endless rounds of negotiations to reach a global agreement on overall targets, it might be better for international efforts to focus on global efforts to fund and coordinate research into technologies like CCS, and to negotiate global emissions standards rather than global targets. This would not be sufficient – and there are lots of other policies needed too, not least a global carbon price. But focusing on the practicalities of CCS might be much more productive than all the political capital that was wasted at Copenhagen and which again looks like being wasted in Mexico in December 2010.

Chapter I
The current situation and the challenges ahead.
Why can we still do more?

The European Union is finding itself being forced to build up its position and strength as well as its competitive advantages on the basis of a new model for the global economy, in which new sectors of industry (the sectors that rely on innovative technologies) are a key element of economic growth. This assumption is a pre-requisite for the EU's security in many areas, but it is no coincidence that energy security has become a priority issue over recent years. The conventional sources of energy in Europe are running out. The average level of dependency on external energy supplies in the European Union is almost 54%.[5] In order to prevent this situation deteriorating any further leaders of the EU Member States have adopted a strategy under the banner of innovativeness, which would enable Europe to face simultaneously two of its greatest challenges: energy security and climate change. This entails building a new model which envisages rationalization of the raw materials that Europe still has and increasing use of unconventional sources. Success of this strategy depends on the rate of development and effectiveness with which innovative low-carbon technologies are introduced.

The EU's climate and energy policy is one of the tools that are supposed to allow Europe to build up its competitive advantages over the United States as well as the rapidly developing Asian countries. The race is on between these global players to see who will become the producer of products that will meet demand in the emerging sectors. The wide range of low-carbon technologies is one of these sectors.

In view of the factors described above Europe will have to look to innovativeness in the energy sector. Some EU Member States have already chosen their areas of specialisation. Poland has a unique

[5] http://www.energy.eu/#dependency

opportunity to join this observed trend – it has a coal-based energy production and only clean coal technologies will enable it to extend the period for which it will be able to use its hard coal and lignite reserves. For Poland this is not a question of choice, it is a question of necessity. Necessity has always been the mother of invention. Poland is in an advantageous situation because out of necessity it could become a pioneer in the new clean coal technologies sector and could benefit from this in the future. There are many forms of clean coal technology, and the number is continuing to rise. Recently Carbon Capture and Storage (CCS) gained an additional edge in Poland over the other technologies aimed at limiting CO_2 emissions. This is connected with the potential for extraction of shale gas in Poland (3 bln m3)[6], which has the potential to become one of the main energy resources in Poland over the next 20-30 years. It will be possible to use CCS technology with great effect, in particular know-how, and transport networks and CO_2 storage facilities built for coal power stations, for the purpose of reducing emissions from gas power stations.

Whether through specialisation in CCS Poland is able to become one of the driving forces strengthening the EU's position in the world and increasing its energy security will depend a great deal on how the existing research and development potential is put to use.

RECOMMENDATION[7]

Poland has at its disposal facilities that could contribute in a successful way to development of CCS technology in Poland. These are, to name a few, the Polish Geological Institute (Państwowy Instytut Geologiczny), the University of Science and Technology (Akademia Górniczo-Hutnicza), Oil and Gas Institute (Instytut Nafty i Gazu), Mineral and Energy Economy Research Institute of the Polish Academy of Science (Instytut Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk), and the Institute for Chemical Processing of Coal (Instytut Chemicznej Przeróbki Węgla). Polish energy and chemical firms affiliated in organizations such as the Polish Power Plant Association (Towarzystwo Gospodarcze Polskie Elektrownie), the Polish Chemistry Industry Chamber (Polska Izba Przemysłu Chemicznego) or the Polish Clean Coal Technologies Platform (Polska Platforma Czystych Technologii Węglowych) also have potential. Individual projects run by those organizations are funded among other

[6] http://bi.gazeta.pl/im/9/7979/m7979279.jpg

[7] All of the recommendations made in this report were devised by the author on the basis of interviews with parties interested in CCS in Poland and abroad.

things from EU funds, the National Fund for Environmental Protection and Water Management (Narodowy Funduszu Ochrony Środowiska i Gospodarki Wodnej) and the National R&D Centre (Narodowe Centrum Badań i Rozwoju). Nevertheless we do not have a platform that would successfully combine the forces of all of the interested parties, therefore a mechanism is needed that enables better coordination of the work of the organizations involved and would make it possible to fill the gaps quickly. If this is not done some of Poland's CCS research and development potential could be wasted.

This chapter has been discussing the current situation and the desirable level of progress in the future in relation to particular challenges on the road to full use of Poland's CCS research and development potential. The political, legal and financial challenges which were discussed extensively in previous reports in the series "How can CCS be introduced successfully in Poland?"[8] are not discussed here.

1.1. CO_2 Capture

Carbon capture technologies (pre-combustion, post-combustion and oxy-fuel) are well known and used widely around the world, but they have one drawback – a CO_2 capture installation reduces a power station's efficiency by approximately 10%.

RECOMMENDATION
Capture is the most expensive element of CCS technology. The efforts of specialists should therefore be focused first and foremost on increasing efficiency of a capture installation – selection of the optimal solvent for the CO_2 absorption process – and at the same time on lowering the cost of the first part of the CCS process.

