

# Annex 1 – Tables of CCS Projects

## TABLE 1: CCS PROJECTS IN CANADA AND USA

Project name	Main focus	Operator / partners	Cost/funding CAD\$/US\$	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
The International Test Centre for CO2 Capture (ITC)	Chemical absorption technology. Two facilities. CO2 flooding for EOR.	University of Regina. Many public and industrial partners.	A \$5.2 and a \$3.3 million demonstration plants.	Coal fired plant and gas powered plants. Absorption by MEA and mixed-amine (MEA-MDEA) solvents.	1,500 (nominal)	ton/year	N/A	Ongoing research.
Weyburn-Midale CO2 project	Injection and storage.	EnCana, Apache, Dakota Gas., SaskPower, RITE (Japan), Chevron. Gov. inst.	\$640 million.	Dakota Gasification coal-gasification plants.	7,000 (EnCana) and 1,800 (Apace). 3,2 million ton/yr (nominal) – 20 million over project lifetime.	ton/day and ton/day	Transport from various sources as far as Dakota (320 km). Depleted oil fields on land.	Phase 1: 2000-2004 Final phase: until 2009
Pembina Enhanced Recovery Project	EOR	Penn West	\$200 – 250 million.				150 km, into oil field for EOR.	
Clean coal project	Capture technology, oxyfuel. EOR.	SaskPower, Babcock&Wilcox, Air Liquide.	\$1.5 million (entire power plant)	300 MW lignite power plant.	8,000 ton/day.		EOR.	Start-up mid 2007. In-service 2011. On hold for now.
BP Carson Project	Pre-Combustion Capture CO2-EOR	BP Edison Mission Group	\$1 billion	convert petroleum coke from refineries into hydrogen and CO2	4 million ton/year		EOR	July 2006 - Engineering feasibility studies completed December 2007 - Front-end engineering and design completed 2009 - Approval of \$1 billion capital investment 2011 -opening
FutureGen	Zero-emission coal power plant. Capture and storage.	12 alliance members from US (8 members), Australia (2), China and UK	\$1 billion	275 MW coal power plant. Coal gasification, pre-combustion capture.			Deep saline formations. Site not determined yet.	2007: selecting site 2009: facility constructs. 2012: plant operation



KBR project	Clean coal, IGCC	KBR, Southern Company, DOE		285 MW	-	-	Operation 2010
Ahlstrom and AEP	Post-combustion. Chilled ammonia. EOR.	Ahlstrom, AEP	-	Phase 1 30MWth, phase 2 200 MW coal.	Phase 1: 100 k ton Phase 2: 1.5 Mton	-	Phase 1: 2008 Phase 2: 2011
Project Pioneer	Post-combustion, retrofit of coal plant	Transalta, Alstrom			1 million ton/years		2012

**TABLE 3: CCS PROJECTS IN GERMANY**

Project name	Main focus	Operator / partners	Cost/funding €	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
Vattenfall "Schwarze Pumpe"	Oxyfuel capture and storage	Vattenfall. Linde AG, Alstom, Siemens, Babcock, univ.	60 million	30 MWt Oxyfuel lignite. Demo: 300 MW Fullscale 1000 MW	75,000 ton/yr		Truck to Altmark gas field (350 km)	Construction start 2006 Inaugurated sep. 2008. Demo scale 2012-15 Full scale 2015-2020
Vattenfall Janschwalde	Oxyfuel and post-combustion	Vattenfall	1 billion	500MW lignite. One boiler oxyfuel, one post combustion				Feasibility Feb. 2008 Project start 2010-11 Operation 2015
RWE IGCC project	IGCC and storage	RWE Dea	1,7 billion	450 MW IGCC lignite	2.6 million ton/yr		Pipeline to North Germany	Project start 2005 Operation 2014
RWE post-combustion	Post combustion	RWE, BASF, Linde	9 million	Lignite				Started July 2009
EON Capture project	Post-combustion	EON, Siemens	10 million	400-800 coal power plant				Construction 2010-14
CO2 SINK	Aquifer injection	GeoForschungs Zentrum Potsdam, 18 institutions. Linde AG	Cost: 14 million Funding: 8.7 million	Commercial CO2	60,000 ton/ 2 years		Saline aquifer	Project start 2004 Drilling 2007-08 Injection start Mar. 2008
EGR in Altmark	Enhanced Recovery	Gas Erdgas Erdol, Gaz de France					Exhausted gas field	2008-2010

