Precious fuels for everything? The Role of Green Gases for achieving climate-neutrality in Austria[1]

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Austria aims to become climate-neutral by 2040. Green gases, such as hydrogen and biomethane, which do not produce CO2 emissions, will play an important role in achieving this goal. However, a more detailed assessment shows that the production of these gases is costly and will require significant land areas. The use of green gases should therefore be limited to those sectors where there are no alternative options for decarbonisation. In particular in the heating and mobility sectors, the use of green gases should be minimized.

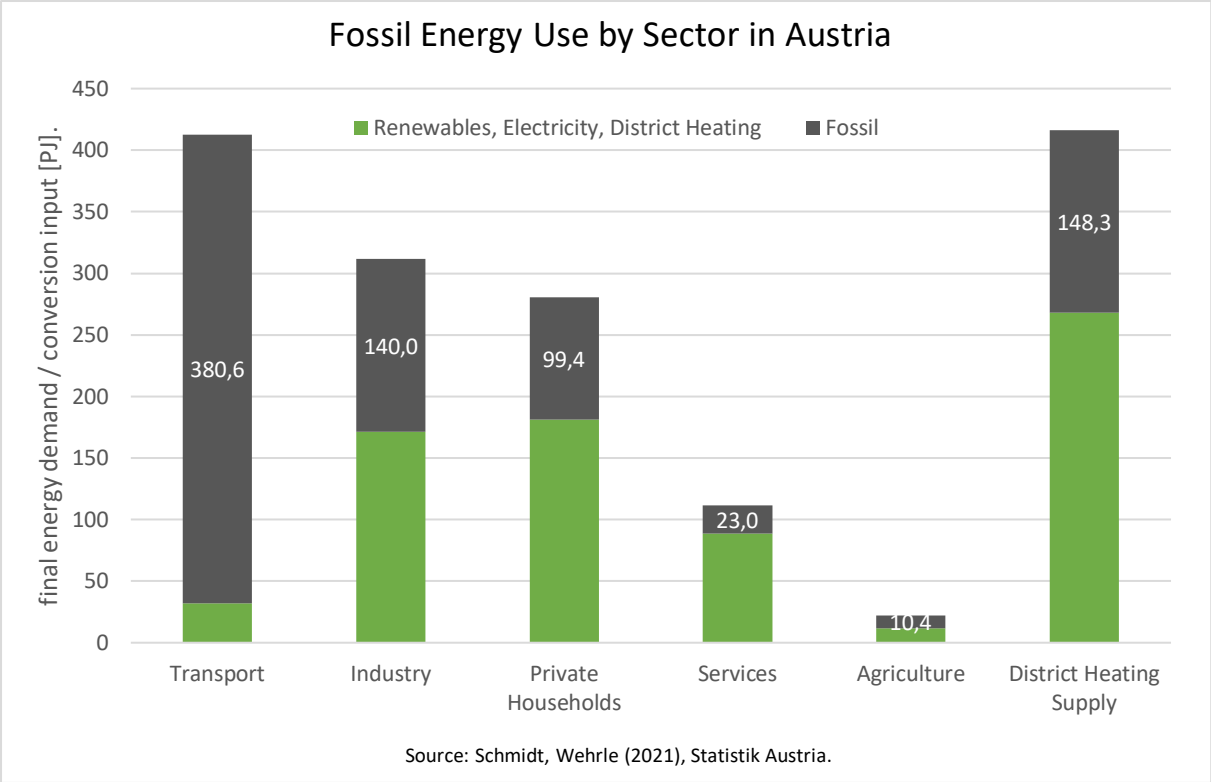
Climate neutral by 2040

The federal government has set itself the goal of making Austria climate-neutral by 2040. In other words, no more greenhouse gases should be emitted than are sequestered in Austria, for example by our forests. The most fundamental contribution to this goal is ensuring that our energy consumption no longer causes greenhouse gas emissions in the future. This would mean that, starting today and for the next two decades, the consumption of fossil energies would have to drop every year by a similar amount as in the pandemic year, when lockdowns decreased fossil energy use significantly.

Decarbonisation of all sectors necessary

The following graphic illustrates the challenge: Considerable amounts of fossil fuels are still used in all sectors. In particular, transport, industry, but also households and electricity and district heating supply still consume large quantities of natural gas, oil and coal.

[1] translated from https://awblog.at/die-rolle-von-gruenen-gasen-fuer-ein-klimaneutrales-oesterreich/



Source: Schmidt, Wehrle (2021), Statistik Austria.