The first Polish demonstration CCS project in w Bełchatów[9] envisages the construction of a post-combustion installation to remove CO_2 from the 858 MW energy block waste gas from burnt lignite. Advanced amine technology will be used for this purpose – there are plans to capture more

[8] A.Hinc, *How can CCS be introduced successfully in Poland? Political and Legal Frameworks*, demosEUROPA – Centrum Strategii Europejskiej, 2010 (http://www.demoseuropa.eu/files/RaportCCS_demosEUROPA.pdf). A.Hinc, *How can CCS be introduced successfully in Poland? The financial framework*, demosEUROPA – Centrum Strategii Europejskiej, 2010 (http://www.demoseuropa.eu/files/Raport_CCS_II_demosEUROPA.pdf).
[9] Implemented by PGE Elektrownia Bełchatów.

than 2.1 million tonnes of CO_2 per year. With respect to the choice of technology, collaboration has commenced with Alstom – the firm constructing the 858 MW block- and Dow Chemical – a global supplier of chemical products, with more than 40 years' experience in processing of amine.[10] Funding of EUR 180 million has been granted for the project from the European Energy Programme for Recovery.

The other potential Polish demonstration project in Kędzierzyn-Koźle[11] is intended not only for production of electricity and heat energy, but also chemical raw materials such as carbamide, hydrogen and methanol and the aim is also to produce synthetic fuels. All of this is to be made possible due to innovative use of pre-combustion technology and the Integrated Gasification Combined Cycle – IGCC.[12] At the moment a feasibility study has been prepared for this project by Foster Miller, and before this the documentation was drawn up, and this took the form of a conceptual plan and financial and economic analyses. The feasibility study also covers gasification and transmission via pipelines, and identifies reference locations for storage of CO_2. The project is to apply for funding from the *New Entrants Reserve – NER300*.

RECOMMENDATION
The two projects (in Bełchatów and Kędzierzyn-Koźle) represent a huge opportunity for development of both the Polish energy sector and the Polish chemical industry. Care needs to be taken to bring about greater commitment on the part of Polish chemical firms and R&D facilities to development of CCS technology.

1.2. CO_2 transport

The plan to construct a network of pipelines for transport of CO_2, appointment of entities responsible for it, and ensuring the appropriate regulation and funding, are top priority. Energy and chemical firms are working on the first part of the CCS technology chain – capture – and geological institutes on the final stage – storage, but if there is no clear strategy linking the first part with the last – transmission – there is no chance of completing any project. Linear investments in Poland are pivotal. By way of example, Przedsiębiorstwo Eksploatacji Rurociągów Naftowych

[10] http://www.rp.pl/artykul/432033.html
[11] Implemented by the ZAK-PKE consortium. The project will be carried only if funding is received from NER300.
[12] http://www.tygodnik7dni.pl/nasza-szansa-ma-kryptonim-ccs-2009,05,15.html

"Przyjaźń" S.A. has been building 3 "Przyjaźń" pipelines for transmission of crude oil (extraordinarily important from the point of view of Poland's energy security) since the beginning of the decade and to this day it has not been completed.[13] The reasons for this situation are mainly gaps in local zoning plans, fragmentation of ownership of the land across which the pipeline is to be laid, and (in some cases) unregulated legal relations between the land owner and the owner of the pipeline. Similar problems may also arise in the case of construction of CO_2 transmission pipelines. An element of exceptional importance, which may turn out to be the stumbling block, is the question of the ecological issues and local community acceptance of the investment.

RECOMMENDATION

Experts underline that with respect to the question of CO_2 transport a "special" act of law will be needed. This act of law – like the one for the motorways, or the one for the construction of the LNG port outside Szczecin – is the only way to construct several hundred kilometres of infrastructure for transmission of CO_2 from the point of capture to the point of storage. At the moment the average time taken to complete a linear investment is 7 years from the moment the decision is made to undertake the investment. This means that none of the Polish CCS demonstration projects could be completed before 2015. The special act would enable this period to be reduced to 4 years, therefore assuming that the special act, the decision regarding the location for storage of CO_2 as well as the decision to construct the pipeline are made in 2011, there is a chance of completing investments by 2015.

1.3. CO_2 storage

At the moment projects related to identification and testing of potential structures for storage of CO_2 from the first Polish demonstration projects appear to be the strongest link in the process of implementation of CCS technologies in Poland. Among these we can include the following:

The feasibility study on storage and transport of CO_2 for the PKE and ZAK project in Kędzierzyn-Koźle (completed project)

[13] http://www.pern.com.pl/index.php?dzid=21

The project was commissioned and funded by the Southern Poland Power Company (Południowy Koncern Energetyczny – PKE) Kędzierzyn-Koźle, completed in 2010 by a team made up of the Polish Geological Institute (PIG) (coordinator), the University of Science and Technology (AGH) and Gazoprojekt. The aims of the project were:

- to draw up a feasibility study as step towards attaining CCS ready status,
- to prepare expert opinions on transmission and storage of CO_2 for the purpose of an application for funding of the PKE-ZAK project as part of the European CCS demonstration programme.

The results of the project reveal that the correct structure for sequestration of CO_2 from the Kędzierzyn-Koźle power station is located no less than 150-200 km from the power station.

National programme: Assessment of formations and structures for safe CO2 geological storage, including monitoring plans.

The project commissioned by the Ministry for the Environment, funded by the National Fund for Environmental Protection and Water Management (NFOŚiGW) and carried out by a consortium made up of: PIG (heading the consortium), AGH, the Central Mining Institute (Główny Instytut Górnictwa, GIG), the PAN Mineral and Energy Economy Research Institute (Instytut Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk), and PBG S.A. The project is run from 2008 – 2012. The main objectives of the project are as follows:

- to draw up an analysis of the potential for storage of CO_2 for the purpose of the Polish energy sector development strategy,
- to identify safe storage regions for the purpose of Poland's concession policy,
- to draw up preliminary data for the purpose of Polish CCS demonstration installations,
- to draw up plans for monitoring, taking into account the need for cost optimisation,
- consultation on the implementation of the EU CCS Directive into Polish law,
- to train personnel in the new field of geological activities,
- to inform the public and hold public and government consultations on the issue of underground storage of CO_2,

- to bring about international cooperation and transfer of know-how.

