SETTING UP ELECTRONIC DATA BASES OF GLOBAL CO_2 SEQUESTRATION PROJECTS

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Introduction

CO_2 capture is a very important part of the energy strategy of every country. The application of innovative pure technologies in the power industry will reduce carbon dioxide emissions. Setting up long-term underground carbon dioxide reservoirs is considered and implemented as one of promising and widely developing areas. The technology of carbon dioxide capture and sequestration will contribute to the changes of energy policy and reduction of the negative impact of man-caused emissions on the environment. The growth of gaseous industrial emissions and the intensity of their environmental impact have its territory and time scope that does not depend on economy development in Russia. The issue of reducing gaseous emissions can be addressed only on the global level. Therefore, all international efforts were united and as a result several dozens of projects have been developed and successfully implemented for over 15 years. Despite serious disputes about the impact of carbon dioxide on environmental temperature change, global projects are developed and implemented, which is primarily caused by the improvement of the environment condition.

In 2009 the Climate doctrine was adopted in Russia. It was followed by the Comprehensive Plan of Implementation of the Climate Doctrine of the Russian Federation to 2020, which was approved in April 2011. Gazprom and Gazprom VNIIGAZ also take part in a number of initiatives aimed at studying the technology of CO_2 capture and sequestration, which will allow Russia to take part in international projects on capture and long-term storage of gaseous industrial emissions.

Objectives and methods

The analysis of global projects on CO_2 capture and sequestration will allow to unite them into a data base that can be modified and adjusted depending on the project development. This analysis and data base show the worldwide experience and prospects of CO_2 capture and sequestration projects. It will be an essential document for such major CO_2 organizations as International Energy Agency, Carbon Sequestration Leadership Forum and Global CCS Institute.

To set up a data base of global CO_2 capture and sequestration projects, the analytical method was used. The existing documents on each project were collected, processed, analyzed and generalized and the respective information was sistematized. It was a comprehensive study and included the analysis not only of general information, but also geological and hydrochemical data.

Results

The technology of CO_2 capture and sequestration is an important aspect of addressing the issue of global CO_2 emissions from industrial and energy sources, reduction of the negative impact of carbon dioxide on the environment for the countries with significant CO_2 emissions and suitable for this technology (having underground storages).

In July 2009 the G8 Summit that was held in Aquila, Italia, identified and set criteria for launching 20 CO_2 capture and sequestration projects. Upon agreement with Carbon Sequestration Leadership Forum (CSLF) and Global CCS Institute, International Energy Agency (IEA) later improved and clarified these criteria. These seven criteria are as follows.

1) The project scope should be sufficiently large to demonstrate technical and operational viability of future industrial projects on carbon capture and storage:

– CHP using coal should capture about 1 Mt/year of CO_2;

– CHP using natural gas and GPP should capture about 0,5 Mt/year of CO_2.

2) Projects should include the complete integration of CO_2 capture, transmission (if necessary) and storage.

3) In the process of project development the main CO_2 storage facility, its parameters and reasonable transmission routes connecting CO_2 capture site and CO_2 storage facility should be identified.

4) All projects should have an inspection, measurement and control plan. This plan provides the high level of confidence that captured CO_2 will be isolated and reliably stored.

5) CO_2 project development strategies should comprise measures for public involvement and unification of public activity on CO_2 project site.

6) Designed projects should be launched on the full-scale before 2020.

7) Main stages of the project should be worked out; corresponding funding is required for running CO_2 capture and sequestration project. The implementation of the project and its investment plans should demonstrate the public and/or private sector support.

In 2009 270 global carbon capture and storage projects were presented to the public, including:

– 130 planned projects;

– 84 running projects;

– 22 completed projects;

– 21 projects were completed by construction of CO_2 capture facilities;

– 7 cancelled projects due to, first of all, inappropriate choice of the injection location and extremely high cost:

- *Red Rock facility (American Electric Power) USA;*
- *Wolverine CFB plant (Wolverine Power Supply Cooperative) USA;*
- *Lubmin-Griefswald (Dong Energy) Germany;*
- *Halten CO2 Project Draugen-Heidrun/Tjeldbergodden (Shell, Statoil) Norway;*
- *BP Peterhead DF1 (BP) UK;*
- *Huntley project (NRG Energy Inc.) USA;*
- *BP Rio Tinto Kwinana DF3 (BP) Australia;*

– 6 projects are awaiting the decision on their implementation:

- *Fairview ZeroCarbon Project (CO2CRC, CSIRO) Australia;*
- *BP Carson DF2 (Hydrogen Energy) USA;*
- *E.ON Killingholme (E.ON) UK;*
- *FutureGen-Jewett, FuturGen-Mattoon, FuturGen-Odessa, FuturGen-Tuscola (FutureGen Ind. Al.) USA;*
- *Monash CTL (Monarsh Energy, Shell, Anglo Coal Australia) Australia;*
- *Moomba Cooper Basin Carbon Storage Project (Santos) Australia.*

158 projects of 238 are integrated, both running and planned, including CO2 capture from various sources and sequestration, and 80 projects are large-scale.

