FOSTER WHEELER

CARBON CAPTURE & STORAGE

WHAT IS CCS?

Carbon capture and storage (CCS) is the process of removing or reducing the CO_2 content of streams normally released to the atmosphere, and transporting the captured CO_2 to a location for permanent storage.

CO_2 can be captured from a wide range of large sources, such as process streams, heater and boiler exhausts, and vents from a range of industries, such as power generation, cement production, refining, chemicals, steel and natural gas treating.

There are three main groups of technologies employed – their applicability varies according to the CO_2 source:

- Pre-combustion capture
- Post-combustion capture
- Oxyfuel combustion capture

Once captured, the CO_2 is compressed, dried and transported to a suitable storage location such as saline aquifers, depleted oil fields (where enhanced oil recovery could be employed) and depleted gas fields.

WHY CCS?

There is mounting worldwide concern about the prospect of climate change due to anthropogenic CO_2 emissions.

Global demand for energy continues to rise and fossil fuels look likely to dominate the energy mix for years to come. The energy sector accounts for around 60% of global CO_2 emissions. Coal-fueled power generation accounts for around 40% of the world's energy generation but has the largest carbon footprint of all the power generation sources. CCS could significantly reduce CO_2 emissions from coal-fired power plants.

With no realistic prospect of major reductions in CO_2 production in the near future, the best available short-term option appears to be to 'store' produced CO_2 in geological formations, rather than release it to the atmosphere.

CCS represents a 'bridge' to a sustainable energy system.

WHY CHOOSE FOSTER WHEELER?

WE UNDERSTAND

We have already worked on a diverse range of CCS projects. We understand the drivers and challenges and have proven experience of working with our clients to enhance the economics, efficiency and performance of CCS schemes and to develop optimized solutions for new or existing facilities.

During the early stage of project development our specialist consulting groups work side-by-side with our clients to deliver quality CCS solutions that add value throughout the project lifecycle, including:

- Technology evaluation and selection
- Optimization and integration studies
- Concept and feasibility studies
- FEED
- Engineering, procurement, construction and commissioning

WE'RE OBJECTIVE

Our breadth of experience covers each of the key elements within a complete CCS chain and the range of available and emerging technologies within each of these areas. We are not tied to any of the technology suppliers and so our clients can be sure that our approach is objective and balanced.

Separation & capture

We can develop CO_2 capture solutions, using whichever of the three technology groups is most appropriate, across the range of power, natural gas, refining and other hydrocarbon sectors.

Compression & treatment

The combination of the expertise of our process and machinery specialists and our close working relationships with key compressor, pump and dehydration equipment suppliers delivers in-depth knowledge and expertise in CO_2 compression and treatment systems.

Transportation & storage

CO_2 sources can be a significant distance away from the location of potential CO_2 sinks. Our pipeline and upstream experts work together to develop CO_2 transportation solutions through a suitably designed pipeline network, develop CO_2 transmission and wellhead facilities, and work with our clients' down-hole team to generate CO_2 profiles for target reservoirs.

As CCS projects move out of the conceptual and study phase, we deliver high quality FEEDs and provide full support to our clients in delivering a robust basis upon which to progress their project.

WE DELIVER

Unlike pure consultancy companies, we can also implement your project. This brings you continuity, and also means that, because we are a well-known global EPC contractor, the solutions that our technical experts develop are practical, constructable and based on detailed local knowledge, with our cost estimates based on real costs and real experience.

With our global network of engineering centers, and a long and successful EPC track record, we work with our clients to 'build their vision', providing project management, detailed engineering, procurement, construction and commissioning expertise to deliver a high quality facility that meets our clients' expectations.

CARBON CAPTURE TECHNOLOGIES

PRE-COMBUSTION CAPTURE

A solid or gaseous hydrocarbon feedstock is fed to an oxygen- or air-blown gasifier or reformer where it is converted to syngas. The syngas is then passed through a shift reactor which increases the hydrogen and CO_2 content of the syngas. The high temperature syngas is then cooled, before being washed with a solvent to absorb the CO_2, leaving a hydrogen-rich stream and a CO_2-rich solvent stream. The solvent regeneration process then releases a CO_2 stream which can be dried and compressed for export.

