The importance of bioenergy and green gas technologies in decarbonisation of energy systems.

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Overview

Because of the need of greenhouse gases (GHG) emissions reduction, energy sector has to be decarbonized. Biomass can play a main role because because CO2 releases of biomass uses are compensated by the CO2 absorbed by the biomass during its growth, so the balance for the entire life cycle is equal to 0 emissions, even negative if coupled with some carbon capture and storage (CCS) devices. Furthermore biomass can be stored and used in periods where intermittent energy isn't available.
Traditional biomass use is direct combustion, while modern biomass is upgraded for electricity, heat, biofuel and biogas production..

Green gas technologies such as methanisation, gasification and power to gas are particularly in development aiming to increase the quantity of green gas in the actual gas network.

In order to plan energy strategies to reach secure, efficient and cost-effective decarbonization, all these interactions between resource feedstock, valorization technologies and final uses have to be highlighted in modelling. Only few research papers address the role of biomass supply chains such as methanisation, gasification, methanation and green gas paths as independent decarbonisation options for energy system. We will wonder what will be the trade-offs and arbitrations in the use of bioenergy and green gas in the XXIth century energy context in determining the proportion of each technology in future energy mixes.

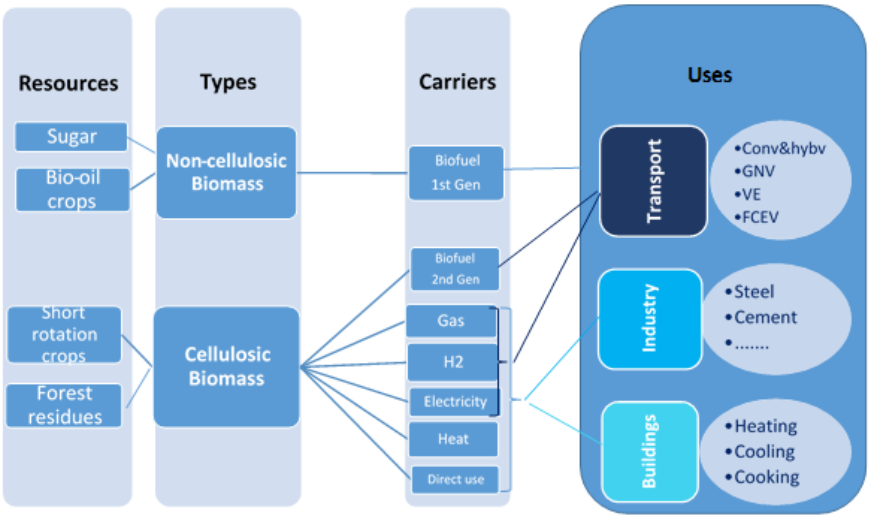
Methods

We will use bottom up long-term modelling tool POLES[1] (Prospective Outlook on Long-term Energy Systems) a recognized simulation model for worldwide energy supply, demand and prices to carry out energy scenarios that span across until 2100.

First we analyse the current modelisation in POLES for biomass feedstock and gas technologies and adapted the different relationship. We adopt the new framework represented in the figure below.

Then we implement simulations with the model to see the future energy mix for 2030, 2050 and even 2100. Two main scenarios are created. A baseline that represents the business as usual case and also known as RCP8.5 in IPCC Fifth Assessment Report reports is considered. An other with some carbon constraints named <2°C scenario (RCP2.6 for IPCC) where climate policies are implemented triggering carbon emissions reduction. In addition, we separate this last scenario in one with the possibility to use carbon capture and storage (CCS) technologies and an other without.

[1] For more information about the model, the description by Enerdata can be found thanks to the following link: https://www.enerdata.net/solutions/poles-model.html



The strength of this study is the consideration of the whole valorization supply chain: the resource potential, the process implementation and the valorization field. Sensivity analysis are also performed on carbon price evolution, technology maturities and costs in order to create a decision tree depending on these key parameters. Technologies and processes penetration rate in the future energy mix are then quantifiable. Last but not least, thanks to POLES framework we will be able to produce these results in different remarkable areas such as European Union, the United States, China, India, Brazil and developing countries to see local subtleties depending on local operating conditions.

Results

We will see the evolution of electricity production, biogas production as well as CO2 releases, etc. The contribution of each valorization path is detailed as well as if they go along or compete with other energy technologies. Overall biomass consumption for energetic purpose and overall green gas production is estimated likewise the repartition through the different final use. Obviously, the climate policies scenario fosters the development of advanced bioenergy valorization and green gas process but different trends appears for the regions concerned. advanced valorization into electricity is more developed in northern countries when biofuel is preferred in southern countries. The sensitivity analysis on technologies maturities or processes cost allows us to quantify the expansion of bioenergy processes or green gas ratio in gas network according to R&D programs and industrialization advances. Hence we are able to assess the role of each technology for the decarbonisation and draw some conclusions on the futures for biomass valorization and green gas importance.

Conclusions

There is no doubt that different technologies of biomass valorization and the utilization of gas network are becoming more and more important in energy systems with the need of decarbonisation. They bring flexibility and security for needs fulfillment in a proper way. This environment is complex but the capture of interactions and competitions between biomass process and other energy technologies is a clue to better describe the decarbonized energy mix for the future. This study based on one long term energy modeling tool focusing on bioenergy and green gas valorization paths is the beginning for a larger work dealing with other resources for flexibility options in the energy system to estimate their own role in the decarbonisation. Some final uses will be also taken into account, in particular, opened with green gas and electricity vector, the mobility will be deeply studied in order to quantify the penetration of clean mobility tomorrow.