Callide Oxyfuel Project

DECEMBER 2013

Technical Fact Sheet

The site of the Callide Oxyfuel Project – Callide A Power Station in Central Queensland, Australia.

Overview

The $245 million Callide Oxyfuel Project is a demonstration of oxyfuel combustion and carbon dioxide capture, and is one of only a handful of projects in the world to move beyond concept into construction and operation.

The project has two parts:

- An oxyfuel combustion and carbon capture demonstration, now underway at CS Energy's Callide A Power Station in Central Queensland.
- Investigations into the long term geological storage (geosequestration) of carbon dioxide.

This fact sheet covers the carbon capture aspects of the project and is aimed at a technical audience.

Goals

The Callide Oxyfuel Project has three broad goals, namely to:

1. Demonstrate a complete and integrated process of oxyfuel combustion of pulverised coal within a National Electricity Market facility, incorporating oxygen production, oxyfuel combustion, CO_2 processing and liquefaction;
2. Obtain detailed engineering design and costing data and operational experience to underpin the commercial development and deployment of new and retrofit oxyfuel boiler applications for electricity generation; and
3. Obtain geotechnical design and costing data and operational experience through participation in a CO_2 storage trial as a learning for the development of large scale geological storage in excess of 1 million tonne of CO_2 per year.

The demonstration project is being augmented by a research and development program to test different coals and operating conditions, so the as-built plant has been designed to allow for operational flexibility and includes the relevant field devices and software systems to facilitate such a program.

Project Conception

The idea of the Callide Oxyfuel Project was first conceived in 2003 as an initiative of the Australian Coal Association COAL21. In 2004, a Working Group was established under the umbrella of COAL21, the CRC for Coal in Sustainable Development and the New Energy Development Organization (NEDO) in Japan to undertake a feasibility study on the oxyfuel conversion of a 30 MWe coal fired boiler at Callide A and the addition of a CO_2 capture plant. The study was completed in 2006, and an application made to the Commonwealth Government for funding under the Low Emission Technology Development Fund (LETDF) initiative.

The Project reached Financial Close in March 2008 with the execution of a LETDF Deed, execution of a Funding Agreement with the Australian Coal Association, and establishment of an Unincorporated Joint Venture.

Project Scope

The Callide Oxyfuel Project has been carried out as follows:

1. Refurbishment of the existing Callide A Unit No. 4 near Biloela in central Queensland (completed in 2008).
2. Retrofit of oxy-firing technology and CO_2 capture (completed in 2012).
3. Demonstration of oxy-combustion and CO_2 capture (2012–2014).
4. Project conclusion and technology commercialisation (post 2014).

Scope of supply has included the following:

- 2 x 330 t/day (nominal) cryogenic oxygen plant, i.e., Air Separation Unit (ASU).
- Oxyfuel retrofit of Callide A Unit No. 4 to allow for MCR generation of up to 30 MWe (gross) of electricity under oxy-firing conditions.
- 1 x 75 t CO_2 product/day flue gas processing and liquefaction plant, i.e. CO_2 compression and purification plant (CPU).
- Nominal 100 t CO_2 refrigerated storage tank and truck loading facility.
- Site preparation and site integration works.

Technical Description

Oxyfuel boiler

The Callide Oxyfuel Project is presently the largest operating oxyfuel power plant worldwide and consists of five main process units, viz: two x 330 TPD cryogenic Air Separation Units (ASUs), Oxyfuel boiler (30 MWe generating capacity), flue gas low pressure pretreatment plant (100 TPD), flue gas high pressure treatment and CO_2 liquefaction plant (75 TPD), and CO_2 load-out tank and facilities.

The Callide Oxyfuel Project boiler included a retrofit to the existing Callide A Unit No. 4 boiler (Figure 2). The boiler retrofit included replacement of Induced Draft (ID) and Forced Draft (FD) fans and installation of new ductwork for the recycled flue gas, primary gas scrubber to dehumidify the primary recycled flue gas to the mills, additional Primary Gas heater for reheating of recycled flue gas (primary gas stream), flue gas low pressure heater (FGLPH) at the boiler outlet for heat recovery, and a Continuous Emission Monitoring System (CEMS) to monitor flue gas quality.

The Callide A unit 4 boiler following the oxyfuel retrofit.

