Poster-Abstracts Eco-Mobility 2026

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Session 1: Sustainable Energy Carriers & Energy Converters

Poster 1: Enabling Sustainable Hydrogen for Future Mobility through Additively Manufactured Solid Oxide Cells

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Solid oxide cells (SOCs) are highly efficient and fuel-flexible electrochemical energy conversion devices with strong potential to support sustainable energy systems and hydrogen-based technologies. Despite these advantages, their large-scale commercialization remains constrained by the complexity and cost of conventional manufacturing routes, particularly when intricated geometries, thin functional layers, and highly integrated cell architectures are required. Additive manufacturing (AM) has emerged as a promising alternative, enabling greater design freedom, rapid prototyping, and the fabrication of geometrically complex ceramic structures that are difficult to realize using traditional processing methods. These capabilities offer new opportunities to optimize SOC geometry, improve material re-utilization, and potentially reduce overall production costs. In previous works, 3D-printed corrugated yttria-stabilized zirconia (YSZ) electrolytes for SOCs showed significant performance improvement. However, the coating with the electrodes remains challenging due to lack of homogeneous adhesion and reproducibility. In this work, stereolithography-based 3D printing with screen printing is combined to obtain optimized interfacial adhesion, strong mechanical integrity and enhanced cell performance. In particular, topologically modified YSZ electrolytes with increased surface area (10–30%) are fabricated using vat photopolymerization printing technique and integrated into full cells. Compared to planar designs, 3D architectures exhibit improved electrochemical performance, achieving the highest current (150 mA cm^{-2}) and power density (105 mW cm^{-2}) at 0.7 V and 900 °C. Scale-up to 5 × 5 cm^2 architected electrolytes is demonstrated, highlighting the potential of this approach for future industrial implementation. This work contributes to strengthening the competitiveness of the mobility sector by advancing a scalable technology for highly efficient and cost-effective production of sustainable hydrogen for mobility applications.

Poster 2: Resilient and Autonomous Multi-Energy Systems

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The proposed research primarily relates to the “Sustainable Energy Carriers & Energy Converters” session listed in the program, as it addresses the modeling and assessment of multiple energy carriers, conversion technologies, storage systems, and renewable energy sources within resilient energy infrastructures.



The increasing complexity of integrated energy infrastructures and their growing dependence on renewable and distributed energy technologies require robust and resilient supply concepts.
This work presents a modelling, simulation, and assessment framework for resilient multi-energy systems under normal and disrupted operating conditions. The framework combines electrical, thermal, and fuel-based energy carriers as well as renewable generation, storage, conversion technologies, and prioritized consumers. A resilience-oriented assessment methodology is applied to evaluate autonomy, security of supply, flexibility, and the ability to maintain critical functions during disturbances. Scenario-based simulations are used to compare different system configurations, technologies, and operating strategies.
The proposed approach supports the systematic assessment and design of secure, efficient, and increasingly autonomous energy infrastructures.

Poster 3: The promoting effect of additional doping elements in Cu-containing perovskites for methanol production

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Converting **CO_2 to methanol** (MeOH) is one strategy to replace fossil fuels and reduce CO_2 emissions as MeOH can be used directly as fuel or as feedstock for chemical production. [1] The important role of Copper (Cu) catalysts for the conversion of CO_2 to MeOH is already well-known [2, 3], but for a viable industrial application further improvement has to be done.

Using the flexibility of Cu-doped perovskite-type oxides for different doping strategies, **bimetallic** and / or **multi-phased nanoparticles** can be grown on the materials surface during reducing or reaction conditions via exsolution (controlled **in-situ growth** of nanoparticles from oxide host). [4] This multiphase nature promotes the catalytic activity of Cu, as the additional doping not only reduces the reaction temperatures, but also different mechanisms are in play.

Various Cu-X doped materials (X = Co, In, Mn, Zn, Zr) are characterised and compared to the undoped versions (only Cu-doping or without Cu-doping): X-ray diffraction of the pristine and reduced materials give insight into phase purity and phase changes, respectively.

Secondary electron microscopy reveals size and shape of the nanoparticles under different conditions, while catalytic testing is compared in regards of onset temperature and selectivity.