However, for the last two years from 2009 to 2011 the number of CO2 capture and sequestration projects has not increased. Today the total number of CO2 projects amounts to 328. They comprise:

– 238 active or planned projects;

– 59 cancelled and suspended projects;

– 31 completed projects.

Many countries of the world have programs and major commercial projects on carbon dioxide capture and sequestration technology development:

- CO2 Catch up (Nuon) the Netherlands, 2010-2015;
- NLECI Project (Australian Government) Australia, 2011-2012;
- MGSC Oil-bearing flood 1 and Oil-bearing flood II USA, 2009;
- Nero Zero Emission Coal NZEC (UK&China) China, 2007-2014;
- NZEC Cooperation Action within CCS China – EU/COACH (EU&China), 1st phase, 2007-2014;
- Ocean CO2 sequestration (RITE, NEDO et al.) Japan, 1997-2012;
- ICO2N (ICO2N) Canada, 2012-2025;
- Hypogen/Dynamis (SINTEF Energy Research, Alstom et al.) EU, 2014-16;
- COHYGEN (ENEL, ENEA), Italy, 2009;
- Fenn Big Valley Project (Alberta Science and Research Authority) Canada, 1997;
- Alberta Saline Aquifer Project (ASAP) (EPCOR, Enbridge) Canada, 2010-2015;
- CO2-ECBM (Asia Pacific Partnership: CSIRO-JCOAL) Australia-Japan-China, 2011;
- C6 Resources CCS Project (C6 Resources) USA, 2011.

Figure 1 shows the breakdown of planned and launched global CO_2 capture and sequestration projects by years. Figure 1 shows that the number of CO_2 projects rapidly increased in 2003. For the recent 10 years the increasing number of countries become involved in implementation of such projects, use new CO_2 capture technologies. Many organizations, governmental agencies, academies and institutes carry out R&D works aimed at studying CO_2 impact on the reservoir, well integrity, development of carbon dioxide capture and sequestration technologies, creation of highly efficient transmission methods as well as monitoring during the whole period of project implementation. The attention is paid not only to injection of CO_2, but also sour gas mixture (CO_2+H_2S).

Figure 2 shows the breakdown of CO_2 capture and sequestration projects by countries. Leaders of CO_2 capture and sequestration projects comprise Austria, the UK, Germany, Canada, the Netherlands, the USA. The majority of CO_2 projects are implemented by the USA that is actively involved in CO_2 capture and construction of new CHP or modification of existing ones.