**TABLE 4.1: CCS PROJECTS IN UK – POST-COMBUSTION**

Project name	Main focus	Operator / partners	Cost/funding	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
E.ON UK – Kingsnorth post-combustion	Post-combustion capture, supercritical coal.	E.ON, Arup, EPRI, Fluor, MHI, Penspen, Tullow Oil.	1 billion GBP (power plants)	2x800 MWe supercritical coal power plants.	2 million ton/year.		Considered later stage.	Planned operation from 2012. Joins the “CCS competition”
RWE npower – Tilbury post-combustion	Post-combustion capture supercritical coal.	RWE npower	1 billion GBP	1000 MW	-		Under study.	Study ongoing. Plant start-up 2013.
Scottish & Southern Energy-Ferrybridge post-combustion	Clean coal project. Supercritical coal. CCS later stage.	Scottish & Southern Power, Mitsui Babcock, Siemens, UK Coal	250 million GBP for power plant 100 million GBP for CCS.	500 MW supercritical coal power plant	For CCS: 1.7 million ton/yr		Under study	Feasibility study completed 2007. Plant online 2011/2012. CCS not determined.
RWE npower – Blyth post-combustion	Super-critical coal	RWE npower	2 billion GBP	2400 MW “cleaner coal”	-		-	Operational 2014
Scottish Power - Longannet and Cockkenzie post-combustion	Conversion to clean coal technology. Supercritical.	Scottish Power, Aker Clean Carbon, Marathon Oil, Alstom, Doosan Babcock		3390 MW	-		-	Construction 2009, operation 2012
RWE npower – Aberthaw post-combustion	Post-combustion, coal demo	RWE npower, BOC, Cansolv, IM Skaugen, Shaw, Tullow	8,4 million GBP for demonstrator	3 MW demo initially, increasing to 100 MW	-		-	Initial demo operational by 2010.
RWE npower – Hunterston post-combustion	Post-combustion, supercritical coal	RWE npower, Peel holdings, Dong energy		400 MW				Operational by 2014

**TABLE 4.2: CCS PROJECTS IN UK – PRE-COMBUSTION**

Project name	Main focus	Operator / partners	Cost/funding	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
Powerfuel - Hatfield Colliery pre-combustion	IGCC. CCS with EOR later stage.	Powerfuel and KRU (Russia)	1 billion GBP for plant.	900 MW IGCC coal plant.			Transport to Brent, EOR	Reopen of coal seam 2007. Power plant start-up unclear.
Progressive Energy - Teesside pre-combustion	IGCC. CCS later stage.	Coastal Energy, COOTS Ltd.	7,2 million GBP	800 MW IGCC coal plant.			Transport, EOR.	Start 2009, start-up 2012.
ConocoPhillips - Immingham pre-combustion	Pre-combustion. CHP	ConocoPhillips	210 million GBP	1180 MWe pet coke, coal.	7.5 million ton/yr		Transport, deposit in North Sea.	Start summer 2009.
<i>E. ON UK - Killingholme post-combustion</i>	Clean coal, capture and storage. IGCC + CCS	E. ON Ruhrgas UK	1 billion GBP (Power plant)	450 MW coal.	-		Transport, deposit in North Sea.	FEED study completed May 2008. Start from 2011.
Valleys Energy, Onllwyn	IGCC	Valley Energy,	2,5 million GBP	450 MW IGCC	2,45 million ton/yr		135 km in north sea.	

**TABLE 5: CCS PROJECTS IN FRANCE AND ITALY**

Project name	Main focus	Operator / partners	Cost/funding €	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
France: Total's project in Lacq	Capture and sequestration.	Total, Air Liquide, IFP, BRGM	60 million	Oxy-fuel gas power plant.	150,000 years.	ton / 2	30 km into depleted gas field at 4,500 meters.	Project launch Feb. 8, 2007. Injection Nov. 2008.
France: PICOREF	Storage in permeable reservoirs.	Ministry of Industry, French companies, research inst.	3,75 million (2005)					Started 2005 – two year project. Following a 4 year study.
France: The CRUST project : K12-B CO2 re-injection	Re-injection. Part of a larger dutch project (CRUST).	Gaz du France Netherland.		Separation from natural gas on offshore platform.			Transport to shore, re-inject into sandstone reservoir at 3,800 m.	Main project (CRUST) in Holland started 2002.
Italy: Enel CCS1	Capture and storage	Enel (Italy), Inst. Of Geology and Vulcanology		660 MW pulverized coal plant. Absorption.	Pilot: 2 ton/hr Demo: 1,5 ton/yr	mill.	Underground reservoir.	Pilot operation 2009. Demo operation 2012
Italy: Enel CCS2	Capture, oxy-fuel	Enel, ENEA and ITEA		Coal combustor demo	N/A		Underground reservoir	Plant design 2009, demo in 2012