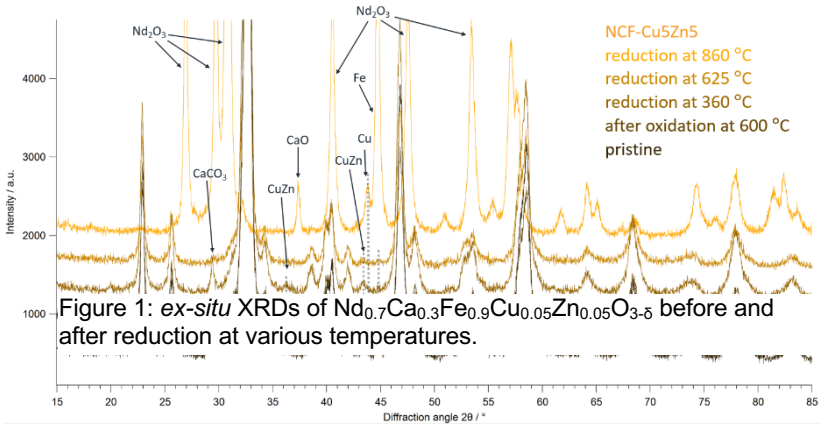


Figure 1: *ex-situ* XRDs of $Nd_{0.7}Ca_{0.3}Fe_{0.9}Cu_{0.05}Zn_{0.05}O_{3-\delta}$ before and after reduction at various temperatures.

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Poster 4: Grid-Smart Multiport Charging Solution for Sustainable and Low-Cost Infrastructure

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The European Battery Electric Vehicle (BEV) market is expanding rapidly, creating significant challenges for charging infrastructure regarding investment costs, grid capacity, and environmental impact. Conventional Fast Charging Columns (FCC) are often unsuitable for widespread deployment at commuter hubs due to high hardware expenses and demanding power distribution requirements, such as extensive cabling and medium-voltage connections.
To address these issues, this work explores two complementary strategies. First, it proposes a bi-polar 650VDC grid energy distribution architecture to connect multiple charging stations, compared to standard 400VAC systems. This approach reduces copper cabling needs, increases efficiency, lowers costs, and minimizes the carbon footprint while maintaining simplicity.
Second, the study introduces a novel Slow Charging Column (SCC) concept utilizing shared infrastructure. Since daily trips require minimal energy, SCCs are preferred over Fast Charging Columns (FCCs) to avoid excessive peak demand and costs. The proposed system allows up to four vehicles to share a single charging unit via time-sharing, where only one vehicle charges at a time, in order to maximize power hardware utilization time. Power allocation is managed through an "Energy Sandbox" that governs distribution based on EV behavior and system constraints.
Furthermore, an Agent-Based Model (ABM) is developed to investigate EV charging systems under varying operational conditions, capturing interactions between EVs, Charging Columns (CCs), and energy supplied by the grid, Photovoltaic (PV) systems, and Battery Energy Storage Systems (BESS). Supporting swarm-inspired and reinforcement learning-based charging strategies, the framework promotes efficient infrastructure utilization, peak-load reduction, lower charging costs, and sustainable electric mobility.

Session 2: Innovative Materials and Production

Poster 5: Flame Spray Pyrolysis of Complex Oxides: Flame-Forged Materials for Sustainable Hydrogen Production Technologies

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The transition towards sustainable mobility requires efficient energy conversion technologies and scalable manufacturing routes for advanced functional materials. In this context, hydrogen produced from renewable feedstocks, such as methanol, is expected to play an important role in future mobility concepts. The performance of such systems strongly depends on robust and resource-efficient catalyst materials. [1], [2]

This work investigates the flame spray pyrolysis (FSP) synthesis of complex oxides for hydrogen-generation applications via methanol steam reforming, such as perovskite-type oxides and spinel-type oxides. FSP is a continuous, scalable process that enables precise control over particle morphology, surface area, and composition while offering significant flexibility for tailoring catalytic materials. Using Cu-Fe spinel oxides as model systems, the influence of synthesis parameters on phase formation, reducibility, exsolution (i.e. controlled segregation of nanoparticles) and catalytic performance was studied.