This process offers significant integration potential as it can be configured to generate a high-purity hydrogen stream and the syngas cooling train can be used to raise a significant quantity of HP, MP and LP steam.

Compared with post-combustion technology, the fuel conversion steps required for this process are more complex, making it more challenging to apply to retrofits. But on the plus side, this process offers the potential of multi-product facilities, combining both power generation with hydrogen and/or syngas production for adjacent chemical and refinery use.

POST-COMBUSTION CAPTURE

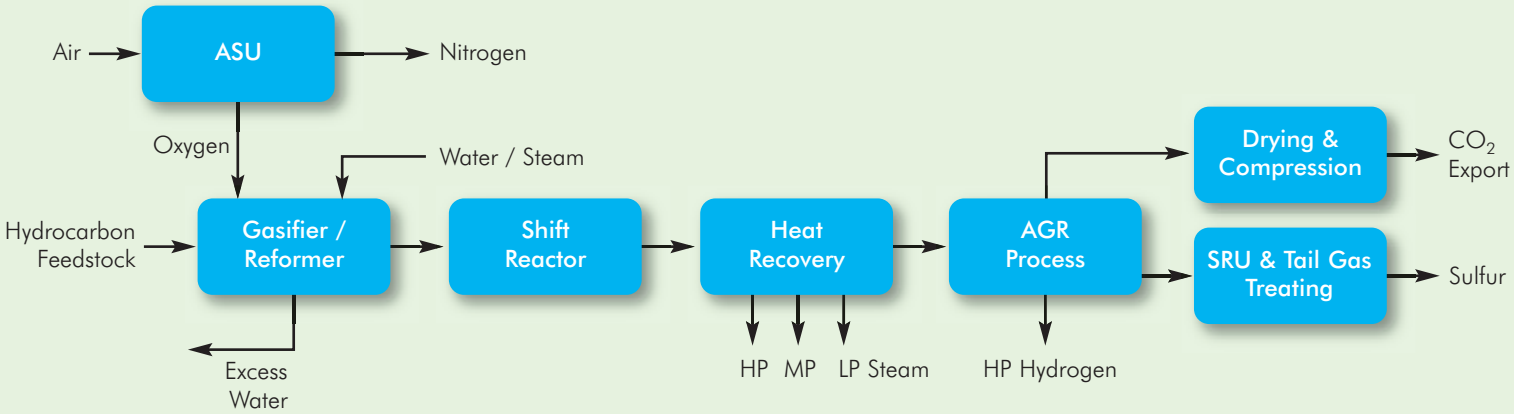
Post-combustion processes separate CO_2 from the exhaust gases produced by the combustion of fuel, such as coal, natural gas, oil and biomass, in air. The concentration of CO_2 in the exhaust gas is low, typically 3-15% by volume, and the pressure is typically close to ambient. The exhaust gas is typically cooled by direct water contact before entering a blower designed to overcome the absorption system pressure drop. The exhaust gas enters an absorption column in which it is washed with a liquid solvent, such as an aqueous amine solution. The CO_2-rich solvent is then heated against lean solvent and regenerated in a stripping column. The solvent then returns to the absorption column while the released CO_2 is dried and compressed for export.

This is ideally suited for new installations as well as retrofits. To date, it has only been used on a relatively small scale. The next steps are to improve its energy efficiency and to deploy the technology on a much larger scale.