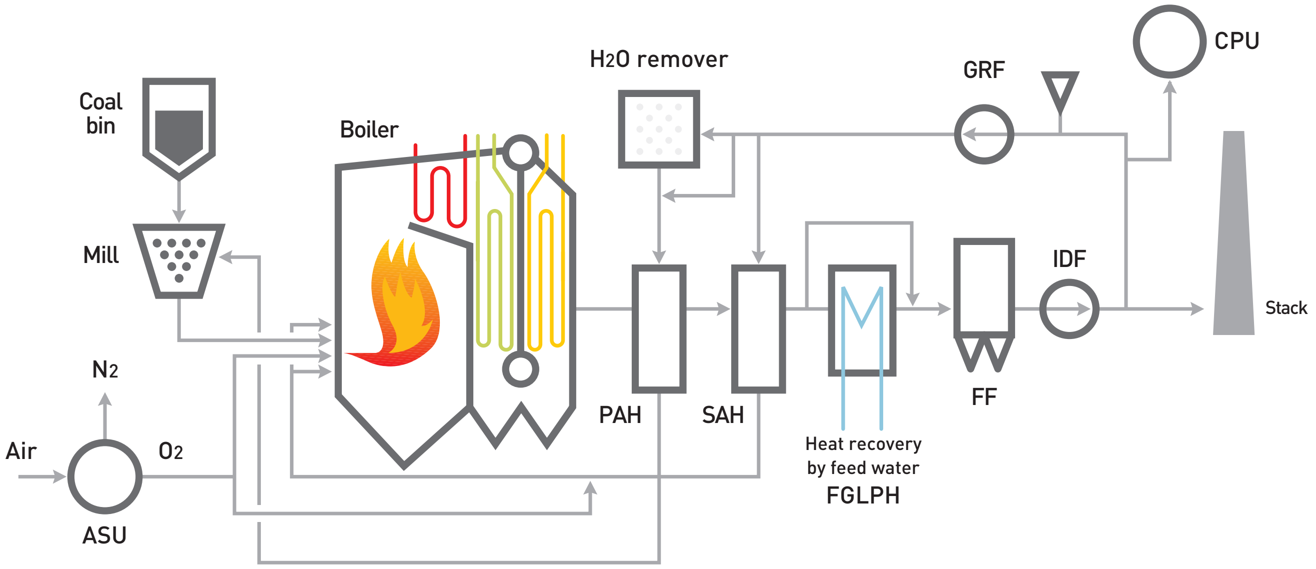


Figure 2: Callide Oxyfuel Process

The Callide oxyfuel boiler in this project is characterized as follows.

- There are three mills on the Callide A boiler, of which two are required for normal full-load operation. Within the operating mills, under oxy-firing conditions, the coal is dried and transported by recycled flue gas that mainly consists of CO_2 and H_2O.
- The boiler has six burners and four burners in it are normally used in service during the operation. The project can compare the characteristics of different burner patterns.
- There is the H_2O remover in the primary line for the transportation of coal to protect the lower temperature parts of the process from corrosion, especially pulverized coal pipes. Bypass operation of H_2O remover can be selected as a demonstration test item.
- FGLPH is installed at boiler outlet for the heat recovery by low pressure feed water to boiler.
- O_2 from the ASUs is mainly mixed with recycled flue gas and in addition a part of O_2 can be supplied to the burner flame area directly.
- Flue gas is recycled from the outlet of IDF in oxyfuel operation by a Gas Recirculation Fan (GRF)/Forced Draft Fan, and air is induced in air-firing operation by the same GRF.

A comparison of the flue gas characteristics in air-firing versus oxy-firing modes is shown in Figure 3. Since nitrogen is removed by the ASUs, the CO_2 produced during combustion is concentrated into about one quarter of the volume of flue gas that would be present under air-firing conditions.

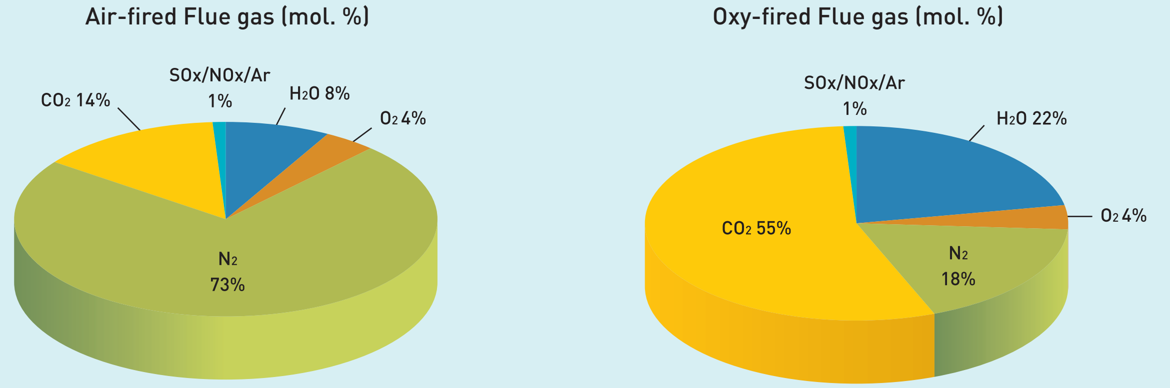


Figure 3: (a) Typical flue gas composition under air-firing conditions; **(b)** Typical flue gas composition under oxy-firing conditions.

