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Setting Up Electronic Data Bases Of Global CO_2 Sequestration Projects

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CO2 Capture, Transport And Sequestration

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CO_2 capture is the important part of the energy strategy

- The application of innovative pure technologies in the power industry will reduce carbon dioxide emissions.
- 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.
- Setting up long-term underground carbon dioxide storages is considered and realized 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.

CO_2 capture is the important part of the energy strategy

- All international efforts were united and as a result several dozens of projects have been developed and successfully implemented for over 15 years.
- In July 2009 the G8 Summit identified and set criteria for launching 20 CO_2 projects.
- 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.

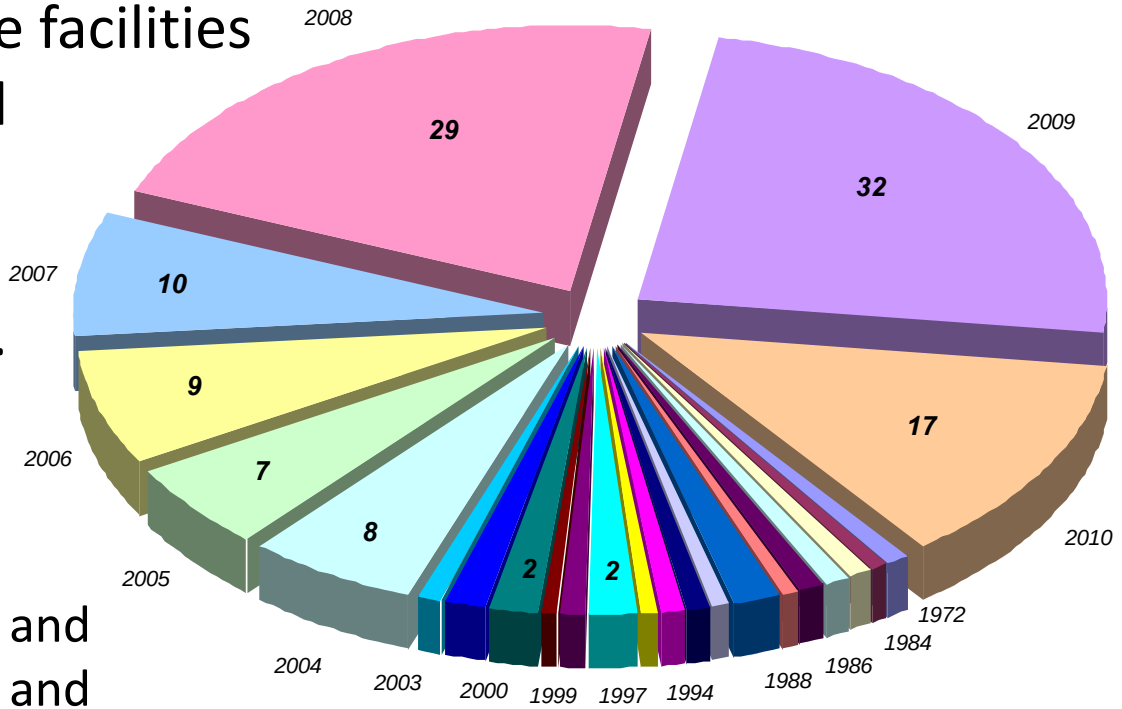
Objectives of setting up electronic CO_2 database

- The analysis of global projects on CO_2 capture and sequestration will allow to unite them into a database that can be modified and adjusted depending on the project development .
- 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.
- It will be an essential document for such major CO_2 organizations as IEA, CSLF and Global CCS Institute.

