AKE 1: AKE 1

Time: Tuesday 10:30–12:30 Location: AKE-H16

Invited Talk AKE 1.1 Tue 10:30 AKE-H16
Ammoniak als Schiffsantrieb — •Angela Kruth — Leibniz-Institut Plasmaforschung und Technologie (INP), Greifswald

AKE 1.2 Tue 11:00 AKE-H16
Net-zero greenhouse gas emission in 2045 - A challenge for the Energy Infrastructure — •Tanja Kneiske — Fraunhofer IEE, Königstor 59, 34119 Kassel

The focus of this contribution is on the transformation of the energy infrastructures to reach the new climate targets. Therefore the main challenges for the energy grids are presented which is the integration of renewable energy resources but also electric vehicles, heat pumps and electrolysers while providing energy reliable for the customers. The contribution will give a holistic view on the connection between the expansion planning of power grids, the transformation of gas grids to a new hydrogen infrastructure and the challenge of installing more low exergy heating grids. A connection of the results from national energy system optmization models with regional energy system simulations in cities and districts will lead to an integrated transformation path.

AKE 1.3 Tue 11:15 AKE-H16
Sektorenkopplung mit dem Entropiesatz - Exergy is the Economy! — •Gunnar Kaestle[1] und Olaf Schilgen[2] — [1]Clausthal-Zellerfeld, Deutschland — [2]Schandelah, Deutschland

Im Rahmen der Sektorenkopplung ist die Beachtung des Arbeitswertes der Energie (Exergie) wesentlich, da die Energie eine Erhaltungsgröße ist, nicht aber die Exergie. Letztere ist das knappe Gut. Exergieverluste bei der Energiewandlung können als variable Kosten angesehen werden.

Bei einer rein monetären Optimierung besteht die Gefahr eines Zirkelschlusses: der Geldwert (Inflation) definiert sich über einen Warenkorb und das Bruttoinlandsprodukt (BIP) wird wiederum in Geldeinheiten gemessen, d. h. Geld als Maßstab ist relativ.

Die Exergie, die zur Herstellung von Waren und Gütern sowie Erbringung von Dienstleistungen benötigt wird, ist daher eine einheitliche physische Eigenschaft aller Teile des BIP. Sie ist eine absolute Größe. Der Exergieverbrauch wird somit als zu messende Eigenschaft von Volkswirtschaften vorgeschlagen. Dieses physische Maß stellt 100% des BIP-Warenkorbs dar und kann einer Geldmenge gegenübergestellt werden. Die Erfassung wirtschaftlicher Aktivitäten kann auf diese Weise sowohl monetär als auch physisch erfolgen. Die Grenzen wirtschaftlichen Wachstums ergeben sich in Abhängigkeit der verfügbaren Exergie.

Um die Größen Energie und Exergie zu unterscheiden, sollten unterschiedlichen Einheiten verwendet werden, z. B. Joule und Rant.

AKE 1.4 Tue 11:30 AKE-H16
Controlling volatility of wind-solar power in Germany — •Hans Lustfeld — Peter Grünberg Institut (PGI-1), Forschungszentrum Jülich, 52425 Jülich, Germany.

The main advantage of wind-solar power is the electric power production free of CO_2. Its main disadvantage is the huge volatility of the system. In fact, if the power production, averaged over one year, corresponds to the averaged electric consumption and is intended to replace all other electric power generating devices, then controlling the volatility of this system by using storage alone requires huge capacities of about 30TWh, capacities not available in Germany. However, based on German power data over the last six years (2015 till 2020) we show that the required storage capacity is decisively reduced, provided i) a surplus of wind-solar power is supplied, ii) smart meters are installed, iii) a different kind of wind turbines and solar panels is partially used, iv) a novel function describing this volatile system, is introduced. The new function, in turn, depends on three characteristic numbers, which means, that the volatility of this system is characterized by those numbers. Our results suggest that all the present electric energy in Germany can be obtained from controlled wind-solar power. And our results indicate that controlled wind-solar power can in addition produce the energy for transportation, warm water, space heating and in part for process heating, requiring an increase of the electric energy production by a factor of 5. Then, however, a huge number of wind turbines and solar panels is required changing the appearance of German landscapes fundamentally.

15 min. break

AKE 1.5 Tue 12:00 AKE-H16
Sustainable energy for research facilities in Europe — •Johannes Hampp and Michael Düren — Center for international Development and Environmental Research, Justus-Liebig University Giessen

Energy imports from countries with abundant wind and solar resources are considered to take on a key role in the European energy transition. Wind and solar power can be converted to chemical energy carriers like hydrogen and then imported by ship or pipeline for subsequent conversion back to electricity and (waste) heat. Inherent to this supply chain are conversion losses, typically of factor 2-3 of the final electricity provided. A more efficient and economic solution is importing electricity directly using high voltage direct current (HVDC) lines.

We propose a pilot project which could be pushed by the European Scientific Community, e.g. lead by CERN, to overcome the barriers and to secure low-cost and sustainable energy supply for European research institutions. Historically, political and economic barriers hindered such projects, prominently DESERTEC 15 years ago. Recent projects like XLink's Morocco-UK-Link are demonstrating this idea's feasibility and opportunities. In our proposed project, electricity could be imported from renewables out of Algeria or Tunisia via undersea HVDC lines to e.g. southern France, where a suitable power network to CERN and other research centres already exists.

Using techno-economic modelling we provide insights on the infrastructure scale and economics of such a project. We investigate the influence of different demand cases and explore alternative options.

AKE 1.6 Tue 12:15 AKE-H16
A Monte-Carlo assessment of the effects of long-term changes on residential energy supply systems — •Elif Turhan and Patrik Schönfeldt — DLR-Institut für Vernetzte Energiesysteme, Oldenburg, Deutschland

Space heating accounts for approximately one third of the global final energy consumption in both the residential and the commercial building sub-sectors. Including hot water, the 2010 IPCC report on buildings attributes 53% of the total final energy demand of the worldwide building sector to the demand for low temperature heat. At the same time, according to the IEA, the share of renewable energy supply in 2019 only met 11% of the global heat demand, leading to a domination of fossil fuels in this sector, contributing 40% (13.3 Gt) of global CO2 emissions. While these facts underline the need for fast changes, in particular integrating the sectors of heat and electricity, decisions should also include long foresight: Once installed, such systems typically operate for decades.

This contribution presents a risk analyses of long-term changes on the national scale on different energy supply systems at the district scale. For example, the effect on changing capacity of renewable electricity generation on the CO2 emissions caused by the residential energy demand is assessed. To evaluate the uncertain characteristic of the future, a probabilistic scenario space is spanned instead of working with distinct scenarios. This space is then sampled using the Monto Carlo method, resulting in probability density functions for previously defined key performance indicators.