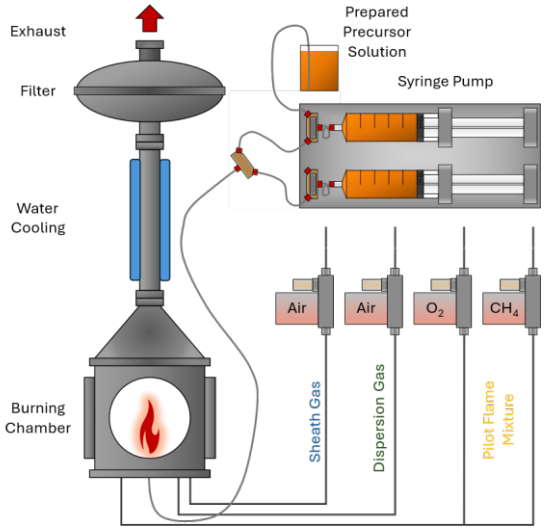


Figure 1 – Schematic illustration of the FSP setup

Comprehensive characterisation by X-ray diffraction, electron microscopy, surface area analysis, and temperature-programmed reduction demonstrates that FSP enables the synthesis of promising materials with tunable properties. Compared to conventionally prepared materials, FSP-derived oxides exhibit distinct structural features that influence nanoparticle exsolution behaviour and catalytic activity.

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Poster 6: Sustainable Calcium-Iron-Oxide-based Composite Air Electrodes for Solid Oxide Cell Applications

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Solid oxide electrolysis cells (SOECs) are a highly efficient technology for producing sustainable fuels and clean energy carriers, such as hydrogen or syngas. Hydrogen is ideally suited for powering fuel cell vehicles, and syngas can be converted into e-fuels by the Fischer-Tropsch process, thus enabling cleaner transportation. In order to advance this technology, integration of sustainable materials is imperative. In this respect, compounds based on brownmillerite $Ca_2Fe_2O_5$ (CFO) are promising candidates due to their high thermodynamic stability, good ionic conductivity, and sustainability, but with the drawback of low electronic conductivity. In this study, we present an approach to mitigate CFO's limitations through systematic modifications, aiming to develop sustainable air electrodes with good electrochemical performance. A composite was fabricated combining CFO and $LaNi_{0.6}Fe_{0.4}O_3$ (LNF) in a 50:50 weight ratio. We measured the electrical dc-conductivity of dense samples as a function of temperature in air. At 800°C, the electrical conductivity of single-phase CFO and the CFO-LNF composite was 0.4 S cm^{-1} and 48 S cm^{-1}, respectively. The electrochemical performance was evaluated in symmetrical cells using electrochemical impedance spectroscopy. Polarisation resistances at 800°C ranged from 1.8 Ω cm^2 (CFO) to 0.45 Ω cm^2 (CFO-LNF). The utilisation of field-emission scanning electron microscopy (FESEM) and energy dispersive X-ray spectroscopy (EDS) provided deeper insights regarding the morphology and distribution of chemical elements. The observed differences in the sintering behaviour of CFO and LNF pose a challenge towards microstructural optimisation, which was addressed by modifying the chemical composition and sintering program. The results obtained so far demonstrate the considerable promise and significant challenges of non-critical materials for air electrodes.

Poster 7: Wood Vision Lab – An Innovation Hub for Hardwood in Advanced Wood-Hybrid Applications

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Wood is one of the few renewable materials available at an industrially relevant scale. Used appropriately, it is also a high-performance lightweight material with specific mechanical properties competitive with established engineering materials. The potential is substantial: if wood replaced 5% of the steel and plastics used in approximately 12 million passenger cars produced annually in Europe, the theoretical wood demand would correspond to only about 5% of Austria's annual forest increment.

The motivation of the Wood Vision Lab (WVL) is to bring wood and bio-based materials into advanced technical applications where their specific properties provide technical, environmental and economic benefits. Demonstrated applications show a lightweighting potential of around 20% while maintaining equivalent technical performance. A particular focus is on hardwood for advanced wood-hybrid applications in *Mobility and Beyond*.

To achieve this, WVL is developing a still rarely found model of a focused, non-university innovation hub. Four interconnected functions form its core: **Research**, **Make**, **Accelerator** and **Qualification**. WVL serves as a hub within a highly concentrated regional ecosystem of research institutions, wood and technology companies, industrial users, education, clusters and public stakeholders, building on twelve years of continuous R&D and collaboration.