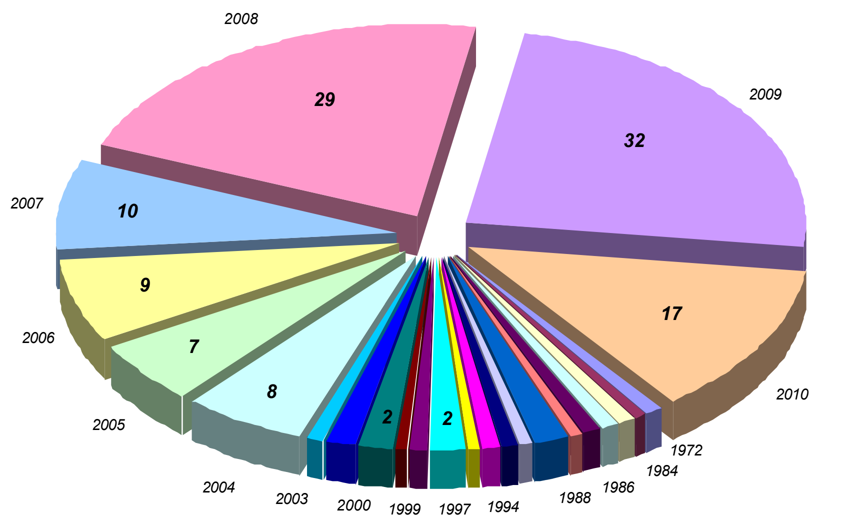

Figure 1 – Breakdown of global carbon capture and storage projects by years

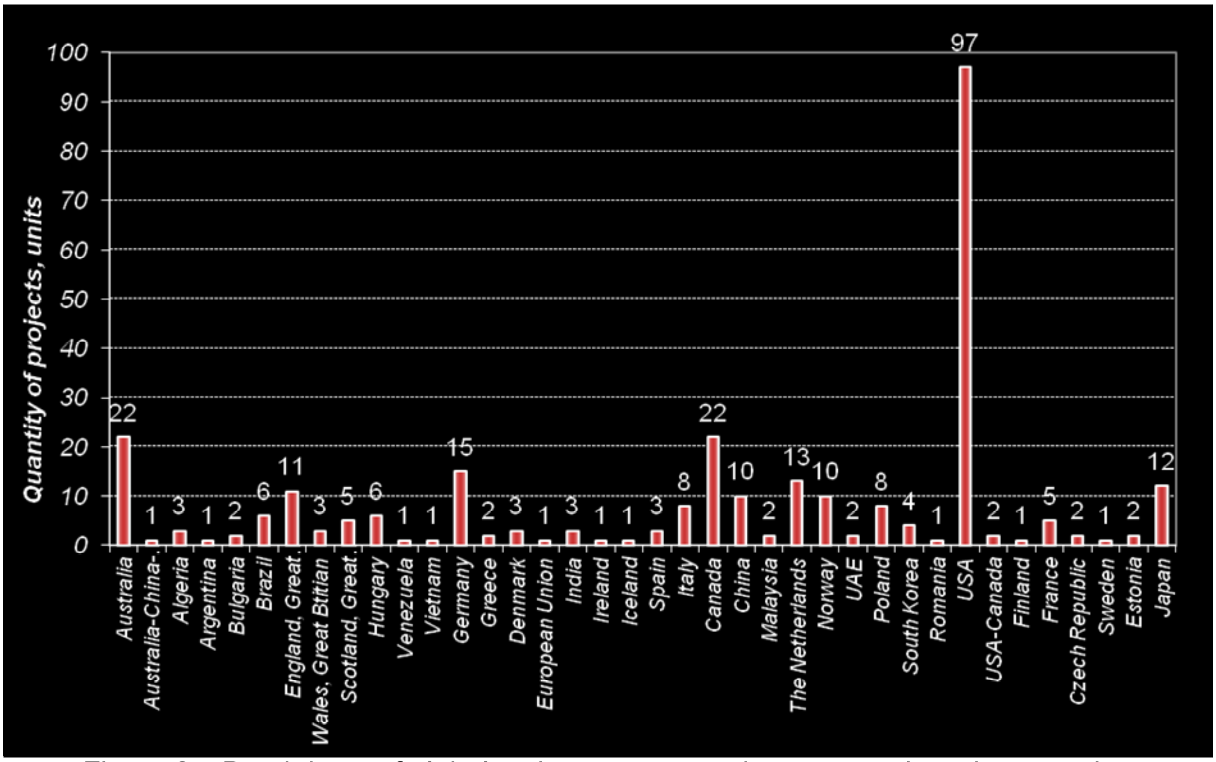

Figure 2 – Breakdown of global carbon capture and storage projects by countries

The analysis resulted in the following quantitative breakdown of projects by countries:

Europe:

- Bulgaria 2 projects;
- UK 19 projects;
- Hungary 5 projects;
- Germany 14 projects;
- Greece 2 projects;
- Denmark 3 projects;
- Ireland 1 project;
- Island 1 project;
- Spain 3 projects;
- Italy 7 projects;
- Netherlands 12 projects;
- Norway 10 projects;
-Poland 8 projects;
- Romania 1 project;
- Finland 1 project;
- France 5 projects;
- Check Republic 2 projects;
- Sweden 1 project;
- Estonia 2 projects.

Asia:

- Vietnam 1 project;
- India 3 projects;
- China 8 projects;
- Malaysia 2 projects;
- United Arab Emirates 1 project;
- Republic of Korea 4 projects;
- Japan 11 projects.

Australia:

- Australia 21 projects.

Africa:

- Algeria 2 projects.

South America:

- Argentine 1 project;
- Brazil 6 projects;
- Venezuela 1 project.

North America:

- Canada 21 projects;
- USA 94 projects.

All projects were analyzed by the following criteria:
- carbon dioxide source;
- storage type.

Sources of carbon dioxide emissions can be classified as follows:

– Industrial sector (mineral fertilizers production plants, steel works, alumina and cement plants, ammonia production plants, LNG plants, organic reagent production plants);

– Heat and power stations using the technology of CO_2 capture after fuel combustion (coal, gas);

– Heat and power stations using the technology of CO_2 capture before fuel combustion;

– Heat and power stations using the technology of CO_2 capture with oxygen fuel combustion.

Moreover, carbon dioxide is captured at gas processing plants and oil refineries or directly on fields where gas or oil with increased carbon dioxide content is produced. Carbon dioxide is separated from the main fluid and injected to under- or overlying formations.