**TABLE 6: CCS PROJECTS IN NETHERLANDS**

Project name	Main focus	Operator / partners	Cost/funding €	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
The CRUST project	Storage	Gas de France Netherland, The Netherlands Ministry of Economic Affairs, TNO-NITG	N/A	Natural gas. Amine absorption	Pilot 20,000 ton/yr, Full-scale 480,000 ton/yr.	480,000	Reinjection in gas reservoir	Injection since 2004.
Enecogen project	Post-combustion capture	Eneco, International Power	37 million	Gas power plant, cryogenic separation	Pilot: 10,000 ton/yr Full-scale: 2 million ton / yr		Not clarified	Pilot from 2009, Full-scale not clarified.
Nuon Magnum	Pre-combustion, IGCC	Nuon	40 million (pilot)	Multi-fuel (gas, coal, bio fuel). 1,400 MW				Pilot 2008, Magnum 2012
ZEPP	Oxy-fuel	SEQ Nederland BV, ENECO Milieu BV, TU Delft, Stichting Energy Valley initiative	60 million	Gas, oxyfuel 50MWe	250,000 ton/yr		EGR (Enhanced Gas Recovery)	Pilot end of 2009

**TABLE 7.1: CCS PROJECTS IN JAPAN**

Project	Type	Operator / partners	Cost/funding US\$	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
Nagaoka injection project	CO2 Storage	RITE, NEDO	59 million Funding from METI	Commercial CO2	10,400 ton over project lifetime		Saline aquifer @ 1100 meters	COMPLETED
JCOP project	Storage	KANSO, MHI, RITE, KEPCO, universities	30 million Funding from METI	Captured CO2 from methane gas from coal seams	115 ton (2005)		Coal seams	COMPLETED
JAPEX project	Storage	JOGMEC	Large Funding from METI	Commercial CO2	100,000 ton/yr.		Offshore aquifer	2009- 2016
Ocean sequestration projects	Ocean sequestration	RITE, NEDO Number of partners	30-40 million 2007-2012: 2.5 million Funding from METI	Commercial CO2	small		Deep ocean	1997-2007 2007-2012 (proposed)
Nanko Pilot Plant	R&D of solvents	MHI, KEPCO	Unknown	Flue gas from natural gas power plant	2 ton/day		N/A	Operation since April 1991
Kurosaki Plant	Chemical Capture	KEPCO, MHI	Unknown	Natural gas/heavy oil boiler	Max 330 ton/day			Start-up Oct. 2005
Matsushima Power plant	Coal Capture	MHI, JPOWER RITE	Unknown	Flue gas from coal power plant	10 ton/day		N/A	Operation since July 2006
Sumitomo capture	CO2 Capture	Sumitomo Chemical plants, MHI, Fluor	Unknown	Flue gas from natural gas/oil boiler.	~60,000 ton/yr (nominal)		CO2 for commercial sale	Operation since 1994.
Nippon Steel	Capture	Nippon Steel, MHI, RITE, KEPCO	Unknown	Steel production	20 ton/day		Reused in process	Project 2004-2008
EAGLE Project	Capture, gasification	coal NEDO, J-Power	Unknown	Coal gasification	N/A		N/A	2007-2009 program.
Toshiba Mikawa	Capture, combustion	post Sigma Power, Toshiba Corp.	Unknown	Coal, 45 MW	10 ton/day		N/A	Start summer 2009.