Biomethane from biomass and hydrogen from green electricity

So-called "green" energy sources could replace these fossil fuels. Already today, the production of biogas and biofuels from biomass is technologically mature: they can be produced from agricultural products such as corn or wheat, from wood, or from biogenic residues. However, green gases and fuels can also be produced from hydrogen – which in turn can be produced by electrolysis, i.e. by splitting water electrically using electricity. However, only if the electricity used for this purpose is renewable, those gases are called “green”. There are also several other options of producing carbon neutral hydrogen, such as from nuclear power ("yellow" hydrogen) or from fossil natural gas, capturing and storing the resulting CO_2 underground ("blue" hydrogen).

If Green Gases exist, why don't we simply replace fossil energies with them?

Biogas and biofuels are already being produced today. However, the amount produced is very small compared to the current fossil gas and fuel demand. Nevertheless, the production of biogas and biofuel already requires significant areas of land. European biofuel policy therefore has been repeatedly criticized because fuels from biomass compete with food and feed production and contribute globally to deforestation. Furthermore, it is often doubted that biomass-based gases and fuels can make a significant contribution to climate neutrality at all, in particular if they cause large-scale deforestation. Of course, waste or residual materials could be used to ensure the energy supply. However, the available amounts are very limited. All available potential studies for Austria show that even under very optimistic assumptions, a maximum of one seventh of the additional green gases needed to reach carbon neutrality can be generated from residual materials. The simple reason is that most residual materials find a use already today and are, for example, burned to generate electricity or used as materials, for example to produce wood fiberboards.

Hydrogen is expensive and requires land-intensive infrastructure

Technologies for producing green hydrogen from (renewable) electricity exist today only as pilot plants. Compared to biomethane, however, the production of green hydrogen requires much less land. The reason is that the electricity needed to produce hydrogen requires less land than the biomass needed to produce the same amount of energy from biomethane. To produce the same amount of gas or fuel, between 5 and 20 times less land is needed if a mix of photovoltaic and wind power is used for electrolysis instead of using biomass as the raw material for biomethane.

Biomethane and hydrogen are expensive

If land availability in Austria is a significant restriction, these green gases and fuels could also be imported instead of producing them domestically. However, uncertainty about the availability of green gases is high. Potential exporting countries would have to build up corresponding, land-intensive infrastructures. This is already today causing conflicts in some parts of the world. The extent to which more of those conflicts will be accepted for the sake of exports is questionable. In addition, the transport of gases, especially hydrogen, over long distances is very expensive. Imports from regions close to Europe are therefore particularly attractive, but of course also our neighbours in Europe will want to import from there. Imports could play an important role in the future. However, relying primarily on imports of green gases and fuels to decarbonize Austria is a risky strategy.

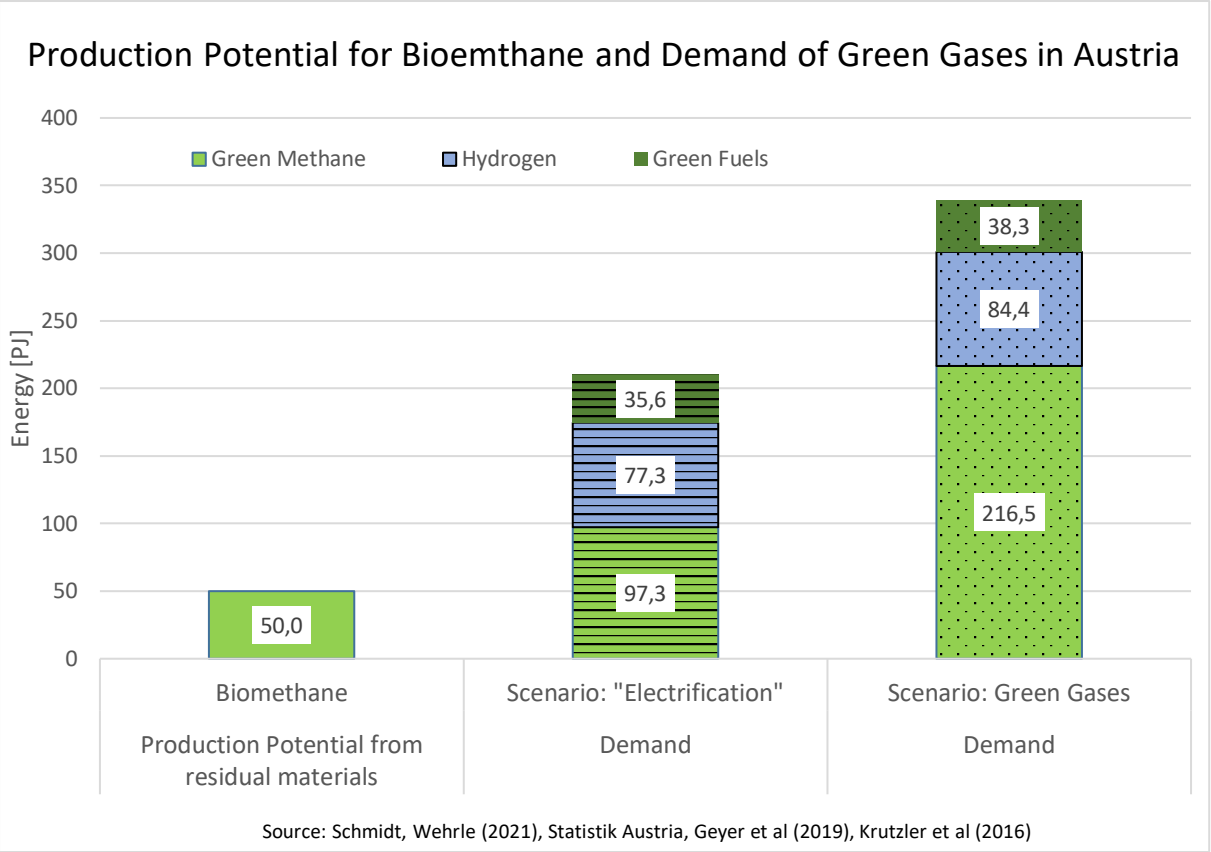
As a result, green gases are also expensive due to high production and transport costs - both compared to fossil fuels and compared to other CO2-neutral options. Estimates suggest that hydrogen imported to Germany costs about 5 times as much as is paid for natural gas in Austria today. Biomethane produced in Austria is probably even more expensive.