As for the storage type, projects are divided as follows:

- the use of CO_2 for enhancing oil and gas recovery and coal methane production followed by its sequestration in the formation;
- the use of CO_2 for manufacturing a new product used in the commercial sector;
- sequestration in geological formations: depleted gas or oil fields; sandstone, carbonate or saline formation; basalt.

Figures 3 - 4 show the projects breakdown by carbon dioxide emission source and storage type.

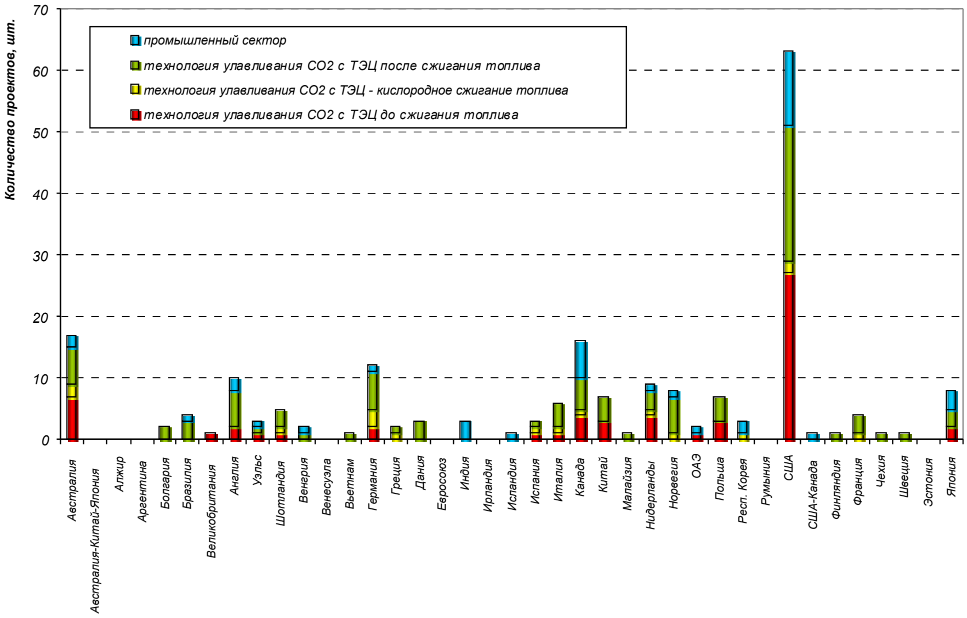

Figure 3 – Breakdown of carbon capture and storage projects by CO_2 emission sources

