

BOUNDARY DAM

CCS CROSSES THE FINISH LINE

October 2014

Canadians can be proud of the Boundary Dam CCS facility, and they too can teach Norway and Europe a few things on delivering CCS. For more than 20 years Bellona has said that CCS is a critical piece in solving the climate puzzle. We now look forward to a new era of CCS deployment with Canada, Norway and Europe in the lead.

Boundary Dam makes clear to all who wish to see that CCS can be delivered on time and on budget. The Norwegian government and industry must examine their own management of CCS projects; it is now clear that mismanagement and not the technology has caused the embarrassing failure to reduce emissions from Mongstad.

The Canadian Emissions Performance Standard that severely limits CO₂ emissions from new and aging coal fired power plants has been the driving policy in delivering Boundary Dam CCS. The performance standard sent an unambiguous signal that polluting, unabated and climactically disastrous coal power would not be acceptable in Canada. In order to meet this new standard, Sask power a relatively small generator constructed the world's first commercial scale CCS power plant. The Canadian EPS demonstrates that clear real world incentives produce tangible real world results.

Canadians success at delivering the first commercial scale CCS power plant will allow for increased collaboration. From the Norwegian side, we must now preserve the rich academic environment and resources developed over recent years. With renewed political will and CCS deployment this knowledge resource will certainly be able to place Norway back to the top of the climate leader board.

"As we say in Bellona, 'seeing is believing' and I take my hat off to Canada as the Boundary Dam show the world that we now believe fully in CCS," says Jonas Helseth, director of Bellona Europa.

	Mongstad TCM & CCM	Boundary Dam CCS	Kemper County
			
Location:	Hordaland, Norway	Saskatchewan, Canada	Mississippi, USA
Project phasing:	Test Centre Mongstad (TCM) to be followed by full scale Carbon Capture Mongstad (CCM)	Commercial then test centre	Commercial
Owned by:	The Norwegian Government, Statoil, Sasol and Shell (TCM); Statoil and Norwegian Government (CCM)	SaskPower (Canadian Crown Corporation)	Mississippi Power, a subsidiary of Southern Company
Feedstock:	Refinery & Natural Gas	Lignite	Lignite
Industrial setting:	Integrated post-combustion capture from residue catalytic cracker (RCC) and combined heat and power (CHP) plant	Integrated post-combustion capture from power plant, retrofit	Transport Integrated Gasification (TRIG) power plant, new-build
Output:	280 MW electricity from CHP facility	110 MW electricity	582 MW electricity
Capture Rate:	100,000 tonnes CO ₂ per year (TCM), 1 Million tonnes CO ₂ per year (CCM)	1 Million tonnes CO ₂ per year	3 Million tonnes CO ₂ per year
Revenue streams:	Electricity + heat (refinery products)	Electricity, CO ₂ EOR, H ₂ SO ₄ , fly-ash by-products	Electricity, CO ₂ EOR
Legislation:	Legal mandate for gas power plants	Federal power plant emission performance standard (EPS) 420 tonnes CO ₂ /GWh	\$2.88 billion in cost recovery from ratepayers
Fate of CO₂:	Vented to atmosphere (TCM), Saline formation (Offshore) (CCM)	EOR (commercial) + small scale saline formation (test)	EOR (commercial)
Cost (\$ US):	\$0.8 billion (TCM), \$3.8 billion (CCM)	\$1.11 billion total (\$538 million for CCS, \$572 million for modernizing of plant)	\$5.53 billion (CCS & power plant)
In-Service:	TCM (May 2012), CCM Cancelled	October 2014	May 2015 (estimated)

Norway & Statoil vs. Saskatchewan & SaskPower Boundary Dam

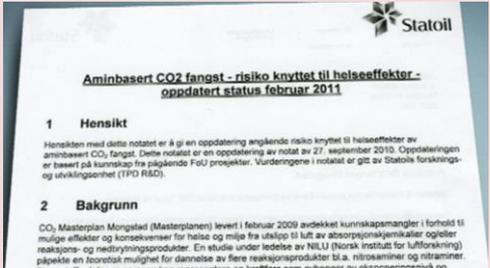
	Mongstad TCM & CCM	Saskatchewan
Population:	5,136,700	1,033,381
GDP/capita:	EUR 80,43	EUR 50,21
Company:		
Assets:	In 2013 Statoil operated 44 assets in the North Sea, the Norwegian Sea and the Barents Sea. They also operate a significant number of exploration licences.	In total, 3 coal-fired power stations, 7 hydroelectric stations, 6 natural gas stations and 2 wind facilities generate: 3,513 MW of electricity.
Assets valued:	EUR 109 billion	EUR 4.7 billion (2013 data)
Net Income in 2013	EUR 4.8 billion	EUR 90 million

	5MW Wind Turbine	Boundary Dam CCS
Generation Capacity:	5 MW	110 MW
Capacity Credit:	0.8	0.3
Annual Low carbon electricity:	770,880 MWh	13,140 MWh
Number of wind		58.5 (installed capacity 292 MW)