Up until now the main obstacles to the project have been, in the first phase, lack of apparatus and software for specific analyses relating to CO_2 storage, cooperation with academic research centres (they have not devised a production cycle) and staying within the tight deadlines for carrying out the commissioned work.

Geological and geophysical tests to select the optimal structure for safe storage of CO_2 from PGE Power Plant in Bełchatów

The project was commissioned and funded by the Polish Energy Group (Polska Grupa Energetyczna S.A. – PGE) reimbursed from funds of the European Energy Programme for Recovery - EEPR and implemented in the years 2009 - 2011 by the PIG in partnership with Schlumberger and business partners – the PRGiW and Geofizyka Toruń. The main objectives of the project are:

- to select the optimal structure for geological storage of CO_2 originating from PGE Elektrownia Bełchatów,
- to complete the geological data and analyse it (projecting and analysing risk) in order to select the optimal structure for further detailed tests, and, in effect, to construct the CO_2 storage facility for the purpose of the demonstration project,
- to draw up an application for funding from EEPR funds.

A series of problems arose during the project:

- short deadlines for completion (provided for in the EEPR schedule) – the need to adopt an unconventional, more risky approach;
- complex and rigorous tender procedures;
- configuration of contracts with business partners;
- the time limit for performing seismic work in the Natura2000 zone;
- protests by the public and local organisations.

The project is in the on-site geophysical and drilling stage. Public protest has meant that not all of the necessary seismic profiles envisaged for the Lutomiersk-Tuszyn profile could be produced. Seismic tests were re-designed and transferred to a different structure. The results obtained up to now show that one of the tested structures – Wojszyce - has a great

deal of potential for storage of CO_2, although difficulties arose in obtaining a seismic image of adequate quality due to its specific nature.

The academic-industrial consortium "GeoCO2"

The consortium was set up on 25 June 2010, as a result of cooperation between the Minister for Science and Higher Education and the Ministry of the Environment. It is made up of AGH, PIG, Messer Polska Sp. z o.o. and Przedsiębiorstwo Robót Wiertniczych i Górniczych Sp. z o.o. The objective of the consortium will first of all be to draw up and submit a bid for implementation of the geological work project to test the absorption properties of water-bearing sand structures, and underground and surface monitoring, and, should the consortium's bid be chosen – implement the project.[14] The project objectives are to be the following:

- empirical testing of the structure parameters in the Dolna Jura – its capacity, volume, tightness, and safety. A structure is to be chosen that has the same characteristics as the intended structure for the first demonstration project in Poland. At the same time it is intended to be excluded from later industrial sequestration;
- sequestration of 20-30 thousands tonnes of CO_2;
- creation of a model for safe storage of CO_2 (sequestration and monitoring) for CCS projects in Poland.

Work connected with the project implemented by the consortium is due to start as early as this year. The schedule will be closely tied to implementation of the first CCS demonstration project in Poland, although it will also depend on a number of external factors such as funding – funds from firms in the energy sector are to be used.

CGS Europe (project being planned)

The project is to be funded from 7 European Union Framework Programmes and implemented by BGRM – several dozen contractors from all over Europe (among them the Polish Geological Institute) between 2010 and 2013. In cooperation with the Bundesanstalt für Geowissenschaften und Rohstoffe – BGR in Germany, the PIG has prepared a conceptual plan as part of the Interreg programme. The contract is to be signed at the end of 2010.

[14] Ministerstwo Środowiska.

RECOMMENDATION

The Polish CO_2 storage R&D projects are very well prepared, nonetheless, the deadlines connected with construction of demonstration projects are extremely tight. Efforts should therefore be made to ensure that the research consortia that examine potential structures for sequestration of CO_2 are not a hindrance with regard to regulatory, logistic or financial issues, or issues relating to lack of public acceptance. Without identification of locations for storage of CO_2 Polish CCS projects have no chance of success.

1.4. Public acceptance

Lack of public acceptance of storage of CO_2 could mean, in the worst-case scenario, that CCS projects in Poland are blocked (starting with the demonstration projects and ending with industrial projects) – this could mean the beginning of the end for CCS in Poland. There is little chance that the EU's strategy with regard to reduction of CO_2 will change, and consequently the lack of locations for storage of this gas will be especially harmful for the Polish energy industry. In such a case cross-border pipelines will be needed, possibly as far as the North Sea, which would mean enormous costs with which the Polish energy sector might not be able to cope.

This is also why, in the view of geologists, the relevant tests need to be carried out and it needs to be established in which structures in Poland storage of CO_2 will be safe. We need to be confident that sites are airtight and we need to know how the CO_2 will react in brine, the rate at which it migrates in the structure and whether it bonds with binding or just with water. A model needs to be developed for safe storage of CO_2 in the identified structures.

It will not be possible to achieve the tasks described above (not to mention perform CCS on an industrial scale) without an information campaign properly planned in advance and executed. We can see this by looking at the examples of Germany and Holland, and our own – conducting tests on one of the structures identified as a potential site for storage of CO_2 for the PGE project turned out to be impossible due to protest from the public and local organisations. Despite its own efforts to provide the public with accurate information regarding storage of CO_2 the PIG was forced to begin work on a different structure. Research and

development generates new solutions. Few fear tried and tested solutions and familiar technology, but promotion of innovative technologies will always be faced with the risk of public protest due to fear of something new and unknown.

The building of social acceptance of CCS is therefore a priority. The Ministry for the Economy and the Environment decided to create a special CCS public information task force. The Ministry for the Economy also drew up a letter to the Marshal of the Łódź region (voivodship) and to the Łódź Voivode asking for assistance in overcoming public opposition to both the performing of geological tests and to any potential storage of CO_2 in geological structures in the voivodship in the future. The prime minister was also acquainted with the issue. Initial action was taken but nevertheless the decision to conduct a public information campaign about CCS has not been taken.