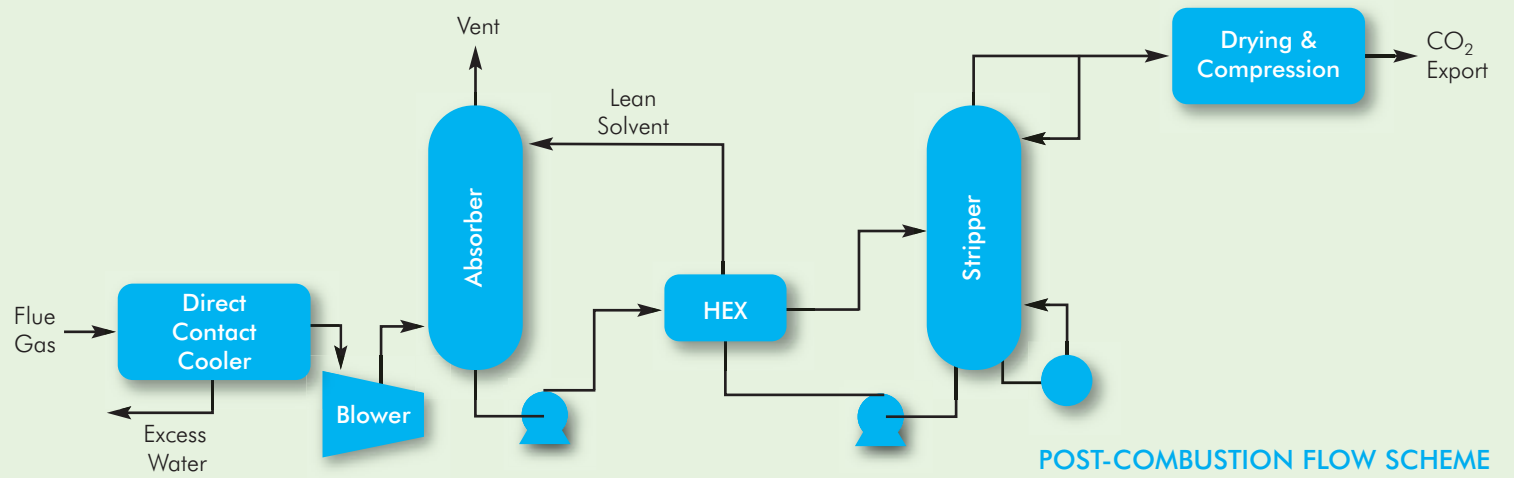
OXYFUEL COMBUSTION CAPTURE

The feedstock is combusted with oxygen from an air separation unit. The temperature in the boiler is moderated by recycling a portion of the flue gas back to the combustion chamber. The flue gas passes through particle removal by electrostatic precipitator, sulfur removal by limestone scrubbing and water removal by cooling and condensation. The CO_2 can then be separated from the remaining flue gas, dried and compressed for export. Steam from the boiler is used to generate power via a steam turbine.

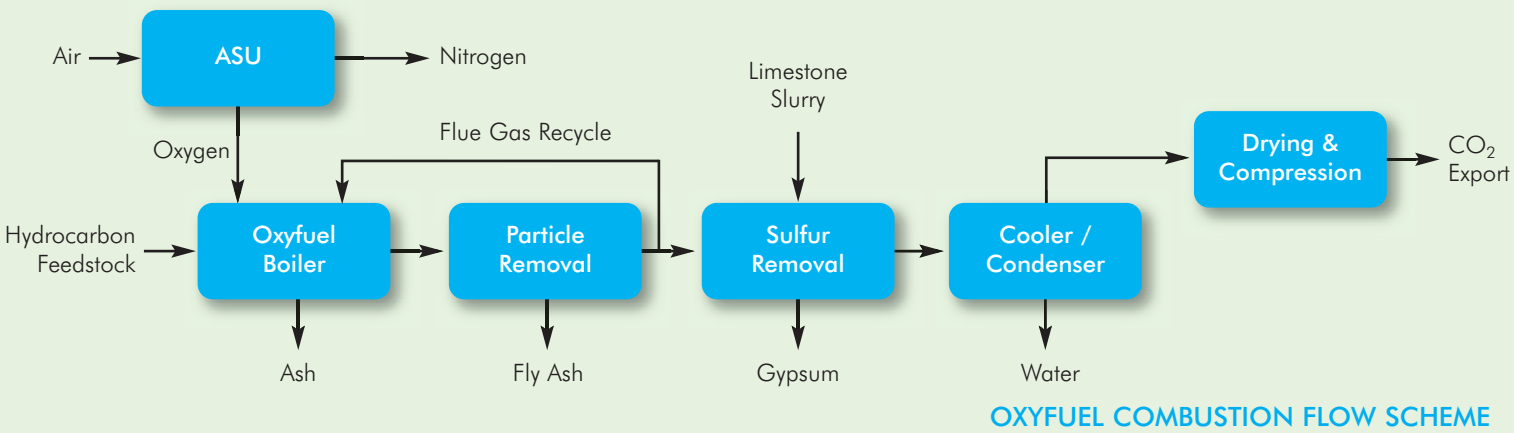
This process is applicable to both new build and retrofit scenarios for steam and/or power generation. Existing boilers can be converted to oxyfuel operation with the addition of an air separation unit, suitable boiler modifications and the addition of relatively small flue gas clean-up equipment (compared with pre- and post-combustion).