A new 2,000+ m² pioneer centre, currently under construction, will bring these functions together in 2027, combining technical and R&D facilities, accelerator offices, knowledge transfer and collaboration.

For WVL, innovation therefore extends from scientific understanding and technological mastery of a material to market introduction and industrial value creation.

Poster 8: Closing material loops beyond OEMs: Actors, material flows and best practices in the Austrian automotive value chain

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Circular economy research in the automotive sector is largely organized around original equipment manufacturers (OEMs). Austria has no passenger car OEM, but hosts a dense supplier industry, primary metal and plastics production and an established recycling sector. Value chain studies concentrate on end-of-life treatment and rarely connect actors with material flows, while upstream actors remain largely unexamined. A scoping literature review (n = 62) provided an initial value chain map, which 15 semi-structured interviews validated and extended. A material flow analysis then completed the map by quantifying material inputs to Austrian vehicle and component production and the domestic treatment of end-of-life vehicles. Results show that recovery depends on the material: metals largely return to production, though mainly in open loops across sectors, while plastics are mostly recovered for energy. Virtually all new vehicles are imported, most production is exported and most end-of-life vehicles leave the country before treatment, so domestic recycling covers only a small share of the materials Austrian producers need. Key barriers to recycled content include contaminated post-consumer material, recyclates often costing more than primary material, and strict OEM approval processes. Best practices demonstrate functioning loops, particularly for production scrap and metals. Together, the mapping and material flow analysis show that Austria alone is too narrow of a frame: for a country without a passenger car OEM, secondary raw materials are a European rather than a national resource. Identified barriers and potentials will feed into a participatory SWOT analysis and an action catalog for industry, policy and research.

Session 3: Battery & Electric Powertrain

Poster 9: In-situ Detection of Hydrogen Fluoride During Lithium-Ion Battery Thermal Runaway Using TDLAS

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Virtual Vehicle Research GmbH

The growth of electromobility has led to an increasing number of lithium-ion batteries in vehicles. As this growth continues, the associated risks, such as thermal runaway (TR), increase as well. Besides fire and explosion hazards, one consequence of TR is the release of large amounts of flammable and toxic gases. Hydrogen fluoride (HF) is among the most dangerous of these gases. Reliable quantification of HF is essential to assess and prevent the resulting hazards. However, established measurement techniques rely on extractive sampling, such as FTIR spectroscopy. Because HF is highly reactive and adsorbs readily onto surfaces, these methods suffer from substantial and poorly quantified losses. In this work, we present an in-situ measurement approach based on tunable diode laser absorption spectroscopy (TDLAS) for the direct, time-resolved detection of HF during TR. The optical measurement path is integrated directly into the reactor, which eliminates sampling lines. An HF absorption line in the range of 1278.0–1278.3 nm is used to determine the concentration during TR. During the initial venting phase, HF was successfully detected in-situ, with concentrations of up to 400 ppm. At the onset of TR, however, the transmitted laser signal broke down completely, most likely due to vibrations and contamiation of the optical path. These results demonstrate the feasibility of TDLAS for direct HF measurement under realistic battery failure conditions and at the same time identify the key challenges for measurements during the main TR event.

Poster 10: Bridging accuracy and speed in battery management: A physics-based reduced-order model for battery voltage and state of charge prediction

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Accurate voltage and state of charge prediction is essential for maximising the range, lifetime, and safety of electric vehicle batteries. High-fidelity electrochemical models deliver this accuracy but are too computationally expensive for onboard use. Empirical models run fast but lack the physical grounding to stay trustworthy across real-world operating conditions.
This work closes that gap. Starting from a fully parameterised high-fidelity model of a large-format NMC pouch cell (57.2 Ah), we systematically derive a reduced-order model that preserves the essential electrochemistry. A two-step calibration first anchors electrolyte dynamics to the high-fidelity physics, then jointly refines them against terminal voltage data.
For battery management system development, the resulting model is:

- **Physics-based and traceable:** systematically derived from a validated high-fidelity model, with physically interpretable states.
- **Computationally cheap:** over 1 000 times faster than real time, suited to embedded hardware and large-scale simulation.
- **Validated:** close agreement with the high-fidelity reference and experiments under constant-current, pulse, and WLTC/NEDC drive cycles (isothermal, 25 °C).

