PATHWAYS FOR BLENDING HYDROGEN INTO THE NATURAL GAS NETWORK

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Introduction

Green hydrogen is being researched as a sustainable energy carrier for a variety of uses especially in the industry and heavy duty transport sector, as well as a way to store renewable energy at a utility scale. It represents the chain that connects the variable renewable sources of energy with the demand independently of the time frame (day/night, summer/winter). Blending the hydrogen into the existing natural gas pipeline network is seen as an important stepping stone towards a hydrogen based gas sector. This is an approach from which both sides, the hydrogen as well as the conventional natural gas sector, can benefit from. The gas mixture offers a decrease of the greenhouse gas emissions for the corresponding share of hydrogen. In addition, the blending could provide a significant and consistent source of demand for hydrogen producers, enhancing the scaling up of hydrogen production units. [1]

One of the biggest challenges for the usage of hydrogen are represented by the production costs which at the present are high (14 c/kWh) [2] compared to the energy share of natural gas price (3,7 c/kWh) [3]. Researches which provide significant learning rates and incremental changes in the investment costs as well as supporting programs and policies predict a significant decrease of the hydrogen costs, especially from the year 2030 onwards. As we face a rapid growing of the CO_2 and natural gas prices in the near future, it can be concluded that hydrogen will become cost-competitive with the natural gas.

The aim of this work is to propose ramp-up curves of the share of hydrogen into the gas network instead of facing-up the challenge of an immediate transformation to a 100% hydrogen distribution network. Storing and transporting hydrogen within the gas blend can offset the cost of building dedicated hydrogen infrastructure, particularly in the early stages of market development.

Methodology

In investigating the breakeven point (BEP) at which green hydrogen becomes cheaper than fossil natural gas, the specific production costs of hydrogen and the energy share of the natural gas price were compared. For the sake of the comparison, the future natural gas price including the CO_2 certificate price and the local gas demands between 2025 and 2050 were researched based on two scenarios, whereas the development of the green hydrogen production costs was considered the same in both cases. The “Mitigation” Scenario represents a more conservative approach and aligns the development of the prices for natural gas (energy share) and CO_2 certificates with the WEM Scenario (With Existing Measures) [4] of the Environmental Agency Austria (EAA). The “Decarbonisation” Scenario represents a possible path towards decarbonized gas sector supported by a significant increase of the natural gas and the CO_2 prices according to the “Transition” and “WAM+” Scenarios [4] of UBA. In addition, a certain share of bio-methane according to the Austrian Hydrogen Strategy which follows a linear interpolation for the future share was also accounted for in both scenarios. Together with the future gas demand, possible transitional pathways of covering a certain energy share with renewable gases were calculated. The costs of the gas-mixture were calculated according to the following equation:

$$C(gas-mixture) = x(H_2)\cdot C(H_2) + y(bio-CH_4)\cdot C(bio-CH_4) + (1-x-y)\cdot C(NG)$$

Where: C – costs of the corresponding gas; x, y – shares of the corresponding gases

By adding hydrogen and bio-methane, the costs of the mixture will be higher than the costs of only natural gas in the network, until the breakeven point is reached. The reason behind that are the higher specific H_2 and bio-CH_4 production costs compared to the costs for natural gas which consist of the energy share of the end-customer price and the corresponding CO_2 price. This means that from

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economic aspect, the transition towards decarbonized gas grid will be from 0% hydrogen before the BEP to 100% hydrogen after reaching the breakeven point between the specific costs of the two gases. To avoid that and to show possible gradual addition of the green gases, the biggest challenge is to limit and close the cost gap. In order to achieve that, this methodology is based on setting the total costs of the mixture to be equal to the total costs of a 100% natural gas network, and to use the costs for the CO_2 certificates as a way to incentivize the hydrogen production.

Results and conclusions

The analysis shows that the most crucial variable in this approach is the price of the CO_2 certificates. Different developments of the future CO_2 prices and their influence was investigated. All led to the conclusion that the renewable gases will achieve cost-competitiveness in the period around the year 2040 depending on the assumptions in the scenarios. The transitional paths represent the add-mixture of hydrogen and bio-CH_4 (energy share in %) in the gas grid from the year 2025 until 2050 with focus on decarbonisation of the gas supply in the corresponding BEP (Figure 1). However, it is not an input point for dedicated H_2–grids which will be necessary from 2035 onwards.

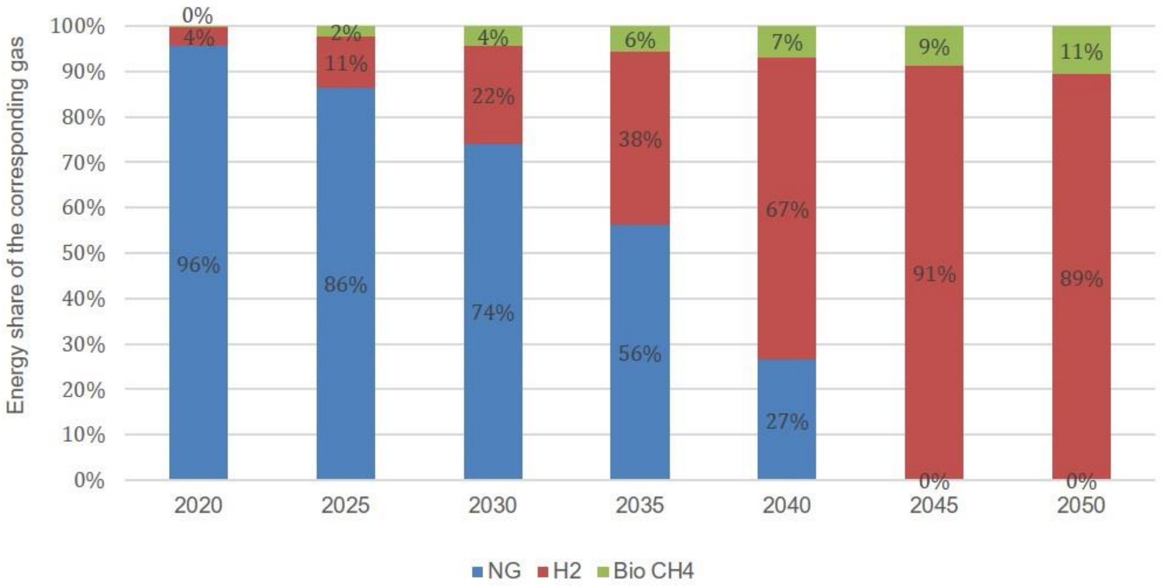

Figure 1: Composition of the gas in the analyzed Mitigation scenario

Before the BEP is achieved, a certain share of hydrogen and bio-methane can be injected in the gas network followed up by additional costs which can be covered by the costs for the CO_2 certificates. This accents the need for incentivizing and supporting the scaling-up of renewable gases, especially hydrogen. The mentioned incentivization of the blending of natural gas can be of an important meaning in the early stages of larger-scale hydrogen production units by providing a stable demand for hydrogen. This could pave the way for future scenarios in which some systems convert entirely to hydrogen.

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