Our **third HYDROGEN Seminar** on 27 September 2022 at KAUST reviewed the main hydrogen storage technologies.

Prof. Hadi Hajibeygi addressed the topic of large-scale underground hydrogen storage. He stated that scaling up TWh-level energy storage technology is as important as scaling up renewable energy production. However, for hydrogen, large-scale storage is a challenge. To solve this challenge, Prof. Hajibeygi introduced an alternative option, which is the utilization of large reservoirs in underground formations such as solution-mined salt caverns, porous depleted oil reservoirs, and aquifers. Simulations and geoscientific experiments are currently underway in Europe and the U.S., which aim at improving our understanding of the behavior of hydrogen in the subsurface, such as to avoid major seismic activity, or hydrogen leakage and contamination of the aquifers. A techno-economic analysis carried out for a hydrogen-based steel mill showed that underground hydrogen storage is anticipated to add $0.1-$0.3 per kilogram to the cost of hydrogen for an overall cost between $1.1 and $1.8 per kilogram.

Dr. Rajesh Ahluwalia addressed the topic of hydrogen storage for transportation and renewable power. He stated that storing hydrogen is difficult due to the low volumetric energy density of both compressed and liquid hydrogen. Specifically, he discussed the current practice of using compressed hydrogen (cH_2) storage at 350 or 700 bar, in carbon-fibre wound "Type 4" tanks, onboard light-duty vehicles. Most of the tank cost is due to the cost of carbon fibre, therefore, research is focused on reducing fibre cost. For comparison, he showed a detailed investigation on using liquid hydrogen storage (LH_2) onboard heavy-duty vehicles, which has a lower cost compared to onboard storage of gaseous hydrogen. Furthermore, he discussed the feasibility of using liquid-organic hydrogen carriers such as dibutyl toluene (DBT) for grid-scale energy storage for renewable energy farms. All of these technologies are within the context of a larger roadmap of hydrogen energy infrastructure including delivery, storage, and dispensing.

Dr. Rombout Swanborn provided a presentation about technologies developed by *HyET Hydrogen* for the electrochemical compression of hydrogen. The electrochemical compressor can compress hydrogen from 100 mbar to 900 bar in one stage without any moving parts. The device can also be used to separate and purify the hydrogen to fuel-cell grade quality. Two specific types of modules were highlighted: H_2 compression + purification (EHC/P), and H_2 extraction + purification (EHE/P). An example application of the EHC/P system for fast refueling of mining trucks in a remote area of Australia was described. Electrochemical separation is considered to be a promising way of extracting hydrogen blended into the existing natural gas pipeline. He highlighted a case study that uses small-scale modular membrane reactors installed in households to accelerate the energy transition by converting natural gas into hydrogen for use in fuel cells and recovering the CO_2 for use in local greenhouses.