Each block newly built according to the CCS ready standard in Poland will have to have a documented identified site for CO_2 storage, and consequently the current problems with identification of structures for the demonstration projects are only a sign of the difficult scenario that may arise if there is no programme for building social dialogue and in the second phase a widespread CCS information campaign.

RECOMMENDATION
In order to create a stronger message the CCS public acceptance programme should be contracted by the government and conducted by professionals. It is it the interest of the state, not just the interest of individual power stations, that CCS is implemented in Poland, and for this reason there is also justification for giving the CCS campaign the status of a government programme. This will make the work of communication experts easier.

1.5. Training of personnel

One of the most important challenges is also the problem with finding the properly trained personnel. The consortia now carrying out R&D projects have already discovered this. Activities performed during those projects are carried out on an incomparably small scale in relation to what will

have to be done on the way to full commercialisation of CCS in Poland. the indirect solution is of course to use foreign intellectual capital, but the aim is for Polish personnel to work on CCS projects.

RECOMMENDATION
It is vital to review the existing courses at higher education institutions in Poland, to improve them where necessary, and to create new subjects and courses. It will also be necessary to re-train personnel in the energy, chemical, infrastructure, mining and geological sectors – through a system of courses and supplementary programmes.

1.6. Closer cooperation between the interested parties

Polish R&D CCS projects have the opportunity to get involved in a wide range of global and European initiatives aimed at efficient implementation of CCS technologies. These include:

- The Global CCS Institute[15], whose mission is to limit the adverse effects of climate change by promoting and implementing projects connected with CCS technology. The Institute aims to further international cooperation, exchange of information regarding best practice and global nurturing of CCS projects.
- The International Energy Agency[16], which has drawn up the CCS Technology Roadmap[17], and which assists with the exchange of information related to CCS projects around the world, among other things within the CCS Regulators Network.[18]
- The European Technology Platform for Zero Emission Fossil Fuel Power Plants – ZEP[19], which is a forum for dialogue between institutions interested in using CCS technology. Its main objectives are to promote CCS technology as key in combating climate change and to create the conditions for commercial application of this technology in Europe.
- The European Energy Programme for Recovery (EEPR), which was adopted by the European Commission in November 2008. Its main objective is to provide support for new technologies in the energy

[15] www.globalccsinstitute.com
[16] www.iea.org
[17] http://www.iea.org/papers/2009/CCS_Roadmap.pdf
[18] http://www.iea.org/work/2009%5Cccs_regulatory%5CKerr.pdf
[19] www.zeroemissionsplatform.eu

sector, in particular implementation of projects provided for in the "Europa 2020" Strategy and to ensure energy security of the Member States. One of the priorities of the Energy Plan is to support CCS demonstration projects.

- NER300 – a financial instrument managed jointly by the European Commission, the European Investment Bank and the EU Member States. Its main objective is to fund both CCS demonstration projects and innovative technologies related to use of renewable energy.
- The European CCS Demonstration Project Network [20], whose objective is to create a platform for exchanging knowledge and know—how relating to CCS technology. It focuses on building public acceptance of CCS demonstration projects, with a view to making easier future use of this technology on an industrial scale.
- The Knowledge and Innovation Communities, created by the European Institute of Innovation and Technologies. Wrocław Polytechnic, and other universities, firms and research centres have created CC Poland Plus – the Polish branch of one of the Knowledge and Innovation Communities being set up. The consortium that has been set up will be responsible for seeking new solutions related to ecological energy sources. All of the communities receive funds for their activity, which come mainly from European Union funds.

Nonetheless the number of Polish initiatives is relatively small. The few that exist include the Polish Clean Coal Technologies Platform (PPCTW). This platform is a concentration of energy firms – Vattenfall Polska, PGE, PKE, Kozienice Power Plant, EDF Polska, Dalkia Polska, Fortum, Electrabel Polska and Assembly Plant Ostrołęka. Several task forces work within the platform, including the legal team, technical team, and team for communication with the public. The objective of the PPCTW is to bring about familiarity with CCS technology, first and foremost of employees at firms operating within the Platform, as well as provide accurate information about the technology to outsiders. In addition to regular meetings, the Platform organises seminars, study trips and press conferences. PPCTW representatives play an active part in CCS events in Poland and abroad. The Platform also prepares reports and analyses on various aspects of CCS technology.

[20] www.ccsnetwork.eu

Energy firms have taken care to create a forum for exchanging information and know-how and have decided to work more closely within the industry. Among NGOs and academic institutions however there is no such initiative – to the detriment of all those mentioned. The level of involvement of the industry in R&D projects in Poland is one of the lowest in Europe.[21] This results in a low level of private funding of projects of this type. The National R&D Centre (NCBiR)[22], which, within the competitions it has announced sets criteria in such a way as to encourage – if not enforce – co-funding of a project from private funds, is trying to face this challenge. This has already brought tangible effects. Approximately 30% of projects funded using NCBiR funds are co-funded by industry. In European programmes in which the Centre is involved, this factor is as much as 60%.

RECOMMENDATION

There are examples of closer cooperation between parties involved in CCS in Poland, but at this stage of works on CCS technology it is vital to establish the framework and method of coordination of cooperation between both governmental, non-government, academic bodies and private entities. In view of the huge diversity of issues related to implementation of CCS technology and need for simultaneous action on many planes (for instance the technological, regulatory, and public planes), only this approach allows Poland's R&D potential to be fully exploited.

1.7. Coordination of work to implement CCS technology in Poland

At the moment there are a few departments responsible for implementation of CCS technology in Poland, principally: the Ministry for the Economy, the Ministry for the Environment, and the Ministry for Education. Upon their initiative projects are being set up relating to selected aspects of CCS technology. Most of the interested parties are suggesting however that better coordination is needed on the part of the government.