The model enables digital twins, fleet-level state estimation, and virtual testing that shortens development cycles. Extending the approach to other chemistries and stationary storage is a natural next step towards technology diversity in a resource-constrained world.

Poster 11: Ni/Mn-Ratio Effecting the Thermal Decomposition of Spinel $LiNi_xMn_{2-x}O_4$ Cathode Materials for Lithium-ion Batteries

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Sustainable mobility offers opportunities to achieve climate goals while reducing dependence on energy imports. Lithium-ion Batteries (LIBs) are one solution to provide electric vehicles (EVs) with an efficient energy storage system. More energy-dense and safer electrode active materials can help to improve such technologies. Spinel structured lithium nickel manganese oxide (LNMO, $LiNi_xMn_{2-x}O_4$, $x \leq 0.5$) is a promising cathode material for the next generation of LIBs. LNMO could enable LIBs with open circuit voltage of around 4.7 V and high specific energy of up to 300 $Wh \cdot kg^{-1}$. These materials show in general long battery cycle life stability, and their production is not reliant on the critical element cobalt [1-3]. However, there are still many open questions regarding LNMOs thermal and structural stability, which are crucial properties for battery safety and thermal management. This conference contribution gives an overview about the key findings of our latest investigations about the effects of the Ni/Mn ratio on the thermal stability of LNMO. In air $LiNi_xMn_{2-x}O_4$ reversibly disintegrates under the release of O_2 giving Ni- and Li-rich secondary phase (rock-salt type) and a Ni- and Li-poorer LNMO. This process starts in the range of 700 – 800 °C depending on the Ni-content which lowers the initial temperature. In Argon the materials decompose at around 670 °C accompanied by higher O_2 release giving Li- and Ni-rich (Li,Ni,Mn)O, Mn_3O_4 and $LiMnO_2$. Lattice spacing, initial decomposition temperature and mass fractions of the decomposition products highly depend on the Ni content in the initial LNMO phase.

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Poster 12: Strain-Based State Estimation of Lithium-Ion Batteries: Effects of Cell Design and Chemistry

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Sustainable mobility relies on lithium-ion batteries (LIBs) that can be operated safely and used over extended lifetimes. Accurate estimation of state variables (SoX), such as state of charge (SoC), is crucial for maintaining LIBs within safe operating limits, preventing damaging conditions, and ultimately extending their service life while reducing resource consumption and environmental impact. Conventional estimation methods primarily rely on voltage, current, and temperature measurements, while additional sensors, such as strain gages, offer the potential for improved estimation accuracy. As the battery industry advances toward new cell formats and manufacturing processes, the influence of cell design on advanced sensing approaches must be evaluated.

In this study, the volume change and resulting surface strain during charge and discharge are investigated for 18650 and 46950 cylindrical cells at multiple locations on their surfaces. Postmortem analysis, including cell disassembly and chemical characterization of the electrodes, reveal that the strong positional dependence of the strain-gage measurements arises from differences in cell design and chemistry. Inhomogeneities in cell construction, especially tab placement and jelly-roll manufacturing, significantly influence both the direction and magnitude of the measured strain. In addition, silicon-enhanced anodes substantially increase the strain response, thereby improving the detectability and reliability of strain-based measurements. These findings highlight the importance of considering cell design and electrode chemistry when developing advanced sensing approaches for accurate state estimation and extended battery lifetime.

Acknowledgements

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Session 4: Hydrogen and Hydrogen Vehicles

Poster 13: It's What's Inside That Counts: Toward Aging-Aware Digital Twins for Fuel Cells and Electrolyzers

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Fuel cells and electrolyzers are key technologies for hydrogen-based mobility and energy systems. Their reliable and durable operation requires insight into local conditions that influence degradation but are difficult to measure directly, particularly under dynamic loads. Detailed physical models provide vital insight, but their computational demands can limit their use during operation.
The research presented in this work addresses these challenges through complementary methods for degradation-aware digital twins, demonstrated in polymer electrolyte membrane fuel cell studies. Combining physical models, measurement data, and computationally efficient algorithms offers three practical benefits:

- **Evaluate aging and operating strategies faster:**
  Networks of simplified, physics-based local models preserve spatial information while accelerating simulations by approximately a factor of 50 in a studied scenario with reduced reliance on manual tuning by data-supported design.
- **Make hidden operating conditions accessible:**
  Model-based observers reconstruct internal state profiles from accessible measurements, providing virtual sensing for condition monitoring.
- **Balance dynamic performance and durability:**
  Predictive control incorporating degradation models demonstrates how operating decisions can mitigate aging while meeting changing power demands.