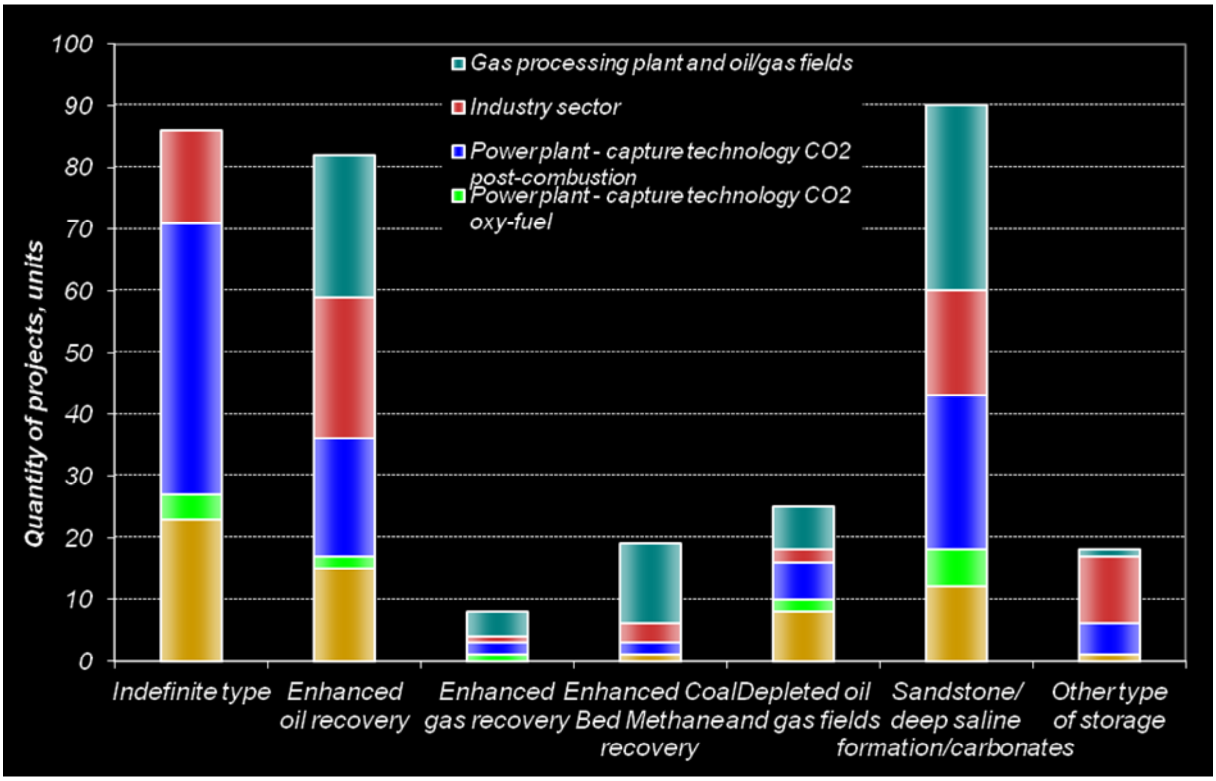

Figure 4 – Breakdown of carbon capture and storage projects by storage type

In the USA the main CO_2 emission source is CHP using the technology of CO_2 capture before fuel combustion, the so called integrated gasification combined cycle (IGCC). In case of other countries the main CO_2 emission source is CHP using the technology of CO_2 capture after main fuel combustion.

Table 1-2 shows examples of global projects breakdown by emission capture source and CO_2 storage/use type.

Table 1 – Global carbon dioxide capture and storage projects

Storage type / **Capture type**	Storage type is not determined	Coal methane production increase	Oil recovery improvement	Gas recovery improvement	Depleted oil / gas field	Sandstone / carbonate formation / aquifer	Basalt / other
Power plant-Coal post-combustion capture	CHP 480 MW 2,9 Mt/year Siekierki (**Vattenfall**) Poland, 2016	CHP 1200 MW from 2,8 to 5 Mt/year Cockenzie (**Scot. Power, Alstom**) UK, 2012-2014	2 CHP 600 MW 3 - 4 Mt/year Harbin power plant-Daqing Oil Field Project и RITE (**CNPC, Toyota**) China, 2009	CHP 250 MW 1,8 Mt/year Janschwalde (**Vattenfall**) Germany, 2015	CHP 400 MW 0,008 Mt/year Esbjerg Power Station-CASTOR (**ELSAM-Elsam Power**) Denmark, 2008	CHP 50 MW (total 419 MW) 0,003 Mt to sandstone + 0,01 Mt to carbonate formation Appalachian Basin-ECO2 R.E. Burger Plant (**MRCSP, Battelle Memorial Institute, First Energy, Powerspan**) USA, 2007-2009 (2 phase of MRCSP)	CHP 320 MW 0,073 Mt/year AES Shady point (**AES Corporation**) and application for freezing and cooling products, for food and drinks production USA, 1991
Power plant-Gas post-combustion capture	CHP 870-1500 MW 0,01 Mt/year with increase to 2 Mt/year Enecogen in Rotterdam (**ENECO, Dong Energy**) Netherlands, 2009-2011	CHP 100 MW 0,1 Mt/year Fairview ZeroCarbon Project (**CO2CRC, CSIRO**) Australia, 2009	CHP 860 MW 2,5 Mt/year Halten CO2 Project Draugen-Heidrun/Tjeldbergodden (**Shell, Statoil**) Norway, 2011			CHP 100-400 MW 0,56 Mt/year Hammerfest (**Hamm. Energy, Sargas, Siemens**) Norway, 2013	
Power plant-IGCC coal pre-combustion capture	CHP 253 MW 0,3 Mt/year Willem-Alexander Power Plant/Nuon Power Buggenum (**Nuon, Vattenfall**) Netherlands, 2010	CHP 300 MW 2 Mt/year Swan Hills ISCG/Sagitawah power project (**Swan Hills Synfuels**) Canada, 2015	CHP 500 MW 4-5 Mt/year BP Carson DF2 (**Hydrogen Energy**) USA, 2012		CHP 750 MW 1 Mt/year Dongguan Taiyangzhou IGCC plant (**Dongguan Taiyangzhou Power Corporation, Xinxing Group, Nanjing Harbin Turbine Co Ltd.**) China, 2015	CHP 600 MW 90% CO2 capture Southern California Edison IGCC Project (**Southern California Edison**) USA, 2008	CHP 914MW 65% of CO2 emission Wallula (**Wallula Resource Recovery LLC and Edison Mission Group**), *basalt* USA, 2013