Growth of CO_2 projects

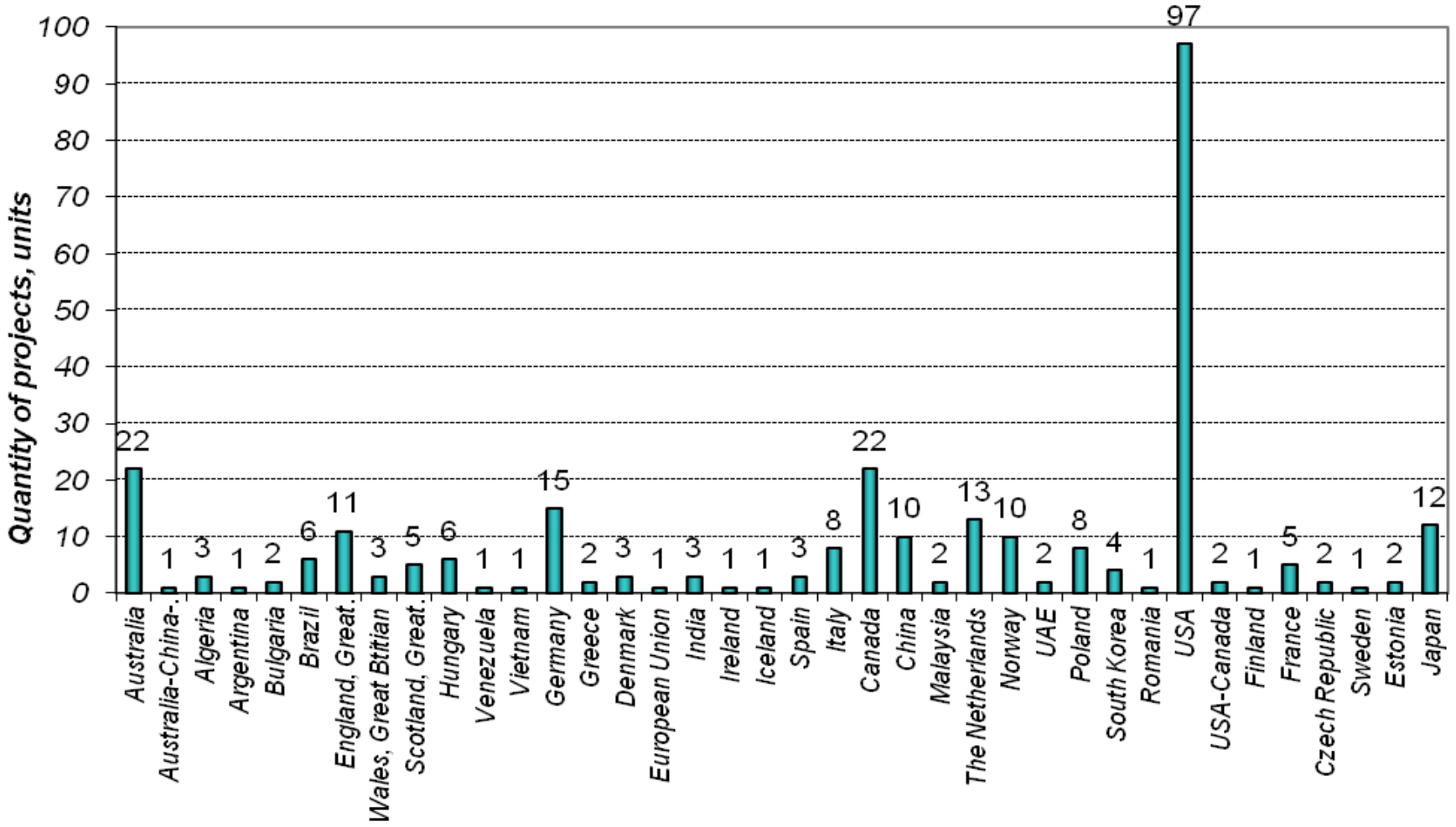
For the last two years from 2009 to 2011 the number of CO_2 projects has increased on 68 projects. Today the total number of CO_2 projects amounts to 328. They comprise:

- 259 active or planned projects
- 23 projects CO_2 capture facilities have been constructed
- 15 cancelled and suspended projects
- 31 completed projects.