Future work aims to integrate these capabilities for monitoring and mitigating local degradation and extend them to electrolyzers. The methods also offer directions for other technologies where inaccessible internal conditions determine performance and lifetime.

Poster 14: Enhancing the Lifetime of Heavy-Duty Fuel Cell Non-Road Mobile Machinery through Health-Aware Predictive Energy Management

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Fuel cell powertrains have the potential to become a key technology for realizing zero-emission non-road mobile machines (NRMMs), due to high energy densities and system efficiencies under short refueling times. However, degradation-promoting non-road ambient conditions and the uncertain, highly dynamic workloads remain challenging, particularly under limited resource constraints. To further increase fuel cell competitiveness and its advancement in NRMMs, meeting hydrogen efficiency and lifetime targets is vital.

This work addresses these challenges with a health-aware predictive energy management strategy, which directly targets hydrogen consumption and component durability in the energy management optimization. Evaluation using real-world wheel loader driving data demonstrates substantial degradation mitigation and fuel-economy improvements even under uncertain future load dynamics in daily operation.

Over the wheel loader service life, however, operating scenarios substantially change. Consequently, the aging of both the fuel cell and battery progresses differently, and the overall wheel loader lifetime is limited due to a premature failure of one component. To overcome these lifetime limitations, an additional cloud-based energy management update strategy balances component degradation effectively throughout the wheel loader's service life.

Investigations over the entire wheel loader lifetime that incorporate progressive component degradation effects underscore significant additional service life extensions achieved by targeted energy management updates, while hydrogen efficiency is kept high.

Essentially, the developed fuel cell wheel loader platform supports manufacturer decisions regarding total lifetime costs, full-lifetime performance, and system sizing - substantial for establishing the fuel cell in non-road applications.

Poster 15: Validation of Liquid Hydrogen Storage Systems for Sustainable Heavy-Duty Mobility

Presenting Author: Antonia Gaugl
SAG New Technologies GmbH

Liquid hydrogen (LH_2) storage technology offers a promising pathway toward sustainable heavy-duty transportation by combining high gravimetric and volumetric energy density with zero tailpipe emissions. As the mobility sector diversifies its technology portfolio in response to global competition and resource constraints, LH_2 systems represent a key enabler for long-range fuel-cell vehicles and other demanding applications.

Since 2021, SAG New Technologies has been developing cryogenic LH_2 storage systems for commercial vehicles. However, the introduction of liquid hydrogen as an energy carrier requires a fundamental reassessment of established validation and homologation approaches. Existing test standards and regulatory frameworks, largely developed for conventional propulsion systems, can only be partially applied to cryogenic hydrogen storage technologies.

This contribution presents the specific challenges faced by an LH_2 system supplier in demonstrating equivalent levels of safety, reliability, and regulatory compliance required for road approval. Particular focus is placed on safety-critical validation methods addressing regulatory requirements as well as expectations from vehicle manufacturers and the public. Due to the limited operational experience available for this emerging technology, manufacturers must establish robust evidence of safe performance under realistic operating conditions.

The poster provides practical insights into validation methodologies, test strategies, and key lessons learned from the development and qualification of cryogenic hydrogen storage systems, highlighting their role in enabling a diverse and sustainable future mobility landscape.

Poster 16: Tailoring microstructure and electrochemical performance of Ni-YSZ fuel electrodes for electrochemical solid oxide cells

