AKE 1: Innovative Contributions for the Energy System Transformation

Time: Monday 14:30–16:45 Location: HS HISKP

Invited Talk AKE 1.1 Mon 14:30 HS HISKP

Bedarf und Rolle von Grundlastkraftwerken in einem treibhausgasarmen Energiesystem — •Philipp Stöcker, Berit Erlach, Sven Wurbs und Cyril Stephanos — acatech - Deutsche Akademie der Technikwissenschaften, Geschäftsstelle, Karolinenplatz 4, 80333 München, Deutschland

Grundlastkraftwerke haben über Jahrzehnte die Stromerzeugung in Deutschland und Europa mit geprägt. Mit dem zunehmenden Ausbau der erneuerbaren Energien nimmt ihr Anteil jedoch aktuell immer weiter ab.

Die vier möglichen Technologien für treibhausgasarme Grundlastkraftwerke werden kurz bewertet in Hinsicht auf ihren Entwicklungsstand, wesentliche Eigenschaften und möglichen Beitrag zur Energieversorgung. Es wird analysiert, wie erforderlich sie in den verschiedenen Dimensionen des Energiesystems in Zukunft sein werden. Die besondere ökonomische Situation für Grundlastkraftwerke wird beleuchtet. Schließlich zeigt die Auswertung von Modellrechnungen auf, welchen Einfluss ihre Präsenz im Modell auf die Zusammensetzung des restlichen Energiesystems und die Gesamtkosten der Energieversorgung hätte.

AKE 1.2 Mon 15:00 HS HISKP

Optimized transformation planning for municipal energy systems by coupling Agent-Based Modelling and Linear Programming — •Hannes Koch[1], Stefan Lechner[1], Michael Düren[2], and Peter Winker[3] — [1]Institut für Thermodynamik, Energieverfahrenstechnik und Systemanalyse, Technische Hochschule Mittelhessen, Gießen — [2]Zentrum für Internationale Entwicklungs- und Umweltforschung, Gießen — [3]Professur für Statistik und Ökonometrie, Justus-Liebig-Universität, Gießen

The transition to climate-neutral energy supply systems is an established necessity. This study provides a framework for detailed optimization and transformation of multi-sectoral energy systems at regional scales and applies it to the county of Giessen, Germany. The methodology combines an Agent-Based Model (ABM) simulating long-term consumer energy choices with a Linear Programming (LP) model that optimizes the economic and climate-neutral transformation of the energy supply system. The ABM incorporates empirical demand data, while the LP utilizes regional renewable energy potential assessments and a pool of available energy technologies to decarbonize the energy supply system. Our findings indicate that the primary drivers of decarbonization are the reduction of final energy demand through renovation of buildings and efficient last-use technologies such as heat pumps and electric vehicles. Additionally, the results suggest that local renewable electricity generation combined with sector coupling presents a more cost-effective and economically resilient solution compared to large-scale renewable energy carrier imports.

AKE 1.3 Mon 15:15 HS HISKP

Meeting Future Energy Needs - A regulatory view on a sustainability path — •Jörg Cosfeld — University of Applied Sciences Düsseldorf, Düsseldorf, Germany

Sustainability demands the cessation of all greenhouse gas emissions to prevent catastrophic climate tipping points. Humanity cannot afford to gamble against these abrupt and irreversible scenarios, which necessitate urgent global political and economic action. This work summarizes carbon dioxide emissions from the energy sector, examining the role of fossil fuels and future expectations. While addressing the challenges of anthropogenic climate change across political, economic, and scientific domains, it highlights the complexity of finding comprehensive solutions.

Rising global energy demands, particularly in electricity generation (40%) and transportation (30%), require solutions that curb emissions. This study explores regulatory frameworks, focusing on the stagnation of American fuel economy progress. From 1975, American Automotive Manufacturers (AAM) improved engine efficiency, enabling greater travel distances per fuel load. However, between 1985 and 2010, due to the lack of updates to Corporate Average Fuel Economy (CAFE) standards, AAM shifted toward heavier vehicles, halting fuel economy improvements.

This work details regulatory gaps and compares fuel efficiency standards in Europe, North America, and Asia-Pacific. It also provides an outlook on under-regulated sectors requiring scientific and regulatory attention.

AKE 1.4 Mon 15:30 HS HISKP

Unterwasser-Pumpspeicherkraftwerke in Tagebaugruben — •Horst Schmidt-Böcking[1], Henry Risse[2], Gerhard Luther[3], Joachim Schwister[4] und Michael Hollerbach[5] — [1]Uni-Frankfurt — [2]TH-Aachen — [3]Uni-Saarbrücken — [4]Kerpen — [5]Seligenstadt

Die Energiewende in Deutschland steht vor einer großen Herausforderung: Der geplante Zuwachs von Windenergie und Photovoltaik verstärkt die Schwankungen im Stromnetz. Die Kapazität für die Kurzzeitspeicherung elektrischer Energie muss daher dringend und massiv ausgebaut werden. Zurzeit sind weltweit zirka 90 % aller großen Speicher für elektrische Energie Pumpspeicherkraftwerke. Diese Technologie hat sich seit über hundert Jahren bewährt, ist umweltfreundlich und hat einen hohen Wirkungsgrad von bis zu 80 % bei niedrigen Speicherkosten. In Deutschland allerdings steht dem weiteren Ausbau als Hindernis die begrenzte Verfügbarkeit von Standorten entgegen. Eine Lösung dieses Problems stellen wir in diesem Artikel vor: Die bald stillgelegten Braunkohletagebaue bieten aufgrund ihrer beträchtlichen Tiefe ideale Topographien, um das Speicherproblem in Deutschland weitgehend zu lösen. Der Hambacher Tagebau zum Beispiel ist an der tiefsten Stelle über 450 m tief. Folglich muss ein Pumpspeicherkraftwerk für den Einsatz in solchen Gruben anders konzipiert werden, um die vorhandene Tiefe und Größe des Tagebaus zu nutzen.