What are the alternatives to expensive and costly green gases?

First and foremost, we should reduce our energy consumption as much as possible, for example by adding thermal insulation to buildings. The way we design our built environment must also allow for other, climate-friendly uses. Instead of designing public space to accommodate as many cars as possible, the public space should favour walking and biking in our cities. Likewise, public transportation must be expanded to support necessary changes in personal habits.

"Electrification first!"

In addition, however, there is another very important alternative to green gases: the use of electric power wherever possible, e.g. in battery-electric vehicles or in heat pumps for heating and cooling. Compared with the combustion of green gases, the use of electric power is significantly more efficient. The following graphic shows two scenarios for climate-neutral energy consumption in Austria: In the first scenario, as many end uses as possible are electrified, i.e. powered by electricity. In the second scenario, green gases are used instead, e.g. for heating. In both scenarios, however, there are also applications that cannot be electrified and therefore green gases and fuels must continue to be used (e.g. in industry, heavy or air traffic). If the scenario of greater electrification is chosen, this means that the demand for electricity and liquid and gaseous energy carriers falls from 350PJ to 200PJ, i.e. to just under 60% of the scenario in which green gases and fuels are also used in the heating and mobility sectors.



Source: Schmidt, Wehrle (2021), Statistik Austria, Geyer et al (2019), Krutzler et al (2016)

To understand how big this difference actually is, we calculated how much land would be needed for energy production in each of the two scenarios. The least amount of land - about 1,500 km^2 - would be needed if energy consumption was electrified as much as possible and green gases and fuels were also produced from renewable electricity.

If more Green Gases and Fuels are consumed instead of electricity, and they are generated from renewable electricity, the land requirement increases to over 2,200 km^2. If the green gases and fuels are produced from biomass, this would require almost the entire arable land of Austria, i.e. 13,200 km^2.

What conclusions can therefore be drawn?

Green gases and fuels will play an important role in the complete decarbonisation of Austria. However, they will not be needed on a large scale until a later date - at least after 2035 - because many other measures should be taken first to reduce emissions (e.g. electrification, building renovation, expansion of renewable power generation). At the same time, as few green gases as possible should be used because they are significantly more expensive and land-intensive compared to energy conservation and electrification. Further expansion of infrastructures for the use of green gases and liquid fuels is not efficient in many sectors –in particular for heating and cooling and also passenger car transport. On the contrary, priority areas of application for green gases must be defined now and infrastructures must be adapted accordingly. This is the only way to prevent sunk costs in the future, i.e. if newly built infrastructures today can not be longer used in a few years time.

The complete study by Sebastian Wehrle and Johannes Schmidt can be found here: Edelsprit für alles? Bedarf und Angebot an Grünen Gasen in Österreich / Precious fuels for everything? Demand and supply of green gases in Austria. (2021)