Decarbonisation options of existing thermal power plant burning natural gas

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Abstract. Nowadays power industry faces deepest crises ever with unprecedented prices shocks and climate challenges at the same time. From one hand we realise the need of energy transformation of power industry towards more sustainable future with climate neutral technologies. From the other hand it become obvious that this change could not happen immediately, and transition period is needed with some fossil fuel technology still playing an important role as a back-up for renewable energy sources. The biggest question what the best and cost-efficient way is to decarbonise existing thermal power generation. We try to address it on the example of existing combined cycle gas turbine (CCGT) power plant fuelled by natural gas. Clearly the following possible options were identified: 1) replacement of natural gas with alternative gases, such as green hydrogen, bio or synthetic methane, 2) carbon capture and underground storage (CCS) in geological formations, 3) carbon capture, liquefaction and export, 4) carbon capture and utilization (CCU) or 5) replacement of power generation technology.

In this publication we try to compare these different options, despite they are not clearly comparable. For the analysis we take natural gas fired CCGT plant Riga TPP-2 in Latvia with installed capacity of 881 MW (in condensing mode).

Option 1. In order to completely (100 % in energy values) replace natural gas by green hydrogen, we need electroliers with capacity of at least 2600 MW. Very roughly this is an investment of at least 2,6 billion EUR for hydrogen production, storage and supply. Additionally, we shall take into account necessary modernisation of CCGT plant to be capable for 100 % hydrogen firing as well as necessity to construct additional wind or solar capacity. Conversion efficiency from power to gas is approximately 60 %, while from gas to power – around 55-57 %. Overall conversion efficiency is 33-35 %. The main advantages of this option are a) possibility for wide use of renewable energy sources (wind and solar) in hydrogen production, b) avoidance of carbon dioxide emissions during the electricity production, c) possibility to supply a surplus of hydrogen to transport sector and industry, d) avoidance of all problems associated with CCS option, including the ban for geological storage of CO_2. The main disadvantages of this option: a) very high costs of hydrogen production, b) very low conversion efficiency, c) necessity to convert CCGT plant for hydrogen combustion and to install considerable wind and solar capacity.

Keywords: carbon capture utilisation and storage (CCUS), green hydrogen, synthetic fuels.