# AKE 2: Processes and Materials for fossil-free Energy Technologies

Time: Tuesday 11:00–12:45 Location: HS HISKP

**Invited Talk** AKE 2.1 Tue 11:00 HS HISKP

**Energy Studies and Energy Models: A Study Comparison** — •Larissa Breuning[1], Anđjelka Kerekeš[1], Alexander von Müller[2], and Thomas Hamacher[1] — [1]Technical University of Munich (TUM), Germany; TUM School of Engineering and Design, Department of Energy and Process Engineering — [2]Max Planck Institute for Plasma Physics (IPP), Garching, Germany

Energy system models offer insights into a number of areas, such as energy supply, demand for different energy sources, current and future interactions between the supply and demand, interactions between energy and the environment, relationship between energy and the economy, as well as energy system planning, including technology expansion and operation. These models and the implemented scenarios cannot predict the future, but they can show possible paths to achieving a desired goal, emphasize no-regret measures, and explore certain scope and uncertainties. This presentation summarizes published scenario-studies on achieving the goal of climate neutrality by 2045. The transformation paths outlined in the studies are compared with an as-is state and actual developments. Different assumptions and setups are highlighted.

AKE 2.2 Tue 11:30 HS HISKP

**Brave New Nuclear World?** — •Friederike Friess — Institute of Safety and Risk Sciences, BOKU University, Peter-Jordan-Straße 76, 1190 Vienna, Austria

There are about 400 light-water reactors in operation around the world. The energy they produce is expensive and there are a number of safety issues. Nevertheless, nuclear power is seen by many as an integral part of the future energy system. For nuclear power to make a significant contribution to reducing greenhouse gas emissions, alternative reactor designs must be used. These include small modular reactors (SMRs) and alternative reactor designs often referred to as Generation IV or advanced reactor designs. These reactors are said to produce cheap, safe and reliable green energy. We take a look at the most prominent of these reactor concepts, including reactor concepts such as the sodium-cooled fast reactor (the Russian BN-800 type) and the high-temperature pebble-bed modular reactor, one of which was commissioned in China in 2023. Based on historical experience and available data on advantages and disadvantages, we discuss why this technology cannot be an integral part of the solution to reach net-zero by 2050.

AKE 2.3 Tue 11:45 HS HISKP

**Some Facts on Small Modular Reactors** — •Matthias Englert and Christoph Pistner — Öko-INstitut e.V., Rheinstr. 95, 64295 Darmstadt

Small Modular Reactors (SMR) are frequently discussed in the public as relevant for the next decades to reach climate goals and to transition to future energy systems. We present data on the technological readiness of and current status of research and development on those reactor concepts and best estimates on their economic viability and timelines for deployment based on sources from literature and the nuclear industry. The focus is both on light water reactor based SMR designs as well as on alternative reactor concepts such as metal-cooled fast reactors, gas-cooled high-temperature reactors and liquid-fuelled molten-salt reactors. For these SMR concepts, extensive research and development work has been taking place for several decades and in some cases since the middle of the last century. Nevertheless, until today no commercially competitive reactor concept exists in the field of SMR. The most extensive technical experience - besides light water cooled systems - is available for sodium cooled and high temperature reactors. However, proof of reliable operation under economic boundary conditions is still required. We finish this talk by summarizing general advantages and disadvantages of the competing SMR systems regarding criteria such as safety, fuel supply and waste disposal, proliferation.

AKE 2.4 Tue 12:00 HS HISKP

**Safety and Licensing Considerations for Small Modular Reactors** — •Markus Drapalik, Friederike Friess, and Nikolaus Müllner — Institut für Sicherheits- und Risikowissenschaften, BOKU University, Wien, Österreich

Several nations are turning their attention to Small Modular (light water) Reactors (SMRs). Proponents argue that these compact nuclear power plants are both more cost-effective and safer than traditional reactors. The BWRX-300, a 300 MW light water reactor, is one such design with projects planned in Canada and Poland. This presentation delves into the key safety principles underlying nuclear power, such as redundancy and diversity. We will explore how these principles are applied in the preliminary safety analysis report of the BWRX-300, comparing them to the standards used for current (larger) reactors. We further discuss different approaches to fasten the licensing process and in how far those might affect safety. Quick licensing processes are a necessity if nuclear power in general and SMRs in particular are supposed to help significantly in cutting down GHG emissions.

AKE 2.5 Tue 12:15 HS HISKP

**Design and Optimisation of a Variable Reluctance Energy Harvester for Wheel End Caps** — •Niklas Pöpel[1], Ye Xu[2], Sebastian Bader[2], and Jan Lohbreier[1] — [1]Technische Hochschule Nürnberg, Nürnberg, Germany — [2]Midsweden University, Sundsvall, Sweden

As vehicular wheel failures are frequently caused by bearing faults, monitoring these components with sensors is very important for effective maintenance. Since the system is rotating, using cables to power the sensors is difficult to implement, whereas batteries only provide a limited lifetime. Therefore, using a rotational energy harvester as an energy supply is a promising alternative. Previous designs have been proposed that implement a Variable Reluctance Energy Harvester (VREH) within the wheel bearing hub. However, this limits installation to the production stage and leads to complicated repairs.

The aim of this study is to design a VREH that can be installed inside the wheel end cap of large vehicles, providing easier access and lowering the installation costs. To adhere with the requirements of the end cap, an existing VREH design is scaled to the smaller dimensions and structurally inverted. Additionally, geometric optimisations are performed. The new designs are evaluated using a finite element simulation with COMSOL Multiphysics. The results are compared in terms of power output and torque, which helps in finding an optimal design for the VREH at the required scale.

AKE 2.6 Tue 12:30 HS HISKP

**Untersuchung verschiedener auf KI-basierender Ersatzmodelle für 3D FEM Simulationen von thermoelektrischen Generatoren zur Optimierung der Topologie** — Eugen Vambolt[1], Niklas Pöpel[1], Lilian Lowe[1], Lars Fromme[2], Elke Wilczok[1] und •Jan Lohbreier[1] — [1]Technische Hochschule Nürnberg Georg Simon Ohm — [2]Hochschule Bielefeld University of Applied Sciences and Arts (HSBI)

Seit Jahren werden diverse Methoden aus dem Bereich der Künstlichen Intelligenz zur Lösung von verschiedensten Aufgaben eingesetzt. Die Vorzüge solcher Verfahren möchte man auch für numerische, physikalische Simulationen nutzen. Bisher werden physikalische Modelle, die auf partiellen Differentialgleichungen beruhen, mithilfe von numerischen Methoden gelöst. Die Berechnungen können dabei je nach Verfahren und Komplexität des vorliegenden Problems bis zu einigen Wochen dauern. Aus diesem Grund werden KI-basierte Ersatzmodelle (*surrogates*) aufgestellt. Nachdem die KI-Modelle Informationen aus zum Beispiel Finite Element Berechnungen extrahiert haben, sind sie in der Lage, die Lösungen, die sonst die FEM-Modelle liefern, mit relativ geringen Abweichungen in Echtzeit ( 1s) zurückzugeben. Die Abweichungen hängen dabei sehr stark von der Anzahl der zur Verfügung stehenden Simulationsdaten und von der Art der KI-Methode ab. Im Rahmen dieses Projektes sollen Ersatzmodelle untersucht werden. Als Anwendungsfall dient die 3D FEM Simulation eines thermoelektrischen Generators, dessen Effizienz maßgeblich von der Topologie des Kühlkörpers abhängt und in dieser Arbeit optimiert werden soll.