

Power-to-Fuels in Hot-Spots for Renewable-Energy

What do we mean by "Hot Spots for renewable energy"? A global story 2

Project "greenfuel"

The local implementation

3

Many reasons for global trade A new standard!

What do we mean with "Power-to-Fuels in Hot-Spots for Renewable-Energy" In 2016 we developed five central hypotheses on green fuels

- 1. Green fuels are a realistic success factor for the energy transition
- 2. Methanol is one of the good fuel options
- 3. Limited German renewable potentials make an import of such fuels likely
- 4. Other countries have much better conditions for green fuel production
- 5. Green fuel export is an opportunity for development in potential export countries



This reasoning was checked and enriched by the Wuppertal Institute early in 2017

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Project greenfuel

Demonstration of entire value chain of green Methanol in Essen

- The demonstration of the entire value chain of a liquid renewable energy carrier is the first one worldwide
- Project "greenfuel" is part of the "European Green Capital – Essen 2017"
- All parts are realized in the city area of Essen



innogy SE \cdot Dr. Richard Kiefer \cdot 29 June 2018





Project greenfuel

"Air + Water + Electricity = Methanol" – The production of green methanol is located directly at lake Baldeney





Project greenfuel MS innogy Ship naming ceremony on August 25th, 2017 in Essen











Project greenfuel Easy refuelling comparable to gasoline or diesel





Project greenfuel

Fuel cell cars serve as a mobile, private power plant and make private home independent





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Many reasons for global trade

Looking at studies, the electricity demand is just one side of the story...



Electricity demand in Germany (TWh)



Sources: Umweltbundesamt, Fraunhofer ISE (2015), Fraunhofer IWES (2015), ESYS (2017), Umweltbundesamt (2013), Fraunhofer IWES (2012, 2013), ESYS (2015), UBA (2010, 2013, 2014), BDI (2018), BMVI (2015)

...because independent of CO₂-goals, they agree on usage of fuels



Electricity demand for Germany (TWh)



With high CO₂-reductions, these fuels would need to be produced mainly from green electricity!

Where will this happen?

¹ Assumption: overall PtX efficiency: 45%

innogy SE · Dr. Richard Kiefer · 29 June 2018

Sources: Umweltbundesamt, Fraunhofer ISE (2015), Fraunhofer IWES (2015), ESYS (2017), Umweltbundesamt (2013), Fraunhofer IWES (2012, 2013), ESYS (2015), UBA (2010, 2013, 2014), BDI (2018), BMVI (2015)

A clear reason for import of green fuels is the limit of German generation potential!



¹ Assumption: overall PtX efficiency: 45%

Sources: Umweltbundesamt, Fraunhofer ISE (2015), Fraunhofer IWES (2015), ESYS (2017), Umweltbundesamt (2013), Fraunhofer IWES (2012, 2013), ESYS (2015), UBA (2010, 2013, 2014), BDI (2018), BMVI (2015)

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Many reasons for global trade

Green fuels as global commodity will leverage ecological and political benefits



- RES volatility: Potential gap of cross year fluctuation (e.g. wind >10%) in electricity generation may be covered by green fuels
- Global Netting: Low green fuel production in one region can be substituted by production on other continents via global trading
- High utilization: High availability of RES in production hot stops increase utilization rate of installed capacities
- Acceptance: Fuel import reduces required national capacities of renewable generation, need for grid expansion and eases customers' CO2-reduction, e.g. in heating.

Efficient use of resources

High security of supply

Lower political costs

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Project "Green methanol supply"

Commercial Power-to-Methanol has been developed with possible commissioning in 2021





Key figures

- Commissioning
 2021/2022
- CO₂ from industrial point source
- Systems size: 100 kta production (expansion possible)

- Low cost, low CO₂ electricity from hydro plants
- Public funding support for first-of-its-kind plant prepared

Project "Green methanol supply"

2050 realised today: Project development shows product costs of <10 ct/kWh¹



¹ excl. public funding | ² Example for Power-to-Methanol Sources: innogy SE, Agora/Frontier 2018 innogy SE · Dr. Richard Kiefer · 29 June 2018 In comparison, Agora stated in 05/2018:

- "In the beginning, synthetic methane/ oil will cost 20-30 ct/kWh in Europe"
- "Costs can fall to 10 ct/kWh in 2050"





Project "Green methanol supply"

EU-JRC approved calculation proves >90% CO₂reduction for predeveloped Power-to-Methanol plant



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Summary

Green fuels will be required in all energy sectors for a successful energy transition

Innogy has showcased the role of the green fuel methanol in Essen in 2017 successfully with very promising results with regard to public acceptance and technical feasibility Germany will need to import green fuels due to limited national resources and unfavorable cost base

Today, the commercial production of green methanol (>90% CO₂ reduction) is possible for costs below 10 ct/kWh

Thank you very much for your attention!

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