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The global comeback of coal-to-liquids (CTL) technologies: can CCS make CTL compatible with climate protection needs?

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Relevance: Facing a growing global energy demand and rising oil prices, a diversification of coal utilisation is being fostered by prominent industrial and political decision-makers. In that context, coal-abundant nations are strongly pursuing the development and deployment of technologies which could reduce their dependence on crude oil imports by converting coal into synthetic liquid hydrocarbon fuels – called coal liquefaction or coal-to-liquids (CTL) technologies. The International Energy Agency (IEA) projects that if the current development proceeds until 2050, global fuel demand will grow from approximately 2.100 million tons of oil equivalent (Mtoe) in 2005 to 4.700 Mtoe in 2050 - 22% of which are expected to be supplied by CTL and gas-to-liquids (GTL) facilities. The scenario estimates that the increasing demand for liquid fuels will cumulate to a total CTL investment of approximately € 320 billion (IEA 2008: Energy Technology Perspectives 2008. Scenarios & Strategies to 2050, Paris). Research Objectives: A global deployment of CTL technologies is likely to lead to a conflict with climate protection needs as the technology is highly carbon intensive. However, CTL processes which are based on coal gasification and Fischer-Tropsch synthesis indicate good conditions for CO2 capture and storage (CCS) as coal gasification produces a highly concentrated CO2 stream and Fischer-Tropsch catalysts require a synthesis gas which is essentially free of CO2. Hence, CO2 capture is an integrated component of the CTL system. The presentation is based on results of a PhD project which includes a multi-criteria analysis of driving forces and barriers for CTL technologies in two potential CTL lead markets – the United States and China. It shall analyse if CCS is capable of making CTL compatible with climate protection needs and which quantity of carbon dioxide – with and without CCS – in comparison to conventional fuel would be discharged if CTL production scenarios for China and the U.S. were realised. Both countries were selected as case studies since they have articulated strong interest in CTL due to the combination of high national demand for liquid fuels, scarce domestic oil reserves and abundant coal reserves. In order to meet the outlined research objectives, the presentation consists of the following sections: Overview of announced CTL plants: At the beginning of the presentation, an overview of globally planned CTL facilities and – if available – information about involved stakeholders, the state and costs of each project are presented. The survey shall imply a focus on projects in the U.S. and China. CO2 intensity as a barrier for a global comeback of CTL: Based on stakeholder interview, a brief taxonomy of driving forces and barriers for a global deployment of CTL is elaborated. The taxonomy shows that while economic barriers are likely to be overcome if CTL is supported by strong industrial and political stakeholders, its high carbon intensity is perceived as a major barrier towards commercialisation. Lifecycle analysis of CTL with and without CCS: This section illustrates the lifecycle greenhouse gas (GHG) emissions of CTL fuel in comparison to conventional diesel or other alternatives and shows to which degree CCS is capable of making the lifecycle of CTL climate compatible. The role of CCS in the political CTL discourse in China and the U.S.: The presentation investigates the question to which degree political decision-makers in the U.S. and China consider CCS as an inevitable precondition for the deployment of CTL. This discussion will comprise an analysis of CTL policies – especially carbon standards included in legislative proposals for CTL subsidies in the U.S. Congress. Estimated carbon footprint of CTL in the U.S. and China: Based on the presented CTL lifecycle data, the presentation presents an estimate of the resulting GHG emission discharge if CTL supply projections for China and the U.S. by the International Energy Agency and the U.S. Energy Information Administration were realised. In a second step, the presentation quantifies the amount of GHG that would be stored in case CTL was combined with CCS. Impact of CCS on the market prospects of CTL: This section shall conclude if or to which degree CCS may help CTL to overcome the 'carbon barrier' or if other mitigation measures or fuel options are needed. Summary of Results: At the time being, 31 CTL plants have been announced globally, ten of which are located in China and 13 in the U.S. Among Chinese CTL plants, four facilities are already under construction (total capacity: 32.000 barrels per day) whereas six plants are at a feasibility or engineering stage (total capacity: 340.000 barrels per day; capacity of two plants is not yet publicly available). In the U.S., no plant is yet being constructed. Total capacity of all CTL facilities planned in the U.S. is 332.000 barrels per day. Without CCS, CTL well-to-wheel (WTW) emissions per produced barrel of

fuel are nearly twice as high as the WTW emissions of conventional diesel. This mainly entails from CTL's immense well-to-tank (WTT) emissions which supersede those of petroleum-based diesel by a factor of eight. Due to CTL's high carbon intensity, most CTL-related legislation in the U.S. Congress contains carbon standards which make CCS an inevitable precondition for CTL deployment. For example, CTL fuels only enjoy a so-called Alternative Fuel Tax Credit if 50% of the CO2 generated during CTL processes is captured and stored. In China, no carbon standard for CTL facilities has yet been adopted but the CO2 problem is gaining relevance. Hence, CTL could become an important area of application of CCS. However, even in combination with CCS, CTL WTW emissions are about 6% higher than those of conventional diesel. Besides high WTT emissions, this may be explained by the fact that CTL's TTW emissions are nearly as high as those of conventional diesel. Conclusions: Combining CTL with CCS merely avoids a significant increase in carbon emissions but does not achieve CO2 reductions below the status quo. CCS, thus, is not sufficient to make CTL compatible with global climate protection needs. Hence, further mitigation measures, such as co-firing of biomass, or new fuel options, such as the production of hydrogen via coal gasification with CCS, would be needed to make coal a climate compatible option for the transport sector.