ATTACHMENT C: CAPTURE OPTIONS

Carbon dioxide emissions originate from three main sources: combustion of fossil fuels including coal, oil and gas, CO_2 emissions from other industrial processes such as cement manufacture, and production of natural gas streams which normally contain small percentages of CO_2. In general most of the combustion gases from existing major energy fuel combustion facilities have carbon dioxide concentrations of between 3 and 33 percent. To date the practice of carbon dioxide capture and separation is only undertaken at natural gas processing and ammonia production facilities to ensure product quality, whereas separation from flue gases is not being done as there are usually large amounts of nitrogen and thus it is more energy intensive and costly

The capture of carbon dioxide is most feasible at stationary point sources where large volumes of it are generated, such as at the location of coal-fired power stations, oil refineries, petrochemical, fertilizer, petroleum and natural gas processing plants, cement works, steel works and pulp and paper mills. Capture of emissions from the existing transport industry using CCS technologies is not feasible. However, a future hydrogen economy with hydrogen as the transport fuel (e.g. fuel cells), where hydrogen is generated from fossil fuels at a stationary plant location which captures and stores the co-generated CO_2, would mean that significant emission reductions could occur across the transport industry. The challenge which the capture technology faces is the separation of relatively low percentages of carbon dioxide gas from other waste gas and vapour products of the combustion process, and to do so at significantly reduced costs.

Three major options are available for the capture of carbon dioxide, being; post-combustion, oxygen-fired and pre-combustion.

Post-combustion involves capturing the carbon dioxide by removing it from a large volume of gas and vapour, including oxygen and nitrogen. The technology to remove carbon dioxide from a flow of gas or vapour has been widely utilised and involves ‘scrubbing’ the gas with a chemical solvent. The carbon dioxide is then compressed into a dense phase so that it occupies about 0.2% of the volume of the same material in a gaseous state. Once in a pressurised form, the carbon dioxide is able to be transported by pipeline, pressurised shipping vessel or by road tanker. The advantage of the post-combustion process is that it can be retrofitted onto existing plant and equipment thus avoiding some major incremental costs. The disadvantage of the post-combustion process is that it requires large equipment to process the large volumes of gas and considerable additional energy to regenerate the solvent and compress the carbon dioxide after capture. Future technology development which may reduce the energy costs of this process would have a significant impact upon the nature of the process.

The **oxygen-fired** approach involves combustion of fossil fuels with oxygen which is separated from air. This virtually eliminates nitrogen from the exhaust (flue) gas and results in a more concentrated carbon dioxide stream in the waste flue gas. While an attractive option, the technology for this process is still under development for large scale operations.

The **pre-combustion** capture process is the most novel approach and it can potentially approach a zero-emissions level for coal-fired power stations, whilst also reducing mercury and SOx and NOx emissions (oxides of sulphur and nitrogen). While still under development for large scale applications, this approach provides the possibility for very clean fossil fuel use with considerable reduction in capture costs.

Pre-combustion is of particular interest for new capacity requirements while post combustion capture and oxyfuel combustion provide a retrofit opportunity and allow for the reduction of emissions from Australia's existing power stations. There has been significant research and development on all three different capture technologies in Australia by a range of institutions including the Queensland Centre for Low Emission Technologies (cLET), the Cooperative Research Centres (including the CO_2CRC and the CRC for Coal in Sustainable Development (CSSD)) and private companies. Many of the CCS capture technologies have been proven at the laboratory and pilot stages and are moving towards commercial demonstration.

A range of other potential capture technologies exists and their significance with respect to both the efficiency of capture and costs are still being evaluated and tested. They may provide significant additional potential cost reduction and or separation efficiency for the capture end of the process.