

Feasibility Study Power-to-Hydrogen/Hydrocarbons (PtH₂/HC): Potentials & Value of PtG in Switzerland for the Mobility Sector

In behalf of BAFU (Federal Office for the Environment) Empa and PSI are investigating the potential of PtG technologies for synthetic fuel production in Switzerland mainly. In this context, data of the electricity grid, gas grid, CO₂ Sources, fuel demand, the mobility grid and a lot of other knowledge about the Swiss energy system is crucial. Spatio-temporal data is of special importance, especially the interconnection of data and its geographical position, since supply and demand are mostly not at the same location or time available. Therefore an object oriented database fed with open data and private data is in development. This data will be the foundation of a GIS based technology & site identification and PtG production cost analysis.

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Introduction

To reduce GHG emissions of the mobility sector dramatic decrease in fossil fuel consumption has to be realised. This can be achieved by more efficient vehicles, less CO₂ footprint in fuel production and reducing mobility demands. Independent of vehicle technology it is important, that renewable energy is used to drive the vehicle (Fig.1). Thus not only the concurrent time of renewable energy availability and demand is an important factor but also the geographic / spatial location of those.

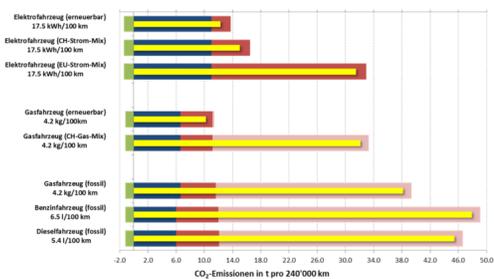


Fig. 1: CO₂-Emissions of electric and combustion based power trains comparing Life Cycle GHG Emissions incl. Fuel production.

Today's Renewable Electricity Production Source for Electricity Based Mobility?

Renewable energy, today and in future, will mainly be provided in form of electricity. To identify the potential of available electricity for synthetic fuel production the current situation has to be analysed. Already in 2014 about 2.8 TWh of Swiss electricity production has been exported during summer (Apr - Sept) while spot market prices were < 50 €/MWh (Fig.3 bottom). Future electricity based mobility will strongly bias future demand profiles. Thus, it will be critical at which daytime and geographic location electricity for future mobility will be demanded, because the momentary CO₂ footprint of electricity is changing. Allowing high efficiency and high flexibility in electricity based mobility along with low CO₂ footprint are often contradictory goals.

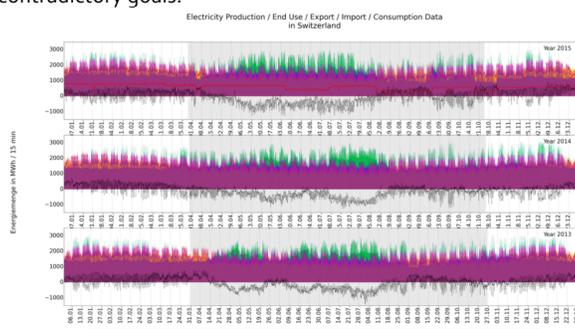


Fig. 2: Swissgrid (Open Data [1]); black line → Swiss residual load **Top:** Year 2015 **Middle:** Year 2014 **Bottom:** Year 2013

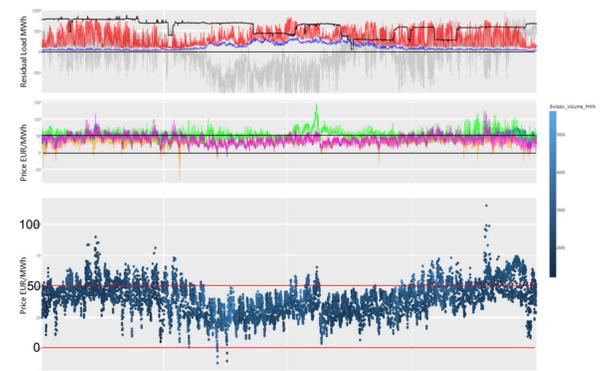
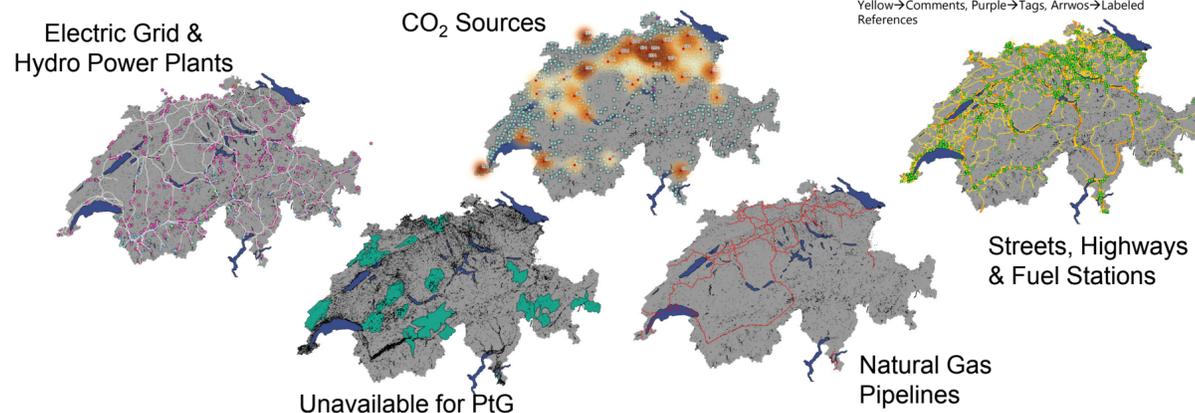
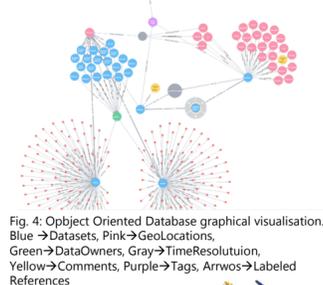


Fig. 3: Data of 2015 **Top:** black line → nuclear el. Production 2015; blue line → Waterflow of Rhone in m³/s; red line → el. Production of Vallais **Middle:** Spot market prices of Germany-Austria (orange), Switzerland (blue), France (magenta), Italy (green) **Bottom:** occurrences of net electricity export volumes in the night between 19:00 and 08:00 with Swiss spot market prices assumed

Object Oriented Database (OOD) & GIS supported PtG prod. cost analysis

- GIS Data and time resolved data stored in OOD (Fig.4).
- Central data management allows visualisation and relevant spatio-temporal calculations
- Data sources: Open Data, industrial & governmental partners labeled according NDA
- Site selection through GIS data
- PtG production cost analysis using time resolved and geo data.



Expected Impact

Our investigations will allow to identify locations, time and situations in which PtG plants are to a high degree beneficial to the Swiss energy system and mobility GHG emission reductions. According to laws and regulations, as well as consumer incentives, the results may strongly differ. The tools will allow to have an overview of the data, visualise the content and identify relations in time and space between data from many different sources. Finally, respecting made assumptions, a heat map of PtG production costs will be provided to the BAFU. If applicable, open data in the database can be shared with the community to enhance energy related research.

References

[1] Swissgrid https://www.swissgrid.ch/swissgrid/de/home/experts/topics/energy_data_ch.html

Partners