AKE 1.5 Mon 15:45 HS HISKP

Modeling of Solid Oxide Fuel Cell and hydrogen storage using Metal Hydrides — •Zahra Harati[1], Jan Lohbreier[1], and Gholam Reza Nabi Bidhendi[2] — [1]Faculty of Applied Mathematics, Physics and Humanities, Technische Hochschule Nürnberg Georg Simon Ohm — [2]University of Teheran

Multi-energy systems provide extensive benefits over conventional single-source power generation including enhanced efficiency, reduced greenhouse gas emissions, and extended reliability. In the considered multiple system, the solid oxide fuel cell has been selected that can flexibly utilize different fuels, including hydrocarbon gases, coal, and natural gas. In this study, pure hydrogen is produced by PEM electrolysis and stored in lithium borohydride used as fuel in SOFC. Using MATLAB/Simulink, we model the SOFC as a black box using a zero-dimensional approach. The model comprehensively accounts for all SOFC losses, including partial pressure, activation losses, concentration, ohmic losses, and exergy losses, allowing for a complete characterization of the system.

AKE 1.6 Mon 16:00 HS HISKP

Optical, structural and electrochemical properties of resynthesized Graphite powder for Anode battery application — •slaheddine Jabri[1], Anna Rollin[2], Sukanya Sukanya[3], René Wilhelm[2], Michael Kurrat[3], Uta Schlickum[1], and Markus Etzkorn[1] — [1]Technische Universität Braunschweig, Institute of Applied Physics, Meldensohn Straße2, 38106 Braunschweig, Germany — [2]Mendelssohnstraße 2 — [3]Technische Universität Clausthal, Institute of Organic Chemistry, Leibnitzstraße 6, 38678 Clausthal-Zellerfeld, Germany

By focusing on preserving the components of Li-Ion battery material through cheaper and envi-ronmental friendly methods, recycling process could introduce scavenged impurities into resyn-thesized material and modify its structural and morphological properties. In this work, we investi-gate the optical, structural and electrochemical properties of recycled Graphite compared to the new material. Our findings reveal that a proper recycling process can remove the Solid Electrolyte Interphase (SEI) layer, which is of significant importance in battery performance. The analysis showed that proper cleaning can significant reduce the amounts of organic and inorganic impuri-ties in the graphite, leading to an improvement in material quality. As a result, the battery perfor-mance can even be enhanced by 89% after 200 charge-discharge cycles compared to the commer-cial base material, demonstrating the potential of recycling methods for improving battery life and efficiency

AKE 1.7 Mon 16:15 HS HISKP

remarkable impact on the structural, optical properties and solar absorbent of ZnO doped into CrNi black coatings — Hanaa Soliman[1], Abdelsalam Makhlouf[2], and •Diaa Rayan[1,3] — [1]Central Metallurgical Research and Development Institute (CMRDI), P.O. Box: 87 Helwan, 11421, Egypt — [2]Engineering, Metallurgy, Coatings and Corrosion Consultancy (EMC3) LLC. Connecticut, USA — [3]Department of Physics, Deraya University, New Minya, Minya, Egypt

Renewable energy is one of the major global challenges towards a clean environment. In solar collectors, high absorption with low thermal emittance represents the main performance parameter during the characterization of the absorber films. This article provides an in-depth study of the co-deposition of Cr and Ni-doped by ZnO coatings and their influence on surface protection correlating it with the absorption of the produced surfaces. Results showed that Cr+Ni+ZnO composite film on Cu substrate outperformed traditional Cr film in terms of surface smoothness, adhesion, corrosion resistance, bending resistance in addition to high solar absorption. Precisely, ZnO inserted into the Cr7Ni3 phase is the key for dual-performance high absorbent and resistant film of CrNi.

AKE 1.8 Mon 16:30 HS HISKP

Multiscale simulations for the investigation of degradation resistant PEMFC components — •Fabian Gumpert[1], Dominik Eitel[2,3], Olaf Kottas[2,3], Uta Helbig[2,3], and Jan Lohbreier[1] — [1]Faculty of Applied Mathematics, Physics and Humanities, Technische Hochschule Nürnberg Georg Simon Ohm — [2]Faculty of Materials Engineering, Technische Hochschule Nürnberg Georg Simon Ohm — [3]Institute for Chemistry, Materials and Product Development (Ohm-CMP), Technische Hochschule Nürnberg Georg Simon Ohm

Hydrogen powered technologies provide a huge potential for the transition towards sustainable energy sources, e.g. for mobile applications. However, degradation effects present a significant challenge that currently constrains the practical applications of hydrogen technologies. Proton Exchange Membrane Fuel Cells (PEMFCs) are important devices for the conversion of chemical to electrical energy. For the PEMFC, the Membrane Electrode Assembly (MEA) is a key component, which is especially vulnerable to degradation mechanisms. In this research, we study novel materials for the MEA which counteract these mechanisms and which enable long lifetimes of the devices. The electrode layer is made of composite material, which consists of different components. A multiscale Finite Element Method (FEM) simulation is developed to investigate the composite material used for the electrode layer and to derive practical guidelines for experiments.