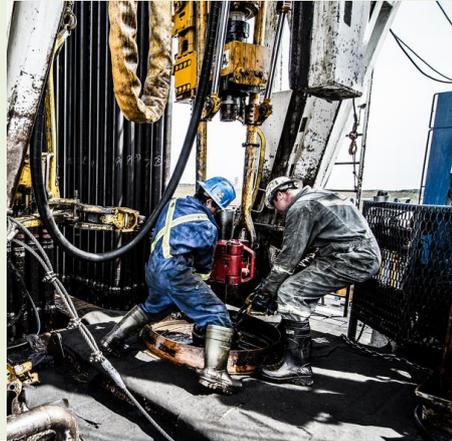
turbines to produce equivalent low carbon electricity:

CCS Timeline: Mongstad vs. Boundary Dam

Date	Mongstad TCM & CCM	Boundary Dam CCS
Oct-06	Government and Statoil agree to build test centre	
Sometime in 2007	Norwegian parliament discusses TCM at estimated total cost of NOK 1.2 Billion	
Jun-07	Ministry of Petroleum and Energy sign deal with DONG Energy, Hydro, Shell, Statoil and Vattenfall on coop toward TCM 	
Feb-08		Federal government commits \$240 million to Saskatchewan for CCS project 
Feb-08		Provincial government in Saskatchewan announces pre-commitment to retrofitting CCS to Unit 3 at Boundary Dam
Late 2008	Planning completed, site preparation	
July 2009	Norwegian parliament makes TCM investment decision on basis of estimated total cost of NOK 4.2 Billion	SaskPower invites vendors to participate in a two-stage procurement process
Apr-09		Fluor Corporation awarded front-end engineering study
Jun-09	Gassnova, Norske Shell and StatoilHydro establish the company European CO2 Technology Centre Mongstad	
Jul-09	Construction begins	Aquistore initial funding secured

		
Oct-09		Aquistore Science Research and Engineering Committee formed.
Feb-10		Hitachi selected to supply steam turbine
Mar-10	Sasol and Gassnova sign deal, Sasol purchase 2.44% of TCM 	SNC Lavalin and Cansolv Technologies Limited selected to oversee the engineering, procurement and construction activities 
Apr-10		Aquistor project management initiated, risk assessment undertaken
Jun-10	Statoil VP states in interview that only suppliers of amine based technology to participate in pre-qualification 	
Sep-10	Statoil delays project citing (largely unfounded) concerns over nitrosamine levels 	
Oct-10	5000m ² admin complex completed	
Dec-10		Go decision for \$354 million rebuild of 150 MW Unit 3

Jan-11		Babcock and Wilcox contracted to rebuild the boiler in Unit 3
Apr-11	Technology Qualification Programme for CCM announced "three-year technology qualification programme to choose a technology, followed by detailed planning that will take two years"	Go decision for CO2 capture at Unit 3 
May-11		Plant construction begins
Jul-11	Utilities and infrastructure construction completed	SaskPower signs \$30 million contract with Stantec for engineering consultancy during design and construction
Aug-11		Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations (SOR/2012-167). Emissions performance standard to be fixed at 420 tonnes of carbon dioxide per gigawatt hour (CO ₂ /GWh) and retroactive to facilities greater than 50 years.
Sep-11	Amine plant construction completed, testing to begin 	
Oct-11		Estevan confirmed as Aquistore storage site, access agreements signed, community engagement begins.
Nov-11	Technology suppliers for Mongstad chosen - Technology Qualification Programme (CCM)(Mitsubishi, Alstom, Siemens, Aker, Huaneng)	
Dec-11	Jacobs Engineering Group selected to supply CCM's engineering and technical assistance services for the combined heat and power plant, chilled ammonia plant construction planned completed and testing to begin	CO ₂ stripper delivered to site

		
Jan-12	TCM opens with Alstom and Aker at total cost so far of NOK 5.2 billion	
		
Mar-12		Storage site construction begins, permanent seismic array and 3D baseline installed
May-12	Official launch	
Jul-12	Test activity begins	Injection well drilled 
Oct-12		Evaluation well drilled
Nov-12		Baseline groundwater and soil gas studies underway, test injection executed, some monitoring installed
Dec-12	Phase III contracts for Technology Qualification Programme - CCM (concept study contract)	SaskPower announces that Cenovus Energy will purchase the full volume of 1Mt/yr of CO ₂ captured for EOR projects near Weyburn

Jan-13	Amine plant operation begins	Alberici selected to remove the old Unit 3 boiler and install a new Hitachi 160 MW turbine
Mar-13	Chilled ammonia plant operation begins (after extensive modifications)	
May-13		The UK Carbon Capture and Storage Research Centre and SaskPower sign MoU for 3-year research initiative aimed at improving costs and performance of CCS
Sep-13	Carbon Capture Mongstad (CCM) Cancelled 	
Sometime in 2014	Planned next round of testing of other absorption solutions (possibly demo Aker Solutions, Hitachi, Mitsubishi, Shell Consolv and Siemens)	
Oct-14		Boundary Dam enters full service 
Sometime in 2016	End of test period, decision on possible commercial phase after this date	
Sometime in 2016	Anticipated FID for full-scale CCM	

Sometime in
2020

Operation of CCM

