Transformation of the Energy System and Climate Protection in the Hanover Region: A toolbased Analysis

Masterarbeit

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1. Introduction

Transformation of the German energy system is one of the intensively discussed topics in German politics. It's affecting everyone's daily life, due to its influence on cost for heating, electricity and mobility. It becomes visible due to solar panels, wind turbines, biofuel production and new energy grids. According to a survey (Vzbv & forsa, 2013) generally 82% of the German population support the Transformation of the Energy System (TES). As main problem 52% complain about increasing energy prices and only 40% of the society are pleased with the current implementation of the TES. According to a (AEE, 2012) the support drops if the TES results in actual projects like free field solar park's (77%), wind turbines (61%) and biogas plants (36%). So obviously a Not in My Backyard (NIMBY[1]) position exists, which slightly decreases if projects are implemented.

In this context people complain about a change in the countryside due to the wind turbines and high voltage power lines, a "Vermaisung" of the landscape and smell from biogas power plants. On the other hand the most accepted technology, photovoltaic, is currently as well the most expensive, has overcapacities on sunny summer days and a lacking supply in winter.

This analysis develops a pathway and shows options for reaching the Hanover's regions aim to become climate neutral in 2050. Therefore this analysis takes a holistic view on the energy system focusing especially on the cost of different types of renewable energy generation, energy storage and energy consumption. Aim is to create an accepted, payable energy system, with local value creation and higher comfort level.

1.1. Review of existing energy concepts

As basis and inspiration for this energy concept existing studies should be used. The regional most suitable would be the "Masterplan 2050" project.[2] Unfortunately currently only preliminary studies are available. One of them is (Siepe, 2011), pointing out, that it is technical possible to supply the Hanover Region with a main combination of solar (24%); wind offshore (24%) and wind onshore

[1] NIMBY describes general support for a policy, but resistance against having its consequences in your direct surrounding.
[2] (Hannover, 2013)

(19%) and biogas (8%). But it is lacking the answer which monetary cost would occur and how questions like energy storage (especially electricity) can be solved.
As preliminary work for the "Masterplan 2050" each district and town of the Region has created own ideas for energy saving. They are all very small scale and regional and identify potentials for regional cooperation's and measurements which might lead to energetic renovations and electricity savings. They identify local, concrete and feasible quick wins and create local awareness for climate protection. Thereby they are a valuable contribution in the short term and for local policy, but their share in a long term and regional scale concept is very limited, due to a lack in prognosis and abstraction level.

Another regional concept is the written by the (NMU, 2012). It provides on overview over the status quo and the potentials until 2020. Its main focus is on electricity generation. In this area lower Saxony is likely to be mathematical self-sufficient[3] (90% excluding, 150% including offshore wind power). In this context the forced modernization and up scaling of energy grids ("Netzausbau") as well as smart grids are mentioned. It also points out, that energy saving in buildings has to contribute for reaching the concepts 80% CO_2-emission saving target until 2050 (40% until 2020 base year 1990). As energy promising energy storage compressed air and power-to-gas (P2G) are mentioned. As P2G technologies the conversion of electricity to methane (Synthetic Natural Gas ((SNG) or Hydrogen (H2) are available and described in section 2.
Furthermore Battery Electric Vehicles are seen as promising smart demand technology for electricity substituting fossil fuels and being carbon neutral if fueled with renewable electricity.
Energy plants are described as controversial topic, due to its conflict with food production and negative impacts of intensification of food production on one hand, but its income generation potential for farmers and its carbon saving on the other hand. Overall the concept concludes that the focus should remain on food production but the potential of bio-waste should be used.
The concept describes the additional potential of hydro energy as very limited; hence locations with favorable topographic conditions are already used.

The (Metropolregion, 2013) offers interesting visions for integration of renewables in live and environment like a "Energy Alley", using mainly unpopulated areas along the freeway A7 as

[3] Mathematical due to time differences in electricity production and consumption, resulting in electricity imports and exports

Photovoltaic has an economic and green potential for those who are willing to accept changes. This includes changes in vehicle engines and countryside. At this point a Carbon free future might be at side. If so the limiting factor of concentrated CO_2 might induce a change from natural gas and SNG to Hydrogen, including a change to hydrogen instead of natural gas grid.
The excess heat from Biogas, SNG and H2 production as well as the production of electricity from natural gas can be used for district heating.
In an optimistic scenario in 2050 the substitution of fossil fuels by electric vehicles, SNG or H2 will be in a late stage and Hanover Region climate protection aims met.

6. Limitations and Outlook

The tool is able to predict future, average production cost and technological learning. In this field especially for infant technologies like Fuel Cells, HEV, BEV, Batteries and offshore wind energy the statistical estimated PR differ. This is the main source of uncertainty in the technological forecasting part. Furthermore often two or more factor experience curve performs better than one factor. Especially patent growth as valuation of research effort often has a strong influence.

The important issue of energy taxation and subsidies and replacement of existing fossil fuels taxation is only included in the tool if they are directly part of the energy prices.

So this system should be seen as direction, where if on technology e.g. Photovoltaic develops worse a better established like wind energy can take its place.

In the field of Batteries Li-Ion is not the only technological Option. Other battery types might perform in the long run better.

The bottleneck of the tool is the energy market and its lack of any real time data. Oversupply and demand lacks are the main driver for technologies like Electrolysis. Also BEV connected to high voltage are able to have a high energy uptake as well as electric heat pumps. Also CHP and Fuel Cells change their viability dependent on the peak price.

The mobility calculation has further improvement potential, with actual distances driven by people and irrational factors influencing car purchase decision.

In the heating and insulation area a finer granularity of renovation actions is likely to identify some economically viable renovation options.

Overall the large amounts of options which can be changed have to be considered making this tool difficult to handle. A menu, offering development scenarios without showing all logic behind, would make the tool easier to handle.