[21] It would be good to quote a source here

[22] The National R&D Centre (Narodowe Centrum Badań i Rozwoju (NCBiR) is a state-run legal entity set up to perform tasks related to the state scientific policy and innovativeness. It has been operating since 1 July 2007 on the basis of the Act of 15 June 2007 on the National R&D Centre (Journal of Laws of 2007, no. 115, item 789), www.ncbir.pl.

RECOMMENDATION

The development of clean coal technologies is highly relevant in strategic terms to the transformation of the Polish energy sector, and therefore it would be reasonable to create the post of a Government Plenipotentiary for Clean Coal Technologies modelled on the Government Plenipotentiary for Nuclear Energy. An institution has been set up for nuclear energy and its task is to coordinate work on construction of two nuclear power stations in Poland. Similarly, a government plenipotentiary, responsible for power stations (which produce more than 90% of electricity), is needed. The Government Plenipotentiary for Clean Coal Technologies should be responsible in particular for drawing up and implementing the Polish Clean Coal Technologies Programme (Polski Program Czystych Technologii Węglowych)[23] and coordination of work related to construction of CCS demonstration projects in Poland.

The urgency of the situation is such that without effective coordination of work to implement CCS technology and other forms of clean coal technology in Poland, it will not be possible to increase in a meaningful way the innovativeness of the Polish energy sector, but it will also not be possible to fulfil the obligations that Poland undertook on the European Union forum with respect to greenhouse gas emissions.

[23] A.Hinc, *How can CCS be introduced successfully in Poland? Political and Legal Frameworks*, demosEUROPA – Centrum Strategii Europejskiej, 2010 (http://www.demoseuropa.eu/files/RaportCCS_demosEUROPA.pdf).

Chapter II
How the challenges can be met? Recommendations for setting up a Polish CCS Cluster.

Poland will benefit from implementation of CCS technology only if it is introduced efficiently. There can be no doubt that heading the global CCS race are the United States, Australia, Norway, and within the EU, Germany or the United Kingdom. Even the leaders have not been able to find answers to all of the technological and organizational issues relating mainly to safety of the process and lowering the cost, however. Moreover there are certain questions to which they will not be seeking answers. For the sake of example, most of them are planning storage offshore, and not onshore, – which is the best solution in Poland. Significantly, onshore storage will also have to be used in China with respect to the majority of power stations. This means that in future there will be huge demand not only for technologies, but also for models for storage of CO_2 underground and monitoring it. The idea has also been put forward of applying CCS technology when extracting shale gas. At the moment no one has yet been able to prove that putting this idea into effect is feasible, but if it was – it would be possible to make use of CCS technology on an even greater scale.

This chapter presents a set of guidelines for how we can help Polish research and development centres make meaningful contributions to solving CCS problems. If we decide to increase innovativeness of the Polish economy, mechanisms must be put in place in individual sectors allowing us to make a start.

RECOMMENDATION

In the energy sector the advisable mechanism is the Polish CCS Cluster[24] – an institution that would be created to make the CCS technology development process in Poland more efficient by coordinating measures taken in various areas – creating the political, legal and financial frameworks, technological progress, building infrastructure and storage sites, building social acceptance, development of intellectual capital, and closer internal and external cooperation.

Clusters are being started up all around the world to encourage research and development potential in innovative fields. A good example of a cluster intended to develop a wide range of Information and Communications Technologies (ICT) is the Australian e-Government Technology Cluster[25], which operates as part of the National ICT Australia - NICTA. The objective of the cluster is to make more efficient and strengthen the ICT industry in Australia's government sector through closer collaboration among multinational corporations, small and medium-sized businesses, associations, the Australia government and research institutions.

An example of a prospering cluster in the cleantech field is the Finnish Cleantech Cluster[26], which, at the beginning of 2010 was named by the International Cleantech Group as one of the world's top three cleantech clusters. This cluster brings together organisations and firms that design products aimed at improving air quality.

Ideas have also arisen for creating clusters concentrating on development of CCS technology. One example is the Carbon Capture and Storage Cluster in North East England[27] – an initiative put forward by the regional development agency One North East[28]. The agency is interested in CCS technology mainly because with its development will come a rise in the amount of investment and job creation in the region.

[24] A cluster is defined in this report as a "concentration of mutually linked firms, specialist suppliers and entities providing services, firma active in related sectors and institutions connected with them (for example universities, standardising entities and industry associations) in particular fields in competition with each other but also working together", Michael E. Porter.
[25] http://www.nicta.com.au/business/market_engagement/industry_clusters/egovcluster
[26] http://www.cleantechcluster.fi/en/
[27] http://www.progressive-energy.com/images/carboncapture.pdf
[28] http://www.onenortheast.co.uk/

2.1. Why does Poland need a CCS cluster?

As demonstrated in the previous chapter there are a range of challenges for full use of Poland's research and development potential with respect to CCS. These challenges are extraordinarily diverse in nature, and consequently an individual entity is not able to manage with all of them. Research and development centres currently carrying out work on particular stages of the CCS process are experiencing obstacles which are:

- technical in nature – difficulties with gaining access to apparatus and software, and an insufficient amount of data,
- organisational in nature – coordination of work between different kinds of facilities,
- related to timing – the deadlines for implementing projects are very tight,
- legal in nature – complicated and restrictive procedures and lack of the relevant legal regulation,
- related to preservation of the natural environment – work performed in the Natura2000 zone,
- social in nature – the problem of public acceptance of the works being carried out,
- financial in nature – problems with creating the budget for the entire investment,
- related to an inadequate number of qualified personnel,
- political in nature – no clear political message.