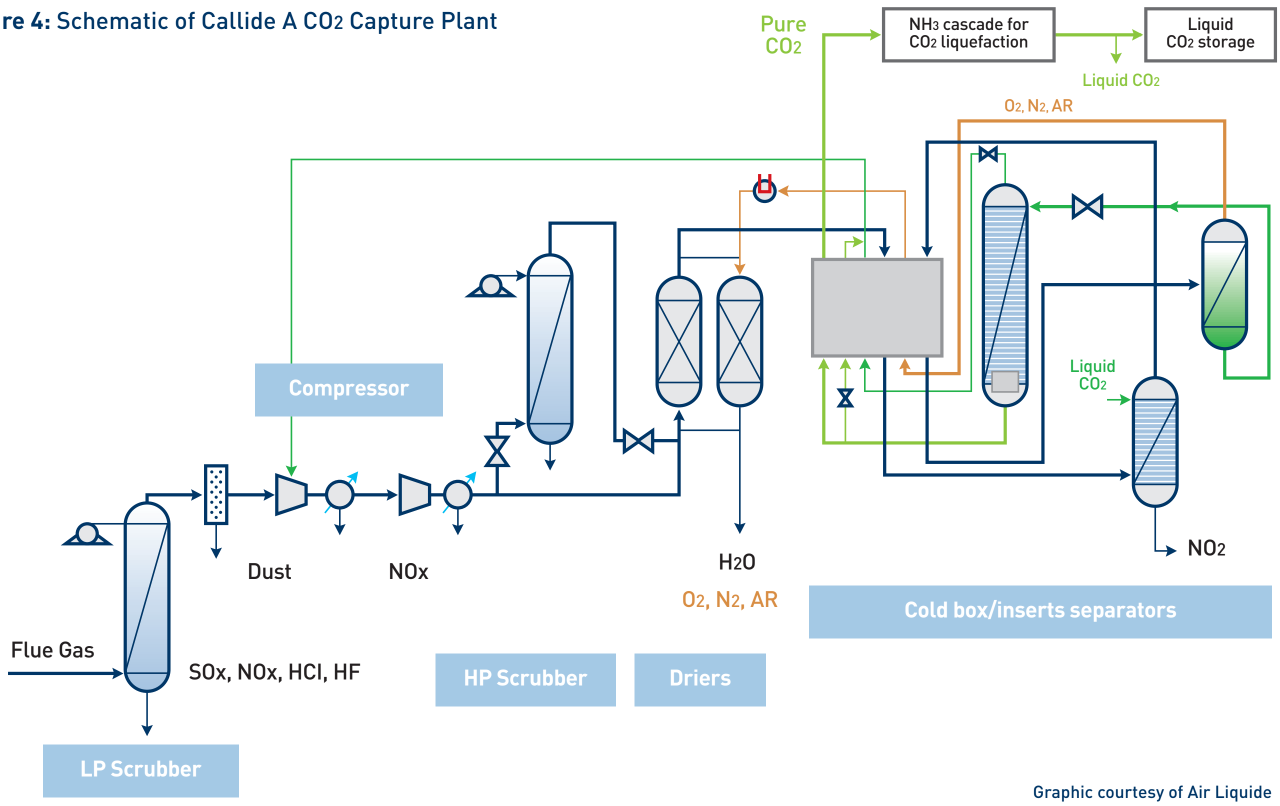
Carbon dioxide capture plant

The CO_2 capture plant, referred to as the CO_2 Purification Unit (CPU), is designed to process a nominal 1.7 kg/s of wet flue gas from the Oxyfuel boiler recycled flue gas duct to produce up to 75 t/day of pure liquid CO_2 suitable for geological storage (Figure 4).

The overall process design for the plant was performed by Air Liquide. Initial flue gas pretreatment involves two low pressure scrubbers (designed by GLP) that cool and dehumidify the gas and control SOX content to (low) ppm levels. This is followed by gas filtration to remove any residual particulates and then compression via a centrifugal compressor.

The next stage of the flue gas treatment process involves further dehumidification via a high pressure chilled water scrubber and drier unit, followed by gas separation and purification in Air Liquide's coldbox/heat exchanger equipment and GLP's liquefaction plant. The final product is pure liquid CO_2 which is contained in a 100 tonne storage/load-out vessel.

Figure 4: Schematic of Callide A CO_2 Capture Plant



Graphic courtesy of Air Liquide

The completed air separation unit and carbon dioxide processing unit on the Carbon Dioxide Capture Plant.

For comparison purposes, indicative product CO_2 specifications are summarised in Table 2 below.

Component	Unit	Sleipner Storage	DYNAMIC EU Storage	Weyburn EOR	E290 additive specification Food Grade	ISBT Food Grade	Callide Oxyfuel Product
CO2	mol %	95	95	96	99	≥ 99	99
CO	ppm		2000	1000	10	≤ 10	
H2O	ppm			20		≤ 20	
N2 + Ar	ppm		40,000	300			≤ 1000
O2	ppm		40,000	50		≤ 30	≤2000
H2	mol %		4				
H2S	ppm	150					
NOx	ppm		100			≤ 5	
Total S						≤ 0.1	
SO2/SO3	mol %		50	Trace		≤ 1	≤ 20
CH4	mol %			0.7			
Other HC	mol %			2.3			
	ppm					≤ 50	≤ 30

Table 2: Comparison of Product CO_2 specifications

Oxyfuel Project Partners

Supporting Collaborator