Hydrogen from coal

The reliable and secure operation of the power systems requires the continuous balancing of the production and consumption resources connected to the electricity network. The temporal and geographical variability of demand and supply, to a certain extent amplified by the increasing penetration of renewable intermittent resources (mainly wind) and by the development of electricity market, calls for fast-reacting and flexible energy generating units - possibly flanked by a further deployment of energy storage technologies and demand management techniques - capable to compensate for power unbalances and able to quickly react to changing market strategies. The combination of two products for different markets allows tailored electricity production by switching from one product to the other. Besides, it lets the units that are common to both processes to operate at full load. Continuous operating conditions favor the investment amortization and protect the main machines from thermal load oscillations.

Integrated Gasification Combined Cycle (IGCC) plants allow the combination of the production of hydrogen and electricity because coal gasification process produces a syngas that can be used for the production of both commodities. This combination can be done mainly thanks to the shift reaction that converts the carbon monoxide contained in the syngas into hydrogen and carbon dioxide. Therefore, the IGCC plant, relying upon a coal gasification process that allows the coproduction of electricity and hydrogen, can provide combined quotas of these two energy carriers in a wide range of power outputs. Hence, it is able to operate in a flexible mode. “Flexible operation” refers to the capacity of a plant to operate under certain previously selected conditions.

Hydrogen and electricity are expected to play an increasingly important role as interchangeable energy carriers in a future sustainable energy economy. Both wells can be co-produced from different fuels as coal or natural gas. This approach is based on coal transformation because it is abundant, it has a wide geographical distribution, and its price is relatively stable. Besides, the Green Paper 2006 of the European Commission alerts over the dependence risk in case of a natural gas-based electricity generation in Europe. However, in the context of climate change the Green Paper 2006 states that the use of coal for electricity production is only sustainable if accompanied by commercialized carbon sequestration and clean coal technologies on an EU level.

The first question that has to be answered in order to develop a dual-nature plant is that of the technology available that would be suitable for such a concept. This work should start by reviewing the basics of the coal gasification process and continues by trying to map all the technological options currently available in the market as well as possible future trends. Besides, it offers an overview of the operating conditions and outputs of each process in order to provide the modeler with a useful information tool enabling an easier analysis of compatibilities and implementation of the model.

1. **Gasifiers**
   - 1.1 Types of gasifiers
   - 1.2 Commercial technologies
   - 1.3 Matching gasifiers to coals
2. **Water – gas shift reaction (WGS)**
   - 2.1 Clean Gas Shift