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The performance and long-term stability of electrolyte-supported solid oxide fuel and electrolysis cells (SOFCs, SOECs) are strongly influenced by the microstructural stability of the fuel electrode. In porous composite electrodes consisting of metallic nickel and 8 mol% Yttria-stabilized zirconia (Ni-8YSZ), Ni coarsening, agglomeration, and redistribution can alter the three-dimensional electrode architecture and reduce the active triple-phase boundary (TPB) density, ultimately contributing to electrochemical degradation and cell failure. Understanding the relationship between microstructural evolution and electrochemical performance is therefore essential for identifying degradation mechanisms and developing approaches for predicting electrode failure.
In this study, symmetrical cells consisting of Ni-8YSZ (50:50 vol%) fuel electrodes fabricated on commercial 8YSZ electrolytes were investigated to evaluate the influence of electrode sintering temperature on electrochemical performance and microstructural integrity. Three electrode sintering temperatures, 1100, 1200, and 1300 °C, were investigated. Electrochemical impedance spectroscopy (EIS) was performed at 800 °C under 100% hydrogen atmosphere. The cells with electrodes sintered at 1200 °C exhibited the lowest polarization resistance compared to other cells. Post-mortem SEM analysis revealed significant differences in electrode-electrolyte integrity, with complete electrode delamination observed for the 1100 °C sample, while cracks developed within the electrolyte for the 1300 °C sample.
To establish a direct relationship between electrochemical behavior and electrode microstructure, FE-SEM and EDS analysis will be used to characterize the morphology and phase distribution of the Ni, 8YSZ, and pore phases. FIB-SEM tomography will subsequently be performed on selected cells to resolve their three-dimensional microstructures. A Deep Learning-assisted Segmentation workflow will be employed for automated phase segmentation and 3D reconstruction, enabling quantitative analysis of the electrode architecture as well as extraction of information about structure–property relationship. By integrating electrochemical characterization with conventional 2D microscopy and AI-assisted 3D microstructural analysis, this study aims to elucidate the influence of electrode processing on Ni-8YSZ morphology and its relationship with electrochemical performance, providing a basis for understanding and ultimately predicting microstructural degradation in SOFC and SOEC fuel electrodes.

Poster 17: PEMLife – Experimental Validation of PEMFC Aging Model Predictions

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Polymer electrolyte membrane fuel cells (PEMFCs) offer significant potential for the defossilization of the mobility sector. However, their performance and lifetime are affected by aging processes that are strongly dependent on operating conditions. The development of lifetime-optimized operating strategies is therefore essential. Although such strategies can be developed experimentally, numerical methods are increasingly being used to accelerate the process. However, due to the wide range of degradation mechanisms occurring in PEMFCs, these models must be carefully calibrated and validated against experimental data.

Data on PEMFC aging was generated through accelerated stress tests (ASTs) in a single-cell setup. A range of electrochemical measurement techniques and microscopic analyses were employed to accurately identify and quantify the degradation mechanisms occurring in the fuel cells. The resulting data was used to calibrate a 0D degradation model for PEMFCs, with particular emphasis on changes in the electrochemically active surface area (ECSA) caused by the dissolution and detachment of platinum particles in the cathode catalyst layer.

Good agreement was achieved between experimental and simulation results. Using the changes in ECSA as the initial calibration basis, the model reproduced a particle-size distribution trend similar to that observed in microscopic imaging. The model also accurately captured the formation of a platinum band within the membrane. At the same time, it predicted that the overall membrane performance and layer thickness would remain largely unchanged, consistent with the observations from the AST. These results demonstrate the model's potential as a tool for developing lifetime-optimized operating strategies.

Poster 18: Circularity of Key Components of a Fuel Cell Electric Vehicle after Ten Years of Real-World Operation

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Platinum, perfluorosulfonic acid (PFSA) ionomers and carbon fibres make fuel cell electric vehicles (FCEVs) dependent on scarce, emission-intensive materials. As first-generation FCEVs reach end of life, recovering them becomes a matter of sustainability and supply security. Within the Austrian contribution to IEA Task 34 “Fuel Cells for Transportation”, this work investigates the circularity of the PEM stack, type IV hydrogen tanks and humidifier of a Hyundai ix35 Fuel Cell (2016) after real-world operation.

Components were disassembled and characterised by material fractions, electron microscopy and single-cell electrochemical testing. Chassis dynamometer measurements of an identical vehicle in 2016 and 2026 quantify system ageing.

After about 77,000 km, stack voltage at equal current decreased by 10–15 %, and the sustained system power was limited from 87 kW to 53 kW. Extracted cells remained functional. The stack offers the highest circularity potential: bipolar plates, gas diffusion layers and catalyst-coated membrane could be separated without destruction, enabling reuse of structural parts and recovery of platinum and PFSA. Reuse of type IV tanks is restricted by missing validated end-of-life criteria and approval rules, making carbon fibre recycling with cascade use the realistic route. The humidifier’s pressed-in membrane bundle hinders material separation.

