

# EXTENDED ABSTRACT

## **Retrofitting study for a 120MW NGCC plant with post-combustion: a particular case to optimize the CO<sub>2</sub> capture process**

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### **ABSTRACT**

The combined cycle that was taken into consideration is a plant designed, constructed and owned by Techint group. It is a Natural Gas Combined Cycle (NGCC) composed by two gas turbines and two heat recovery steam generators where the recovered heat is converted into steam, feeding a Steam Turbine. The plant had been also designed for cogeneration purposes: some steam extractions from the turbine are used, in fact, both for supplying heat to a steel factory and for district heating (DH) to the Municipality and domestic users close to the plant. Nominal electrical power is about 120 MWe, while maximum heat provided is about 12 MWth for steel factory and 35 MWth for DH. Yearly CO<sub>2</sub> emissions are about 300 000 tons. Techint E&C, part of Techint Group, being highly interested to increase internal know-how about CCS technologies, decided to investigate the possibility to perform the produced CO<sub>2</sub> capture at the mentioned power plant. A pre-feasibility study was developed to assess if this choice may become convenient, especially considering the forthcoming 3<sup>rd</sup> period of the European Emission Trading System (ETS) after the crucial date of 2012. As the emission allowances will be decreased, the rate unit of emitted CO<sub>2</sub> could significantly increase and the realization of a capture plant may become more attractive also from an economic point of view.

The study had therefore been focused to find specific solutions both to optimize the process and the energy consumption, and also to make as much as possible the industrial initiative economically free-standing.

To get this target, the project has been conceived as a modular one, so two different phases are envisaged. In the first phase, capture will be limited to about 45 % of the overall emissions and the captured CO<sub>2</sub> is expected to be delivered to local industrial users. Second phase will involve the capture of additional CO<sub>2</sub> quantities, up to a maximum of about 90 %. Taking into account the limited request of the Italian market, this additional CO<sub>2</sub> flow cannot be delivered to customers and should be stored underground. So, the study includes also some preliminary geological investigations.

As far as capture is concerned, being this case a retrofit application, the most viable solution is a post-combustion process. The study took into consideration a number of alternatives, including the "classical" amine scrubbing with MEA, and alternative solvents (i.e. Econamine<sup>SM</sup> Plus by Fluor, KS-1<sup>SM</sup> by MHI, and Chilled Ammonia by Alstom). Since the alternative solutions are not completely described in the available literature and data are covered by licence, a complete process simulation and economic analysis was possible currently only for the MEA solvent, even if the preliminary results showed the potential of significant improvements, in terms of efficiency and energy cost, by using such alternatives. For these reasons the results of this study are to be considered conservative.

In the MEA absorption/regeneration process, specific attention has been devoted to energy efficiency optimization, keeping in mind the mandatory necessity to guarantee a large steam flowrate from the turbine to satisfy the heat requirements of factory and district heating.

Particular attention has been dedicated, to this scope, to materials selection, equipment design and plant configurations.

As a matter of fact, results are in line with literature data and the overall estimated capture cost, of the order of 70 Euro/t<sub>CO2</sub>, can be considered reasonable if compared with equivalent data for coal fired power plants, that normally are expected to be less penalized by CO<sub>2</sub> capture. As far the final CO<sub>2</sub> disposal is concerned, the possibility to commercialize up to 30 % of the emitted CO<sub>2</sub> in phase 1 of the project has been positively verified, and is a “tailored” solution, applicable only to a specific local industrial background.

For phase 2, the quantity to be delivered to customers is too large, so a geological storage must be included. A preliminary geological analysis has been performed, showing that a suitable storage location is available at a reasonable distance (about 25 km) from the plant.

A preliminary financial analysis was performed, taking into account the investment cost and energy penalty and, in term of benefits, primarily the saved emissions valorized according to the ETS system and the income from CO<sub>2</sub> commercialization (depending essentially on the purity that will be achieved): this last term could result important as it could potentially cover all the additional expenses for CO<sub>2</sub> capture.

**Keywords:** CO<sub>2</sub> Capture, ETS, Process solutions

**Proposed Topic:** Process optimization and CO<sub>2</sub> commercialization