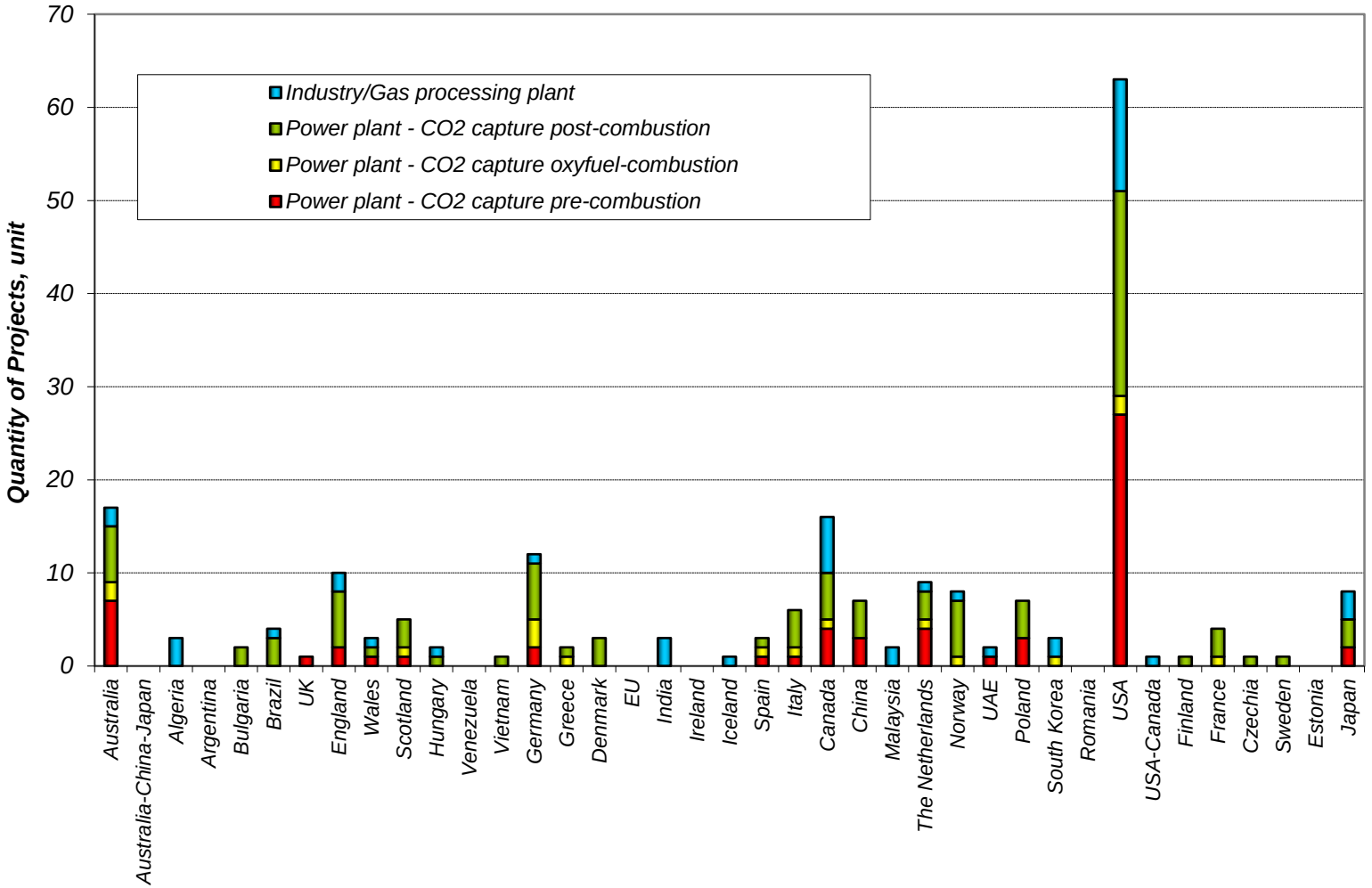


The breakdown of planned and launched global CO_2 capture and sequestration projects by years

