The second life for gas:

Optimizing decentralized load balancing through the use of locally available gas resources.

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Summary

The European Union is striving for a high penetration of renewable energy production in the future energy grid. Currently, the EU energy directive is aiming for 20% renewable energy production in the year 2020[1]. In future plans the EU strives for approximately 80% renewable energy production by the year 2050[2]. However, high penetration of wind and solar PV energy production, both centrally and de-centrally, can possibly destabilize the electricity grid. The gas grid and the flexibility of gas, which can be transformed in both electricity and heat at different levels of scale, can help integrate and balance intermittent renewable production. One possible method of assisting the electricity grid in achieving and maintaining balance is by pre-balancing local decentralized energy grids. Adopting flexible gas based decentralized energy production can help integrate intermittent renewable electricity production, short lived by-products (e.g. heat) and at the same time minimize transport of energy carriers and fuel sources. Hence, decentralized energy grids can possibly improve the overall efficiency and sustainability of the energy distribution system. The flexibility aforementioned, can potentially give gas a pivotal role in future decentralized energy grids as load balancer. However, there are a lot of potentially variables which effect a successful integration of renewable intermittent production and load balancing within decentralized energy systems. The flexibility of gas in general opens up multiple fuel sources e.g., natural gas, biogas, syngas etc. and multiple possibilities of energy transformation pathways e.g. combined heat and power, fuel cells, high efficiency boilers etc. Intermittent renewable production is already increasing exponentially on the decentralized level where load balancing is still lacking [3].

There is a big need for decentralized load balancing. The system achieving this should be optimized on sustainability, efficiency, stability and economics. From the aforementioned, one can conclude that there is a need for an optimization tool. The Flexigas project is working towards economic and sustainable integration of (bio)gas into future decentralized energy system[4]. One of the main goals is to design a modeling tool called the (Dynamic) BioGas Simulator. The theoretical background (methodology) of the simulator is based on the industrial metabolism concept and life cycle analysis. The method allows for the integration of local dynamic factors, multiple fuel sources and transformation pathways. This is achieved by integrating three known methods into the BioGas simulator. First, the Material Flow Analysis method is used to simulate the decentralized energy system. Second, the Material and Energy Flow Analysis method is used to determine the direct energy and material requirements. Finally, the Life Cycle analysis is used to calculate the indirect material and energy requirements. Complexity in the method is handled with a modular approach that separates the whole system into individual physical processes. Dynamics will be introduced through the use of hourly intervals and relative patterns. Furthermore, combining the developed theoretical background with the developed Dynamic BioGas Simulator will result in a faster and better explorable set of results than using a static model with a static simulator. Running thousands of simulations with all kinds of variations is now possible, where time and the dynamics of demand and production can be taken into account. Using the many calculations as mentioned, the reverse process can also be calculated. Given that we want to minimize our environmental impact and carbon footprint or maximize our efficiency, the model can calculate the best combination of applicable input parameters or market conditions to achieve the given.

The resulting BioGas simulator will be capable of integrating fuel availability, energy demand, flexible energy production and energy production by intermittent renewable sources, such that conclusions can be drawn on the sustainability, efficiency, flexibility and economy of load balancing within local decentralized smart energy grids. The tool can be programmed with average data, retrieved from literature, giving a general overview or it can be programmed with more precise data, referring to a specific location, to give a more specific indication of performance. Together with future research the tool can help determine, first, if decentralized load balancing is a suitable solution for renewable integration, second, how much gas is required to achieve the previous and finally, how the flexibility of gas can be used most effectively in specific decentralized energy systems. The model can indicate the big need for decentralized load balancing, which can usher in a second life for gas and the gas network.

Sources

[1] DIRECTIVE 2009/28/EC of the European parliament and of the council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance)
[2] European Union, Energy Roadmap 2050. Publications Office of the European Union, 2012 ISBN 978-92-79-21798-2 doi:10.2833/10759
[3] Eurostat, 2012. Eurostat renewable energy production in Europe in 1000 tons of oil equivalent (EU 27 countries) http://epp.eurostat.ec.europa.eu/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=ten00082&language=en
[4] The Flexigas project 2013, www.flexigas.nl