All of the obstacles described above can be mitigated by closer cooperation of the principal interested parties on the administrative, business, academic, research and development, and NGO side, in the form of a cluster. Sensible teamwork will always bring better results than a collection of a few individual business enterprises. With respect to CCS this theory is confirmed further due to the need to act in several areas at the same time, and use of know-how gained in individual projects and their proper coordination will make it possible to work on both the capture and transmission and storage of CO_2 with greater efficiency. Moreover if properly managed, state policy can be implemented not only with regard to CCS alone, but also with regard to increasing the innovativeness of the Polish economy.

Poland's Achilles' heel in the field of innovativeness is that in most cases research projects do not translate into commercial prospects. There are relatively few joint initiatives between business and science that will result in delivery of new technology or a new product on the market. Creation of clusters has proved to be a successful solution to this problem in many countries around the world. In Europe one of the best illustrations is Germany, where business constantly makes use of assistance from academic and research and development facilities. R&D projects conducted by Vattenfall are a good example of this. By way of example, the overall objective of the project in terms of CCS is to examine and develop concepts that can be used for CCS projects, both pilot and demonstration, and which facilitate their commercialisation. The structure of Vattenfalls' R&D projects is divided into two parts. The first deals directly with support for the firm's internal projects. The second deals with developing know-how on the basis of cooperation with international corporations and scientists of world renown. [29] This model has led Vattenfall to become a leader in the field of CCS on a European and global scale.

In Poland the institution behind the combining of science and business with respect to new energy technologies is, among others, the National R&D Centre (Narodowe Centrum Badań i Rozwoju). This coordinates strategic projects aimed at providing state support from the academic side in the achievement of economic and social objectives. The NCBiR also provides support for the academic community and industry. Nevertheless the funds are insufficient to revolutionise the coal sector in Poland, and revolution is what is needed.

2.2. Objectives of the Polish CCS Cluster

The Polish CCS Cluster – like all of the other clusters – must be a commercial venture. Its principal task should be to make optimal use of the existing technology and to develop new technology to allow greater CCS safety and efficiency.

[29] CCS R&D Programme Annual Report 2009, Vattenfall.

RECOMMENDATION
The particular objectives of the Polish CCS Cluster should be:

- to implement state policy
- to commercialise CCS technology
- to build up Polish specialisation in CCS
- to increase innovativeness of the Polish economy – the R&D potential
- to build new intellectual capital
- to build public acceptance
- to bring about closer cooperation between the interested parties
- to protect intellectual property

Objective 1. Implementation of state policy

Development of clean coal technologies, including first of all CCS technology, is in Poland's interest. This area of policy can be implemented in a variety of ways. As an example, the President of the United States decided to set up the Interagency Task Force on Carbon Capture and Storage)[30], whose main responsibility is to draw up plans for construction of between 5 and 10 commercial CCS demonstration projects by the year 2016. The CCS taskforce was set up by President Obama in February 2010, and is made up of 14 departments and federal agencies, and is managed jointly by two departments – the Department for Energy and the Environmental Protection Agency. In August 2010 the taskforce drew up a report with a set of recommendations for the President, relating to elimination of the obstacles to broad and effective dissemination of CCS technology over the next 10 years in the United States. 14 federal agencies were involved in the work, as well as hundreds of interested parties and experts.

RECOMMENDATION
Given the success to date of the US Interagency Task Force on Carbon Capture and Storage, the Polish CCS Cluster should be set up with the Government Plenipotentiary for Clean Coal Technologies as an active participant.

[30] http://www.whitehouse.gov/administration/eop/ceq/initiatives/ccs

Objective 2. Commercialisation of CCS technology

Commercialisation of CCS is a global challenge, but Poland does have the capacity to contribute to streamlining the process of commercialisation of selected elements of this technology.

RECOMMENDATION
The Cluster should make a contribution to facilitation of the transfer of technology and the creation of means of breaking into the market. Projects implemented within a Cluster should identify the technological niches and fill the gaps on the global CCS market. The Cluster should devise a model for commercialisation of innovative low-carbon technologies. This model could then be used to place on the market Polish technologies connected with renewable energy or increasing the energy production efficiency of the installations. The Cluster should also set new standards for services provided by research and development facilities in such a way as to make them more attractive to business.

Objective 3. Establishing a Polish area of specialisation in CCS

Many new technologies, mechanisms, and solutions can be created on the basis of CCS, and these have broad applicability in the electricity sector. One example might be the use of CCS to increase the rate of extraction of shale gas. The element of potential creation of new technologies should not be underestimated, nevertheless there are even now areas in which Poland could specialise.

One of the potential areas of Polish specialisation could be a model for underground storage of CO_2 in water-bearing brine layers. This model could be applicable to all structures of this type regardless of geographical location.

CCS also creates an opportunity for development of the Polish chemicals sector. In the first part, connected with CCS capture, there are processes such as conversion, CO_2 purging, separation of sulphur, and compression. Another important issue is the application of the optimal solvent for the CO_2 absorption process. Capture is the most expensive part of CCS, and

therefore any improvements whatsoever that increase its efficiency are worth their weight in gold.

Objective 4. Increasing innovativeness in the Polish economy – research and development potential

The Cluster should perform research that is interesting from the point of view of a potential client. To this end the highest standards should be introduced not only with regard to equipment or personnel, but also with regard to models for R&D project management. Selection of partners to carry out projects within a cluster has to be scrupulous.

RECOMMENDATION
Projects that are carried out within a cluster should be directed towards finding new solutions both in the area of products and services, and processes. A cluster's strategy should be to make optimal use of the potential of its members in such a way as to maximise prestige and influence of the research projects. The final objective of each of the projects should be commercialisation, which can take various forms: spin out, licensing, sale of inventions/technologies, joint ventures, opening businesses.

Objective 5. Building new intellectual capital

The gathering, building and optimal use of intellectual capital should become one of the key objectives of a cluster.