**TABLE 7.2: INTERNATIONAL CCS PROJECTS WITH JAPANESE PARTICIPATION**

Project name	Main focus	Operator / partners	Cost/funding US\$	Gas source & capture process	Amount handled CO2	Transport and storage	Time schedule
CS Energy: Oxy-firing demonstration and carbon sequestration project (Australia) (Callide)	Stage 1: Oxy-fuel demo (retrofit of existing plant) Stage 2: transport & storage	CS Energy, Mitsui, JPower and IHI (Japan); ACALET, Xstrata Coal, Schlumberger.	Total A\$206 million. Mix public/private funding, including Japanese. A\$50 million from LETDF.	30 MW(e) black coal. Oxy-fuel pulverized-coal technology.	17,000 ton/year for up to 3 years.	350 km (land). Geological storage (site undecided)	Construction of Oxy-fuel plant late 2008. Operation from end 2010. Transport/storage from 2011.
Yantai IGCC (China)	IGCC	5 Chinese comp. EU and Japanese partners.	US\$ 420 million.	Coal gasification.	N/A	N/A	N/A
Daiquin Oil Field project (China)	Transport and storage.	China Nat. Petro. Corp., RITE (Japan), Toyota Motors, JGC Corp (Jp)	US\$ 200-300 million.	Existing coal power plants (capture not included in project)	1-3 million ton/yr. Total capacity 150 million ton	EOR, Daiqing oil field.	Announced May 2008
White Tiger CCS project (Vietnam)	Capture and storage	MHI, Marubeni Vietsovpetro	Unknown	Combined cycle natural gas	4.6 Mton/yr (phase 1) 7.4 Mton/yr (phase 2)	144 km Active oil field	Start-up 2010
Bintulu CCS project (Malaysia)	Capture and storage	MHI, JGC Petronas	Unknown	Natural gas from LNG plant.	3 million ton/yr	120 km Sub-sea saline aquifer.	Start-up 2011
Malaysia CO2 capture project	CO2 capture/recovery	MHI Petronas Fertilizer	Unknown	Flue gas of steam reformer/ammonia plant	~60,000 ton/yr (nominal)	CO2 recycled in process	Operation since Oct. 1999
India CO2 capture project	CO2 capture/recovery	MHI India F. Fertilizer	Unknown	Steam reformer flue gas	~330,000 ton/yr (nominal)	Urea synthesis	Operation started Dec. 2006
Abu Dhabi CO2 capture project	CO2 capture/recovery	MHI Ruwais Fertilizer	Unknown	Steam reformer flue gas	~150,000 ton/yr (nominal)	Urea synthesis	Start-up 2008

**TABLE 8.1: CAPTURE ONLY PROJECTS IN AUSTRALIA**

Project name	Main focus	Operator / partners	Cost/funding Aus. \$	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
HRL IDGCC project	IGCC pre combustion capture	HRL Developm. Harbin Power Engineering, CO2CRC	Total 750 million. 100 million from LETDF, 50 million from ETIS	IGCC: 400MW brown coal. Precombustion capture	Reduce 40% of emissions	of	Not specified	Under negotiation: commence construction of plant 2007, complete 2009
Hazelwood PCC	Post combustion capture and sequestration.	International Power, Alstom, RWE, Process Group, CO2CRC	Total 369 million. 50 million from LETDF and 30 million from Victoria Govt.	Post-combustion capture of 200 MW brown coal power plant.	10,000-20,000 ton/yr.		CO2 utilized for ash water treatment and sequestered as CaCO3.	Start-up early 2007. Completed end of 2009. CO2 capture operational 2008.
Munmorah PCC	Post-combustion capture (chilled ammonia)	Delta Electricity, CSIRO and ACA.	A\$5 million. Phase 2: A\$150 mill.	Coal power station.	3,000 ton/yr, increasing to 100,000 ton		N/A	Commissioning Jul 2008 Pilot phase Feb. 2009. Large scale from 2011
Loy Yang PCC	Post-combustion capture.	Loy Yang Power, CO2CRC, CSIRO, Process Group.	A\$5 million.	Post-combustion capture of brown coal power plant.	1,000 ton/yr.		N/A	Capture started August 2008
Tarong Energy PCC	Post-combustion capture.	CSIRO and Tarong Energy	A\$5 million.	Coal power station.	1,500 ton/yr		N/A	Start Sept. 2009 Research completed 2011
CO2CRC H3 Capture Project	Post-combustion capture. Test project.	CO2CRC, International Power	N/A	Absorbent, adsorbent, membrane technologies.	N/A		N/A	