Storage type / Capture type	Storage type is not determined	Coal methane production increase	Oil recovery improvement	Gas recovery improvement	Depleted oil / gas field	Sandstone / carbonate formation / aquifer	Basalt / other
Power plant-Oxy-fuel	CHP 50-70 MW volume n/a ZENG Risavika (**ZENG AS, Shell Technology Norway, Statoil, Norwegian government funding agency)** Norway, year n/a.	CHP 50-200-1200 MW 0,6-2,5-7,5 Mt/year SEQ Ijmond/Zero Emission Power Plant ZEPP (**SEQ Nederland B.V., ENECO, TU Delft**) Netherlands, 2009	CHP 300 MW 3 Mt/year SaskPower Clean Coal Shand power station (**SaskPower**) Canada, 2012		CHP 30 MW 3 Mt/year (total volume 87 Mt) Coolimba (**Aviva Corp.**) Australia, 2009	CHP 300 MW 2,75 Mt/year OXI-CFB300 - Compostilla EI Bierzo/Ciuden CCS Facility (**EDP, Endesa)** Spain, 2010 (injection in 2015)	
Industry sector (plants, factors)	Steel works 0,00073 Mt/year (to 1 Mt/year) POSCO CO2 (**Pohang Iron and Steel Co.**) Korea, 2010-2011	Ethanol production plant total 0,01 Mt CSEMP-Red Deer Area-Ardley Coal (**Suncor Energy, Alberta Research Council**) Canada, 2005-2006 (further - monitoring)	Mineral fertilizers production plant and other chemical plants 0,135 Mt/year Petrobras-Buracica field (**Petrobras**) Brazil, 1987	Oil refinery 0,35 Mt/year Danube refinery/Ulles EGR (**MOL**) Hungary, year n/a	Steel works 6 Mt/year Redcar, Scunthorpe, Port Talbot (**CORUS**) Uk, year n/a.	Synthetic fuel palnt 15 Mt/year Monash CTL (**Monarsh Energy, Shell, Anglo Coal Australia**) Australia, 2016	Mineral fertilizers production plant 0,06 Mt/year (returned to the process) Petronas fertilizer plant Kedah (**MHI Petronas fertilizer**) Malaysia, 1999

Light blue	CO_2 capture plant is constructed
Grey	Planned and designed projects
Olive green	Implemented projects
Bright green	Completed projects
Orange	Canceled projects
Yellow	Temporary suspended projects
Magenta	Programs and commercial projects

Table 2 – Global carbon dioxide capture and storage projects

Storage type / CO_2 source	Coal methane production increase	Oil recovery increase	Gas recovery increase	Depleted oil / gas field	Sandstone / carbonate formation / aquifer	Basalt / other
Oil/gas and gas processing plants	Total 870 t JCOAL Yubari/Ishikari (**KANSO, MHI**) Japan, 2002-2007	Total 3 884 Mt Budafa and Lovászi field (**MOL**) Hungary, 1972-1996	0,02 - 0,5 Mt/year K12-B CRUST (**GDF SUEZ Netherland**) Netherlands, 2004	Boiler 30 MW 0,075 Mt/year (total 0,15 Mt - 2 years) Lacq (**Total, Air Liquide, IFP, BRGM, Alstom**) France, 2009	3 Mt/year (together with LNG plant) Bintulu CCS Project (**MHI, JGC Petronas**) Malaysia, 2011	
Other /CO2 natural field	Total 0,001 Mt Black Warrior Basin (**SECARB**) USA, 2009	0,14 Mt/year Paradox Basin-Aneth oil field test (**SWP**) USA, 2007	Total 30 Mt Budafa Szinfeletti Field (**MOL, ERDGAS, Kohle**) Hungary, 1985-1996	0,065 Mt Otway Stage 1 (**CO2CRC**) Australia, 2008-2009 (monitoring in progress)	0,45 Mt/year TOUAT/Hassi Ilatou (GDF Suez, Sonatrach) Algeria, 2013	SUGAR project (**IFM-GEOMAR, BMWi, GFZ Helmholtz-Zentrum Potsdam, BASF, Linde, Wintershall, RWE, EON Ruhrgas AG, Marum**) storage in gas hydrates Germany, 2008-2011, 1 phase
Commercial projects and programs	*Commercial project* volume n/a. CO2-ECBM (**Asia Pacific Partnership: CSIRO-JCOAL**) Australia-Japan-China, 2011			0,2 Mt/year PICOREF (**Gaz de France, Air Liquide, Alstom, Total и др.**) France, 2005 (studies with further CO2 injection in 2015)	*Commercial projects* (38 plants, different industrial sources of CO2) 0,4 - 4 Mt/year Alberta Saline Aquifer Project (ASAP) (**EPCOR, Enbridge**) Canada, 2010-2015	