RECOMMENDATION
A cluster should broaden the culture of entrepreneurship in such a way that the gathered capital (varying in nature) is not wasted. The involvement of distinguished scientists and professional personnel needs to go hand in hand with introduction of team management systems. This method would allow world class research teams that entities from all over the world will approach, to be formed.

Cooperation with institutions of higher education is extraordinarily important because they will provide the cluster with scientists that have vast technical knowledge. The cluster should suggest and if necessary fund creation of new programmes and study areas, depending on what kind of specialists are in demand. An approach of this kind will also require

close cooperation with the relevant government ministry. The cluster should involve students in its work, even at the early stage of education, so that once they graduate they can demonstrate not only theoretical knowledge, but also experience.

Objective 6. Building public acceptance

The provision of reliable information about CCS and a professional means of presenting it to the public will be key for the success not only of demonstration projects but also for widespread implementation of CCS on a commercial scale (if not above all).

RECOMMENDATION

A special unit should be created within the cluster, and his unit would be responsible for preparing programmes for building social dialogue, informational schemes, educational programmes and public campaigns concerning CCS technology. Most of all experts on communication with the public should be involved in work on those elements (as coordinators) as well as energy enterprises, research institutes, NGOs, and state administration. Work to devise informational and strategic dialogue schemes with local communities should be started as soon as possible. Within a short space of time a broad information campaign should be planned and put into effect, in connection with the need for transformation of the Polish economy in the direction of low emissions, for instance using CCS technology.

Objective 7. Closer cooperation between interested parties

By definition the activities of the Cluster should be based on close cooperation of representatives of the largest possible number of interested parties – from those representing the government, through scientists to people from industry – both Polish and international. That cooperation should be supported by a well prepared framework. Each entity needs to have precisely defined rights and obligations, and in addition the management structure of the cluster should allow for the greatest possible amount of benefits from the cooperation.

RECOMMENDATION
The partners working within the Cluster should meet regularly, and these meetings should take various forms – meetings of project teams, courses, seminars and conferences. This will make the exchange of information not only within, but also outside of the Cluster effective.

Objective 8. Protection of intellectual property

The Polish CCS Cluster should act as a safeguard of intellectual property (IP) created in the course of its individual projects. To achieve this an IP strategy should be devised for all research and development projects. This strategy should be updated regularly. All of the scientists working within the Cluster should be informed of the fundamental means by which intellectual property can be protected, in such a way that they are aware of the potential consequences of their actions – for example failure to keep confidential professional secrets. The results of scientific research will be more attractive and useful for industry if intellectual property rights are well protected, and this protection is comprehensively documented. In addition, industry will be inclined to make the technology in its possession available if it is confident that its assets will be protected. The Cluster must ensure that this is the case.

RECOMMENDATION
All new technologies developed as part of the Cluster's projects need to be systematically patented. A special division should be responsible for he Cluster's IP issues. This would be responsible for making sure that training is provided for employees systematically and for formal issues connected with protection of intellectual property and granting of patents.

2.3. What do members of the Cluster have to gain?

The Polish CCS Cluster is likely to be successful only when it is attractive for all of its members.

RECOMMENDATION
The members of the Polish Cluster should include, first and foremost:

- state administration,
- business,
- institutions of higher education and research and development centres,
- NGOs,
- Experts (on communication with the public and other areas).

Membership of the Cluster will have the following benefits:

State administration (the government plenipotentiary for Clean coal Technologies, key ministries, state institutions):

- implementation of state policy,
- increased innovativeness of Polish businesses,
- increased competitiveness of the Polish economy,
- development of Poland's intellectual capital,
- a conscious process of transformation of the Polish economy,
- increased cooperation with entities outside of government,
- greater transparency of government activities,
- timely and effective introduction of CCS technology.

Business (in the energy sector, chemical sector, infrastructure, and others):

- increased access to others' information and know-how,
- close cooperation with state administration,
- greater influence over legal and financial frameworks for CCS technology,
- better opportunities for entering the market with new technologies,
- access to qualified personnel,
- greater exposure in the international arena,
- a better image,
- new business opportunities,
- the possibility of exchange of resources and joint participation in tenders
- enhancement of skills,

- creating and expanding new markets,
- timely and effective introduction of CCS technology.

Institutions of higher education and research and development centres:

- increased importance and prestige of Polish science,
- greater opportunities for cooperation with industry – implementation of projects of commercial relevance,
- a greater chance of obtaining funds for research programmes,
- development of academic staff,
- an increased number of laboratories,
- greater participation in achievement of the state's objectives.

Non-government organisations:

- the chance for joint formulation of state policy,
- the chance to implement a greater number of programmes,
- raising of the qualifications of employees,
- greater opportunities for collaboration with business,
- greater visibility – greater access to target groups.

Experts (on communication with the public and other areas)

- the chance to become involved in projects of national importance,
- greater prestige,
- greater opportunities for cooperation with business,
- raising of one's own qualifications,
- the opportunity to take part in events (meetings, seminars, conferences) of international importance.

2.4. How can the venture be financed?

The Polish CCS Cluster should have financial stability allowing it to function (without disruption due to lack of funds). Until full functionality is reached (the first few months) the Cluster should be funded by the state budget and later begin to collect membership fees and begin commercialisation of its activities. The Cluster's funds (apart from administrative funds) need to be distributed within individual task forces coordinating research and development programmes.

RECOMMENDATION

The Cluster should be given a so-called start-up grant by the Polish government of EUR 1 million, similar to the one applied for by the Polish branch of CCS Poland Plus to the European Institute of Innovation and Technologies.[31] Upon completion of the preliminary phase a membership fee should be introduced for business enterprises – it is these that will gain the most benefit from the functioning of the Cluster in the long term. By way of example – thanks to projects connected with examination of locations for CO_2 storage and plans to construct transmission infrastructure – firms in the energy sector will be able to demonstrate that they qualify as CCS ready. Also, commercialisation of CCS technology is mainly in the interest of industry. CCS technology will enable the largest emitters of CO_2 to avoid the need to purchase CO_2 emission rights.