PRE-COMBUSTION FLOW SCHEME



POST-COMBUSTION FLOW SCHEME



OXYFUEL COMBUSTION FLOW SCHEME

PROJECT EXPERIENCE

Advanced Pre-Combustion Decarbonization

Assessment of a novel CO_2 capture technology applied within a petroleum coke-fed IGCC with carbon capture-to-power flowscheme. The cost of capturing and storing CO_2 has a significant impact on the economics of electricity generation and therefore the aim was to achieve an overall reduction in the incremental capital and operating costs of carbon capture.

Advanced Post-Combustion Decarbonization

Assessment of a novel post-combustion CO_2 capture technology. Study of the potential process performance and integration benefits and the scale-up of the process, compared with a conventional amine-based post-combustion CO_2 capture technology.

Cost of CO_2 Capture

Study to develop a picture of the relative costs of CO_2 capture for a wide range of potential carbon capture projects on a US$-per-tonne-of-$CO_2$-captured basis. The aim was to identify those projects characterized by a high volume of CO_2 captured for relatively low cost, and included both retrofit cases and new-build power projects.

Decarbonized Fuel Power and Desalination Plant

Feasibility study to develop key technical and cost data for a decarbonized fuel power and desalinated water plant. The study considered both pre-combustion and post-combustion CO_2 capture power plant configurations, targeted to export 1,000 MW of electricity, a carbon capture level of >90%, and to export up to 80 million gallons per day of desalinated water. Study included potential site locations, local infrastructure issues, seawater intakes and outfalls, feedstock supply and power, water export and CO_2 export.

Hydrogen to Power

A ground-breaking industrial-scale project for BP planned to generate electricity using hydrogen manufactured from natural gas to create 'decarbonized fuels'. It was planned to create 475 MW of carbon-free electricity, enough to power almost half a million homes in the UK. The project could also permanently store 1.8 million tonnes of CO_2, the equivalent of removing more than 400,000 cars from the roads. We have been involved in the study and FEED phases.

Gas-to-Liquids (GTL) CO_2 Capture

Concept study to investigate the integration of CO_2 capture and compression technology into a proposed GTL facility. Technology screening exercise to assess potential locations and technologies, both pre-combustion and post-combustion, considering technical suitability, CO_2 quantity removed/captured, technical risk, utility requirements, preliminary CAPEX and OPEX.

Decarbonization for Combined Cycle Power Plant

Analysis of both pre-combustion and post-combustion decarbonization for a range of natural gas-fed combined cycle power generation schemes, including overall performance and efficiency comparisons, cost estimating, evaluation of the relative economics of different schemes and risk comparison.

Power Generation with CCS

Feedstock and technology study for a wide range of generic power generation plant configurations. A total of 29 configurations were analyzed, including conventional power plants with no CO_2 capture, and pre- and post-combustion CO_2 capture power plants.

Within each group, feedstocks included natural gas, petcoke, black lignite, brown lignite, international steam coal and heavy residue oil. Process technology included combined cycle gas turbine, circulating fluidized-bed boiler, ultra-supercritical pulverized-coal boiler, autothermal reforming and IGCC. Gas turbines included both E and F class, either 50 or 60 Hz machines.

Post-Combustion Decarbonization

Estimation of capital costs associated with post-combustion CO_2 capture technology when applied to a pulverized coal-fired ultra-supercritical boiler. Three differing capacity schemes were considered, ranging from 1,100 tonnes per day CO_2 captured (equivalent to 50 MW electricity generation) to 24,200 tonnes per day (1,100 MW).

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GLOBAL E&C OFFICE LOCATIONS