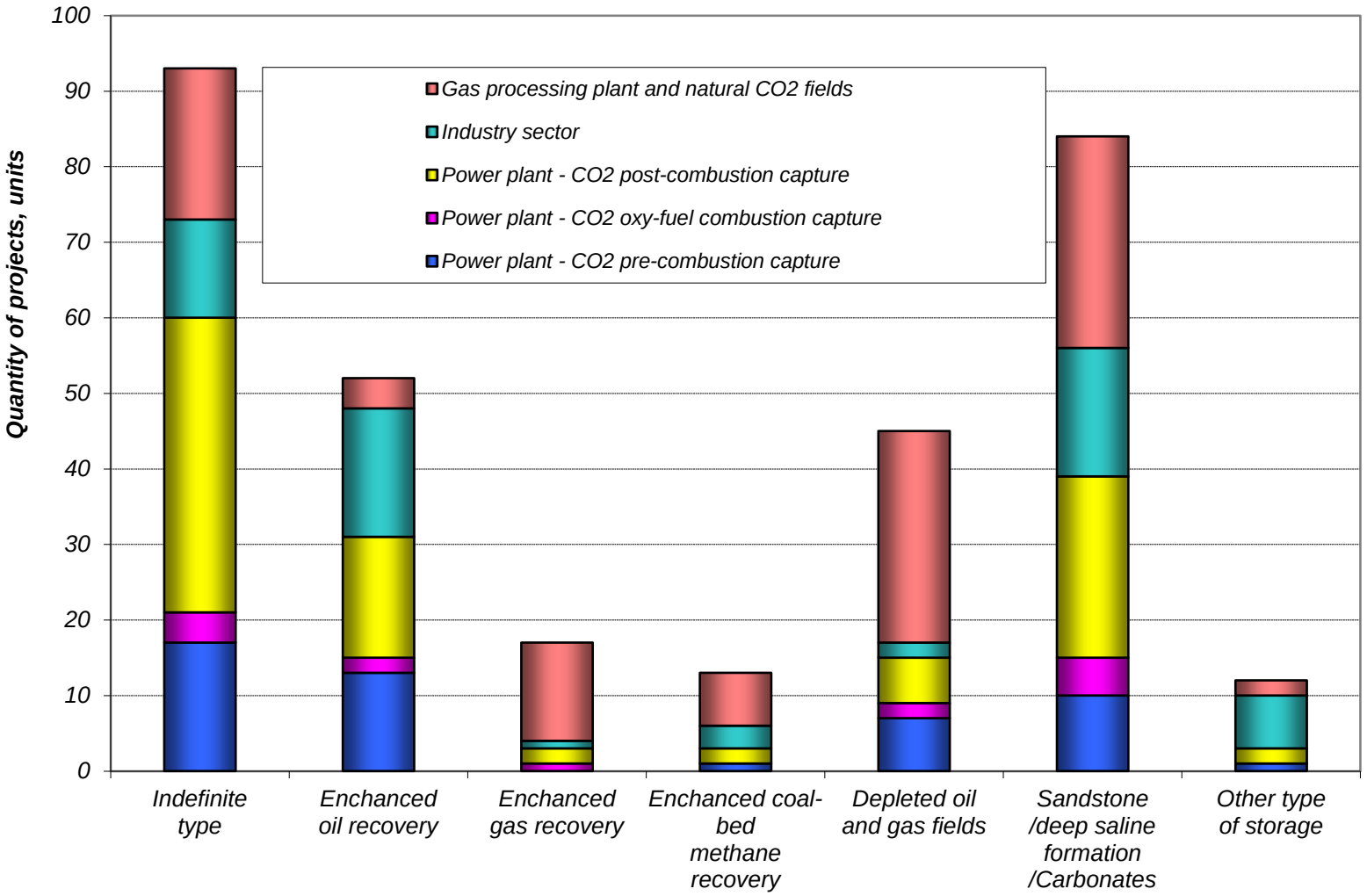
Distribution of CO_2 capture and sequestration projects by countries



Distribution of carbon capture and storage projects by CO_2 emission source



Distribution of CO_2 emission sources by types of storage



Structure of CO_2 projects distribution

Storage type / Capture type	Not determined	ECMR	EOR	EGR	Depleted oil / gas field	Sandstone / carbonate formation / aquifer	Basalt / other
PP-coal post-combustion					Canceled projects		
PP-gas post-combustion			Implemented projects				
PP-IGCC pre-combustion		CO_2 capture plant is constructed		Planned and designed projects		Programs and commercial projects	
PP-Oxy-fuel	Temporary suspended projects						
Industry sector							Completed projects
Oil/gas processing plants			Implemented projects				
Other/CO_2 natural fields	Completed projects						

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 (**EL-SAM-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
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 El 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

CO_2 capture plant is constructed

Planned and designed projects

Implemented projects

Completed projects

Canceled projects

Temporary suspended projects

Programs and commercial projects

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 CO_2 database

General information on the capture:

- country, location;
- key companies;
- project cost;
- emission source;
- CHP or plant capacity;
- initial feedstock;
- capture type;
- capture technology.

General information on the transport and storage:

- transmission to the injection location;
- distance from the source to the injection location;
- storage type;
- type, concentration and volume of injected gas or gas mixture;
- date of project launch and completion;
- project status;
- project type

Geological and hydro-geological information of formation storage:

- temperature, pressure;
- formation depth, thickness (general and effective);
- formation lithology and mineralogy;
- porosity, permeability (minimum, maximum, average);
- cap lithology and thickness;
- CO_2 capture mechanism in formation;
- type of formation water;
- density, mineralization, saturation and pH of formation water;
- monitoring types.

CO_2 projects database

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			

CO_2 projects database

Project name	General information on CO_2 capture facility and transport											
	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

CO_2 projects database

Project name	Geological, hydro-geological properties of storage													
	Reservoir for CO_2 storage	Formation lithology	Depth, m	Total thickness, m	Net pay, m	Min. and max. porosity (aver), %	Min. and max. permeability (aver), mD	Formation cap lithology	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
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	

Summary

- Several countries have started to assess and document (develop a regulatory base) potential and efficient locations for CO_2 sequestration.
- The analytical material gathered and systematized for all global CO_2 projects 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 technologies.
- Gazprom JSC and Gazprom VNIIGAZ Ltd 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.

THANK YOU