- CO_2 capture plant is constructed
- Cancelled projects
- Completed projects
- Planned and designed projects
- Temporarily suspended projects
- Implemented projects
- Programs and commercial projects

Setting up a data base requires not only the general information on the capture project:

- country, location;
- company in charge;
- project cost;
- emission source;
- CHP or plant capacity;
- initial feedstock;
- capture type;
- capture technology;
- transmission to the injection location;
- distance from the source to the injection location;
- storage type;
- volume of injected carbon dioxide;
- date of project launch and completion;-
- project status;
- project type,

But also information on geology and hydro-geology of the formation where the carbon dioxide (or gas mixture) will be stored:

- temperature, pressure;
- formation depth, thickness (general and effective);
- formation mineralogy;
- porosity, permeability (minimum, maximum, average);
- cap lythology, thickness;
- mineralization, saturation and pH of formation water;
- monitoring types.

Geological properties determine the criteria for the selection of reservoirs for long-term and safe storage of carbon dioxide.

Tables 3 – 5 provide examples of general, geological and hydro-geological information on CO_2 projects from the data base on global projects.

Table 3 – General data on global CO_2 projects

Project name	General information							
	Country	Location	Company-organizer	Project cost, US $	Date of project launch	Date of project completion	Project type	Project status
Appalachian Basin-R.E. Burger Plant 1	USA	Ohio, Shadyside	MRCSP Battelle Memorial Institute First Energy Powerspan	27 490 564,00	2007	2009	Carbon dioxide capture and sequestration	Pilot
Large-volume Sequestration Test-Decatur/ADM Ethanol Facility	USA	Illinois, Decatur	MGSC Archer Daniels Midland Company	612 000 000,00	2012			
Lacq	France	Lacq	Total Air Liquide IFP BRGM Alstom	73 834 200,00	2009	2011	Carbon dioxide capture and sequestration	
Karsto	Norway	Rogaland, Karsto	Naturkraft	243 813 000,00	2009			
Zama Link	Canada	Alberta, Zama	PCOR Partership	26 059 889,00	2006			
CO2STORE Asnæs power station-Kalundborg	Denmark	Kalundborg	Dong Energy		2016			
Altmark	Germany	Salzwedel	Gaz de France Erdgas Erdol		2008			

Table 4 – General data on CO_2 capture source, transmission and sequestration

Project name	**General information on CO_2 capture facility**											
	CO_2 source	Min. capacity of CHP, MW	Max. capacity of CHP, MW	Fuel type	Capture type	Capture technology	Transmission	Distance from the CO_2 source to injection location, km	Storage type	Injected gas	Volume of injected gas, Mt/year	Total volume of injected gas, Mt
Appalachian Basin-R.E. Burger Plant 1	CHP	50	419	coal	Post-combustion	Absorption treatment – water solution of ammonium carbonate	Tank trunk	0,7	Sequestration	CO_2	0,003	
Large-volume Sequestration Test-Decatur/ADM Ethanol Facility	Ethanol production plant						Pipeline		Sequestration	CO_2	1,1	
Lacq	Gas processing plant Boiler		30	gas	Oxy-fuel		Pipeline	27	Sequestration in Rouss depleted gas field	CO_2 O2 Ar N2	0,075	0,15
Karsto	CHP	420		gas	Post-combustion	Absorption treatment – mono-ethanolamine	Pipeline	250	Sequestration	CO_2	1,2	
Zama Link	Enhanced CO_2 and H_2S content in hydrocarbons Gas processing plant						Pipeline	170	Oil recovery increase	CO_2 H_2S	0,067	
CO2STORE Asnæs power station-Kalundborg	CHP		600		Post-combustion				Sequestration		3,4	
Altmark	CHP	30		coal	Oxy-fuel		Tank trunk	350	Gas recovery increase of Altmark gas field	CO_2 N_2 CH_4	0,01	0,1