**TABLE 8.2: CAPTURE AND STORAGE PROJECTS IN AUSTRALIA**

Project name	Main focus	Operator / partners	Cost/funding	Gas source & capture process	Amount handled	CO2	Transport and storage	Time schedule
CS Energy: Oxy-firing demonstration and carbon sequestration project (Callide)	Stage 1: Oxy-fuel demo (retrofit of existing plant) Stage 2: transport & storage	CS Energy. Mitsui, JPower and IHI (Japan); ACALET, Xstrata Coal, Schlumberger.	Total A\$206 million. Mix public/private funding, including Japanese. A\$50 million from LETDF.	30 MW(e) black coal. Oxy-fuel pulverized-coal technology.	20,000 ton/year for up to 3 years.		350 km (land). Geological storage (site undecided)	Construction of Oxy-fuel plant late 2008. Operation from end 2010. Transport/storage from 2011.
ZeroGen Project	IGCC Demonstration CO2 capture and Storage	Shell, Queensland Gov, ACALET, ZeroGen, Mitsubishi, Mitsubishi Heavy	Fullscale plant: A\$4.3 billion.	IGCC: Coal gasification integrated cycle. 530MW plant	>420,000 ton/year		Deep saline aquifers (2000 meters)	Test drilling completed. Feasibility study 2011, Operation 2015
Coolimba	Oxyfuel. Capture and	Aviva Corp.	A\$1 billion	Oxyfuel	N/A		N/A	Potentially 2011-2012

	storage.					
Galilee Project	Capture storage	and	Waratah Coal	A\$7.5 billion	900 MW coal fired	
Wanodan Project	Capture storage	and	GE Energy, Stanwell, Xstrata Coal		400 MW IGCC	Operation by 2015-16

**TABLE 8.3: STORAGE ONLY PROJECTS IN AUSTRALIA**

Project name	Main focus	Operator / partners	Cost/funding	Gas source & capture process	Amount handled	CO <sub>2</sub>	Transport and storage	Time schedule
Gorgon CO <sub>2</sub> Injection Project.	Storage. Part of a large offshore gas exploitation project	Chevron, ExxonMobil, Shell Australia	Total A\$841.3 million. A\$60 million from LETDF.	Natural gas.	125 million ton over 40 year lifetime. Up to 4 million ton/yr		200 km (partly seafloor). Low permeability saline aquifer.	Injection start 2009. 40 year life span.
CO <sub>2</sub> CRC Project.	Otway Storage monitoring geological formations.	and in CO <sub>2</sub> CRC, 15 companies and 7 gov. agencies.	A\$40 million	Natural gas, CO <sub>2</sub> well.	100,000 ton over 2 years		Porous depleted gas field (2100 meters)	Project launched April 2008. Injection until 2009. Monitoring - 2010

**TABLE 9: CCS PROJECTS IN CHINA**

Project name	Main focus	Operator / partners	Cost/funding	Gas source & capture process	Amount handled	CO <sub>2</sub>	Transport and storage	Time schedule
GreenGen	IGCC, capture and storage	Huaneng Group; 5 power comp., 2 coal comp. 1 invest. Comp. Supported by MOST and NDRC.	Phase 1: US\$ 280 million (IGCC power plant)	Precombustion (IGCC). Phase 1: 2MW, Phase 2: 400MW.	N/A		Phase 3, combined with NZEC (?)	Phase 1: 2006-2008 Phase 2: 2010-2015 Phase 3: 2016-2020
NZEC	Capture from coal PP, transport, storage.	UK-China partnership; Chinese partners, international. Financed by DEPRA	Phase 1: US\$ 7 million.	Coal gasification.	N/A		Pipeline,	Phase 1: 2007-2009 Phase 2: 2009-2011 Phase 3: 2014-2015
COACH	Preparation for CCS projects in China. Capture, storage.	EU funds. Chinese partners.	8 million (EU funding 1,5 mill)	Phase 1: Euro 2.62 million (EU funding 1,5 mill)	N/A	N/A	N/A	Planning: 2006-2009 Building plant: 2011 Capture/storage: 2015
Yantai IGCC	IGCC	5 Chinese comp. EU and Japanese partners.	US\$420 million.	Coal gasification.	N/A	N/A	N/A	N/A
Daiquin project.	Oil Field Transport and storage.	China Nat. Petro. Corp., RITE (Japan), Toyota Motors, JGC Corp (Jp)	US\$ 200-300 million.	Existing power plants (capture included project)	coal plants not in	1-3 million ton/yr. Total capacity 150 million ton	EOR, Daiqing oil field.	Announced May 2008