Identifying National and Regional Carbon Sources for Synthetic Fuel Production: Case Study for Finland

Hannu Karjunen, Tero Tynjälä, Timo Hyppänen
Lappeenranta University of Technology
Finland

Introduction

The global share of solar and wind in electricity generation could increase to 50 % by 2050 [1,2]. Energy systems with large amounts of intermittent energy sources require more rigorous power stabilization and storage services than conventional systems. **Power-to-gas** can produce synthetic fuels, which can be used for energy storage or transportation, for instance.

The manufacturing process for hydrocarbons requires two basic components: hydrogen and carbon dioxide. **Hydrogen can be obtained from electrolyzers**, ideally operated with low-cost sustainable energy such as solar and wind power. **Carbon dioxide could be captured** directly from air, or from stationary point sources, e.g. power plants.

The objective of this work is to identify the potential carbon sources for large scale application of P2G in Finland, and to investigate the different infrastructural challenges associated with P2G deployment. Focus is on the scale of CO2 sources, size of storages and the consequences of different configurations of CO2 capture.

[1] IPCC. Climate Change 2014: Mitigation of Climate Change

Methodology

A model has been developed to track the amount of CO2 emitted by the energy sector in Finland in an hourly time resolution. The CO2 emissions are also distributed to smaller regions according to current statistics. A similar approach is done for the demand side by predicting the synthetic fuel demand in different regions. **CO2 balance can be formulated for each region**, and as a result the required storage sizes are obtained and, if necessary, possible transportation routes and costs for CO2. An in-depth analysis of single regions is possible when details about individual plants are fed into the model.

**Conclusions**

The final extent of P2G technology adaptation is unknown at this moment. Deployed pilot P2G units in the world are using high quality CO2 sources, such as biogas. Bulk production would require shifting to more conventional CO2 sources, such as pulp and paper facilities and baseload power generation units. Seasonal fluctuation of CO2 generation dictates that storages are required unless intermittent operation is accepted.

The largest factor for CO2 price for P2G is likely the cost of capture, both in terms of investment and operation cost. Pipe transport requires large quantities of CO2 to be economically viable. Rail transport could be a feasible alternative for smaller quantities. The geographical deployment of P2G has important consequences in the electric, gas and heat grids that should be investigated further.

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