



University of Cologne

Department of Economics – Chair in Economics and Energy Economics
Prof. Dr. Marc Oliver Bettzüge

Seminar in Energy, Resource and Environmental Economics

Summer Term 2020

Hydrogen as an Energy Carrier

Modern, industrialised economies predominantly use three energy carriers to provide for their enormous consumption of final energy: mineral oil products, natural gas, and electricity. E.g., for Germany, the respective shares in the final energy mix for the year 2018 are 37% (oil), 24% (natural gas), and 20% (electricity).

Given the EU's (and Germany's) ambition to become 'climate-neutral' by the year 2050, it is obvious that this composition of final energy carriers needs to change dramatically, as both oil and natural gas would no longer be available. Electricity could potentially pick up some of the shortfall, especially in the heating sector and parts of the mobility sector, adding benefits in terms of energy efficiency along the way. However, it is generally accepted by now that an 'all-electric' final energy mix based on intermittent sources of renewable energy (wind, solar) does not seem a feasible nor economically desirable scenario. Apart from electricity, further energy carriers with higher energy densities and different properties will most likely continue to play an important role.

Hydrogen (H_2) currently receives a lot of attention as a potential alternative to oil and natural gas. Specifically, H_2 can serve as an energy carrier similar to natural gas, and, derived from renewable or nuclear electricity or conventional sources, it can have a significantly reduced GHG footprint compared to the fossil energy carriers currently used. H_2 can react with oxygen in a process similar to combustion in an engine or in a fuel cell to generate electric power, and has further interesting industrial uses. Hence, H_2 and its properties as an energy carrier may give promising opportunities with respect to the decarbonisation in different sectors (e.g. industry and mobility). However, its ecological footprint should be evaluated with respect to its sourcing with various technologies.

Currently, there are three main low-carbon options for producing H_2 at industrial scale: *electrolysis* using low-carbon electricity, *steam reforming* of natural gas accompanied by CCUS (carbon capture and use/storage), or *pyrolysis* of natural gas providing black carbon next to H_2 . None of these technologies currently operates at the scale required for broad adoption of H_2 as an energy carrier.

In order for H_2 to reach scale in the energy system, substantial investments and innovation activities will have to play out on three different levels of the value chain: origination, infrastructure, and final energy applications. Thus, two major economic questions arise: What are the current and potential cost structures, compared to their alternatives? And: How to coordinate the activities required for a successful diffusion of H_2 in the energy system. In this context, important interdependencies with the European *Emissions Trading Systems (ETSs)* and the European internal market for natural gas emerge.

Given this background, the seminar studies relevant economic and regulatory aspects of the potential transition to an H_2 -based share of the energy system, specifically its role as a potential (green) energy carrier in the future, its technology cost and ecological footprint, as well as the specific regulatory challenges.

Schedule

07.04.2020 <u>10:00-12:00</u>	Introductory Meeting <i>Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne</i> - Organizational Issues - Introduction - Seminar Topics
tba	Deadline Submission of Topic Preferences Please submit your seminar topic preferences to cordelia.frings@uni-koeln.de
Seminar Topics will be allocated to you	
tba <u>tba</u>	Guest Lecture <i>Tba</i>
tba	Deadline to Register or Withdraw from the Examination
29.04.2020 <u>14:00-15:30</u>	Skills Seminar <i>Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne</i> Expectations on your paper and helpful tips on how to find a research question, write a research paper and give a presentation
20.05.2020	Deadline Submission of First Draft of the Paper Email first draft of your paper to your peer and to cordelia.frings@uni-koeln.de so that your peer can prepare feedback Mandatory

Individual Meeting(s) with Mentor (<i>optional, but highly recommended</i>) Discussion of first ideas, paper structure, research question, analysis etc.	
25.05- 29.05.2020	Seminar Presentations <i>Institute of Energy Economics, Vogelsanger Str. 321a, 50827 Cologne</i> ▪ Presentation by each seminar participant ▪ Peer Review ▪ Submission of written peer review ▪ Discussion Mandatory
tba	Company Visit <i>Open Grid Europe GmbH (OGE)</i>
12.07.2020	Deadline Submission of Final Seminar Paper Please submit your seminar paper via <u>ILIAS</u> . Mandatory

Application

A maximum number of applicants of 30 can be admitted to the course, priority will be given to students of the WiSo Faculty. Please register on KLIPS for the seminar as early as possible (first registration period).

After you receive a seat in the seminar, please make sure to register for the examination on KLIPS as well (use the Lehrveranstaltungsprüfung "Seminar in Energy, Resources and Environmental Economics"). Only those, who have a seat in the seminar can register for the examination! Thus, if you decide to not take the seminar, please make sure to deregister from the course so your peers are able to enroll for the remaining spots before the exam registration phase ends!

Once you have registered for the examination, the registration is binding and students who do not hand in a seminar paper or who do not present their paper will receive a failing grade. Thus, please make sure that you are able to attend the presentation days, before registering for the course.

Mode of Examination: combined examination

The final grade consists of:

- 50% Seminar Paper (max 5000 words)
- 40% Presentation at seminar meeting (10 minutes)
- 10% Oral discussion of a peer's presentation (3-5 minutes) and written peer feedback (max 500 words)

General Requirements

The seminar is designed for students to prepare for a Master thesis in Energy Economics. The seminar participants are expected to gain in-depth insights into their topic independently. Thus, we expect students to already have a solid foundation in Energy Economics (i.a. have taken other courses in the Energy specialisation) before taking the seminar.

While overall topics will be distributed, students are expected to determine the main focus of their seminar paper themselves. The emphasis within the own topic as well as the draft structure of the paper shall be discussed with the mentor at an early stage. Furthermore, students should deal critically with the contributions of other participants. Active participation in the seminar discussion is expected. We provide a guideline for the preparation of seminar papers. This includes all design requirements.

Further Information

Allocated Modules	▪ Specialisation in Energy Economics – Seminar in Energy, Resource and Environmental Economics ▪ The seminar can also be selected by IMES students.
Credits	6
Language	English
Examiner	Prof. Dr. Bettzüge
Cooperation Partners	Open Grid Europe GmbH (OGE) Further tba
Organisation	Please contact. Cordelia Frings in case you have any questions about the seminar (cordelia.frings@uni-koeln.de)