2.5. Which model for management of the Cluster should be used?

RECOMMENDATION

A managing body with a chairman and a supervisory board need to be set up to coordinate the Cluster's activities. The board should consist of the Government Plenipotentiary for Clean Coal Technologies and representatives of the key ministries: the Ministry of Economy, the Ministry of the Environment, the Ministry of Infrastructure, the Ministry of Science and Higher Education, and the Ministry of Foreign Affairs. Task forces should be set up to coordinate work on individual projects.

Each of the task forces would be responsible for a particular field, and these mainly include:

- capture of CO_2,
- transport of CO_2,
- storage of CO_2,
- legal framework,
- financial framework,
- commercialisation,
- protection of intellectual property,

[31] http://www.smartgrid.agh.edu.pl/documents/KIC_Konwent_Kwiecien2010.pdf

- personnel,
- social acceptance,
- commercial activity,
- cooperation with international organisations and organisations active within other countries.

2.6. The Cluster's commercial activity

The Polish CCS Cluster needs to become a business enterprise as soon as possible and to be self-financing without the need for additional funding from the government.

RECOMMENDATION
The Cluster's commercial activity should be based on:

- performance of commissioned works – research programmes commissioned by business enterprises;
- sale of the developed technologies;
- drawing up of expert opinions for national entities as well as for international firms/organisation;
- consulting;
- organisation of training and courses;
- licensing.

Conclusion

Poland has huge CCS research and development potential. Whether it is used properly and whether it will render an increase in innovativeness in Poland depends mainly on how those main parties interested in CCS (on the government, state administration, academic and R&D side and in business) manage with the range of obstacles that stand before them.

One of the greatest barriers at the moment are time constrains. There are many issues that have to be treated as top priority right now, such as identification of locations for storage of CO_2, devising a plan for construction of pipelines, legal and financial frameworks, building public acceptance, training of personnel. Neglect of any of these matters could significantly delay introduction of CCS technology in Poland and by the same token cause Poland's chances of becoming a leader in innovative low-carbon technology to decrease considerably.

The second potential obstacle for implementation of CCS R&D projects is public acceptance. Democratic society must and should be an active player in implementation of CCS in Poland. The fears that are being expressed about storage of CO_2 are connected with the fact that the technology is something new for the public – never before have projects like this been conducted on such a large scale. Incompetent handling of social dialogue in this respect might not only squander the plans relating to the demonstration projects but also prevent implementation of CCS on a commercial scale.

The third obstacle is nature itself. This is because it is becoming clear that we are not familiar with nature enough to be able to predict the effects of our actions. We are constantly surprised by nature – at times positively, and at times negatively. The task of scientists and researchers to is minimise the effect of the risk factors connected with our intervention in nature. In the case of storage of CO_2 this is done by way of a series of analyses and tests of underground structures. The more those structures can be analysed the more information we will have about what capacity there is for storage of CO_2 in Poland.

The fourth challenge is being willing to act in the face of uncertainty. Accepting and managing risk is crucial for fostering innovation not only in CCS but in every field of research and development. The uncertainty about whether in a few years from now the technology we are now investing in will be overtaken by completely new technology is one of the factors hampering innovation in the Polish economy. The inherent uncertainties associated with further technological breakthroughs, new solutions and new technologies means that in the field of R&D –including CCS – risks have to be taken.

There is after all a barrier which is the uncertainty connected with the regulatory sphere. The lack of an adequate legal and institutional framework means that businesses make decisions regarding multi-million investments. Poland needs investments on this scale if there is no transformation of the Polish energy sector, in which CO_2 capture and storage technology plays one of the leading roles.

In this report we present a set of detailed recommendations pertaining to the challenges described above. Among them there are two key recommendations of strategic importance.

The first concerns creation of the post of the Government Plenipotentiary for Clean Coal Technologies. During the first phase of implementation of CCS in Poland the signals made by the government and public administration will be extremely important. The appointment of the Government Plenipotentiary for Clean Coal Technologies would be a signal giving credibility to the whole range of actions intended to build up Poland's CCS know-how. The government plenipotentiary would also be able to control coordination and efficiency of the process of implementation of CCS technology in Poland.

The second key recommendation is the creation of a Polish CCS Cluster which would combine the efforts of all of the parties interested in CCS connected with capture, transmission and storage of CO_2, putting in place financial and legal frameworks, building public acceptance, training of personnel, and closer cooperation within Poland and abroad. Closer cooperation and the taking of joint measures are the road to success of CCS technology, and by the same token also to the success of all of the interested parties.

A Polish CCS Cluster could not only bring about successful implementation of CCS technology in Poland but it could also become a model solution for use of Poland's research and development potential in other strategic areas.

Annex

A list of interviews conducted by Agata Hinc, Project Leader, Low Emission Economy, demosEUROPA – Centre for European Strategy.

Preson	Date
1. Cezary Filipowicz „GeoCO2"	7 July 2010
2. Marek Jarosiński Polish Geological Institute	7 July 2010
3. Daria Kulczycka Polish Confederation of Private Employers Lewiatan (PKPP Lewiatan)	8 July 2010
4. Jerzy Majchrzak Polish Chamber of Chemical Industry (PIPC)	16 July 2010
5. Zbigniew Szymczak National Contact Point in Poland	23 July 2010
6. Eugeniusz Sutor Zakłady Azotowe Kędzierzyn S.A.	25 July 2010
7. Ewa Gąsiorowska Vattenfall Poland S.A.	2 August 2010
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About the author

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