Design for disassembly, documented usage histories and reliable condition assessment emerge as key levers for resource-efficient hydrogen mobility.

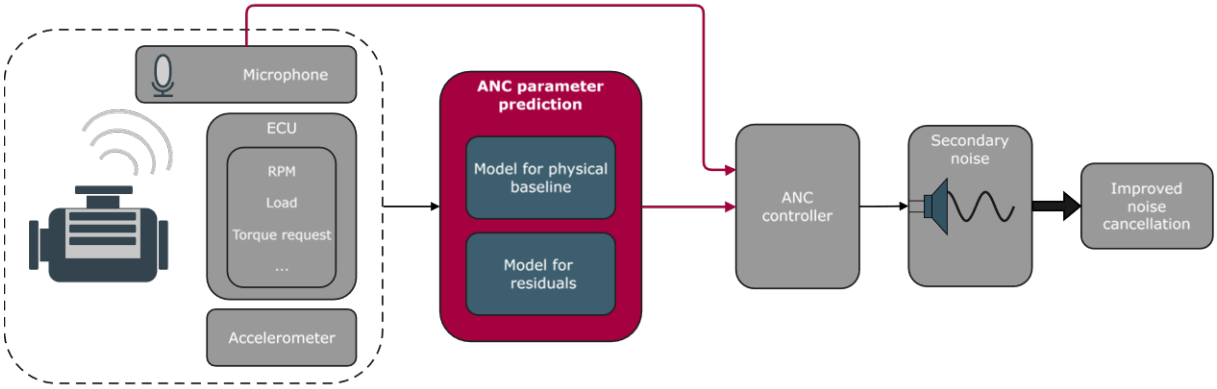
Keywords: PEM fuel cell, type IV hydrogen tank, end of life, circular economy, critical raw materials

Session 5: Vehicle Innovation, Safety and Sustainability

Poster 19: Physics-Informed Machine Learn ing for Active Noise Control in Vehicles

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The proposed research primarily relates to the “Vehicle Innovation, Safety and Sustainability” session listed in the program, as it addresses improved acoustic comfort and the reduction of vehicle-related noise emissions.



Active Noise Control (ANC) reduces unwanted sound through destructive interference by generating a secondary sound field that counteracts the primary noise. When noise characteristics or acoustic paths change, the adaptive controller used in ANC requires time to reconverge to optimal filter parameters. During this transient adaptation period, noise attenuation can temporarily decrease.
The objective of this project is to improve the stability of noise reduction during transient operating conditions in vehicle propulsion and auxiliary systems. For this purpose, a hybrid modelling approach is proposed that combines physics-based models with data-driven prediction to estimate suitable controller parameters in advance.
In particular, selected machine-state information is used to anticipate changes in the acoustic state. Based on this information, suitable controller parameters are inferred and provided to the ANC controller. By supplying these parameters in advance, the adaptation time otherwise required by conventional ANC controllers can be reduced or bypassed. This approach has the potential to provide improved and more stable noise cancellation during transient operating conditions.

Poster 20: Overcoming Hurdles in Implementing Energy Transition: A Proven Pathway to Economic Success for Early Entrepreneurial Adopters

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The global energy transition presents significant technical and economic challenges, alongside substantial opportunities for early entrepreneurial adopters. Transitioning heavy-duty transport to sustainable solutions requires overcoming key bottlenecks, including high initial investment costs, limited public charging infrastructure, and complex renewable energy integration.

Battery Electric Trucks (BETs) offer a viable, highly efficient alternative to traditional diesel fleets. However, widespread adoption relies on building reliable private charging infrastructure and integrating renewable energy sources, such as solar or wind power, to ensure operational reliability and lower energy costs.

Achieving economic success in this transition hinges on comprehensive Total Cost of Ownership (TCO) analysis. Evaluating long-term economic viability enables businesses to make data-driven decisions regarding fleet electrification and infrastructure investments. Real-world testing and continuous optimization using digital tools further validate assumptions and maximize operational efficiency.

In conclusion, overcoming energy transition hurdles requires strategic planning, investment in private charging, renewable energy integration, and rigorous TCO evaluation. This multifaceted approach provides a proven pathway for businesses to achieve long-term economic success while supporting sustainability goals.