Table 5 – Information on formation and formation water of CO_2 global projects

Project name	Geological, hydro-geological properties of storage													
	Reservoir for CO_2 storage	Formation lythology	Depth, m	Total thickness, m	Net pay, m	Min. and max. porosity (aver), %	Min. and max. permeability (aver), mD	Formation cap lythology	Formation cap thickness, m	Capture mechanism	Formation water mineralization, mg/l/type of formation water	T,C	P, MPa	Monitoring methods
Appalachian Basin-R.E. Burger Plant 1	Appalachian basin Oriskany formation Tuscarora/Clinton formation	 Sandstone Sandstone	 1798 2500	 762 64	 46 28	 3 – 20 (10) 3 – 11 (5)	 2,2 – 60 (27) 0,2 – 40 (3)	 Clay shales of Middle Devonian Marcellus formation and limestone of Onondaga formation Clay shales and limestone of Antes, Utica, Rose Hill formations	 152		 250 000	 80		Cross-well shear seismic survey, well microseismic survey, tracer monitoring (PFC tracer), logging diagram with wireline equipment, liquid saturation profile identification, analysis of formation water, P-T monitoring
Large-volume Sequestration Test-Decatur/ADM Ethanol Facility	Salinized Mount Simon Sandstone formation	Sandstone	2100	> 200	30 - 60	8 – 18 (13,4)	(234)	Crystalline dolomites, sandstone dolomites, argillites, clay shales, mudded sandstone of Eau Claire formation			Chloride - natrium	35 - 50	16 - 20	2D and 3D seismic monitoring Temperature and pressure monitoring Water monitoring

Project name	Geological, hydro-geological properties of storage													
	Reservoir for CO_2 storage	Formation lythology	Depth, m	Total thickness, m	Net pay, m	Min. and max. porosity (aver), %	Min. and max. permeability (aver), mD	Formation cap lythology	Formation cap thickness, m	Capture mechanism	Formation water mineralization, mg/l/type of formation water	T,C	P, MPa	Monitoring methods
Lacq	Mano depleted gas formation	Fractured dolomite	4500	121	70	3 – 20 (6)	0,1 (1)	clay marl	2000			150	3 (initial 48)	CO2 injection monitoring Microseismic monitoring of formation and cap Gas leak monitoring
Karsto	Salinized Utsira aquifer	Sandstone	800-940	300		27 – 42	2000	Shale, silty grey clay Shale Drape	50 - 100	Hydrodynamic and carbonization of formation minerals	Chloride-natrium			
Zama Link	Salinized Keg River pinnacle reef aquifer Cardium formation	Dolomites	1500	343	120	(10)	10 - 1000	Muskeg/Prairie anhydrites	70			71	15	Geochemical pressure monitoring, tracer monitoring, isotope and ion chemistry monitoring
CO2STORE Asnæs power station-Kalundborg	Danish basin, Havnso structure, Gassum formation	Sandstone	1460	150	100	36 (25)	2000 (500)	Argillites of Fjerritslev formation	500	Stratigraphic		50	15	
Altmark	Salzwedel-Peckensen depleted gas formation	Sandstone	3150 - 3700	226		4 – 28 (8)	10 – 100 (30)	Halite of Zechstein formation	> 300		357 000/calcium-magnesium	120	20	

The analysis of pressure and temperature properties of projects shows that CO_2 is in liquid or supercritical state. Depth of formations designed for CO_2 sequestration and use varies from 600 to 4500 m. Studies of carbon dioxide long-term storage in underground storages shows the level of efficiency, safety and cost of this method. Carbon dioxide long-term underground storages are considered and constructed as one of promising and actively developing areas.

Works performed in this area and project implementation will in future result in the development of legislative documents regulating emission reduction for a specific region or area using new technologies of industrious gaseous emissions capture and treatment, selection of geological sites for carbon dioxide injection for the purpose of long-term and safe storage.

Summary

Several countries have started to assess and document (develop a regulatory base) potential and efficient locations for CO_2 sequestration. It is very important but even more important is improving the assessment and identifying all options of CO_2 storages.

The achievement of significant national and international GHG emission stabilization targets will require international cooperation on CO_2 capture and sequestration.

The number of CO_2 projects grows all over the world and new projects appear every day. Many countries have largely invested into CO_2 project studies, development and initial construction, including assessment of potential CO_2 storages. This analysis is a review of CO_2 projects developed and implemented worldwide. Project information is often updated, including legislative regulation, R&D, comprehensive geological and geochemical analysis of formation, dates of project launch, etc.

First of all, project implementation requires identification of connection between CO_2 emission source and injection location. All projects include thorough analysis of potential locations for CO_2 storages, large scope of experiments, studies and calculations of the mechanism of CO_2 capture in a geological structure, physical and chemical processes in the reservoir and risk assessment. The final stage of the project is development of CO_2 transmission infrastructure. The experience obtained by carrying out numerous CO_2 projects and studies will allow to run such a project in Russia and take part in international projects. Today the Russian Federation is involved in development of collective measures of the global community aimed at mitigation of man-caused climatic impact and assists developing countries in implementation of measures aimed at adjustment and mitigation of the negative impact of climate change together with other CO_2 project countries.

Thus, the analytical material gathered and systematized for all global CO_2 projects is an analytical document that can be the basis for rational and efficient selection of potential locations for CO_2 long-term storages and implementation of promising, advanced and safe for subsurface CO_2 capture, transmission, injection and storage technologies.