GAMMA TECHNOLOGIES

EBOOK

GT FUEL CELL SOLUTIONS

HOW LEADING COMPANIES LEVERAGE SIMULATION TO DRIVE FUEL CELL TECHNOLOGY DEVELOPMENT

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HOW LEADING COMPANIES LEVERAGE SIMULATION TO DRIVE FUEL CELL TECHNOLOGY DEVELOPMENT.

GT GLOBAL CONFERENCE RECAP

Fuel cells represent a promising clean technology that will play a vital role in the transformation roadmap of many OEMs towards sustainable mobility, from on-highway to off-highway and aerospace, marine, and power generation.

In this transformation, digitization plays a crucial role. It enables engineers to experiment with what-if scenarios to gain confidence in the technology faster and at an affordable price, with minimum risk of failure. This approach has proven to be very helpful to the transportation technology in the past to mature faster with a higher degree of standardization and security.

During the Gamma Technologies' 2021 global conference, and as can be expected from the significant uptick in fuel cell and H2 interest recently, we have seen a high presence of fuel cell technology presentations, reflecting the fast-paced transformation happening in the industry.

In this blog post, we would like to highlight a few presentations from leading OEMs, suppliers, and researchers in the field of fuel cells and how they leverage simulation to advance fuel cell technology. The motivation is to share it with the community, drive the collective discussions and play our part in shaping the "H2 engineering ecosystem".

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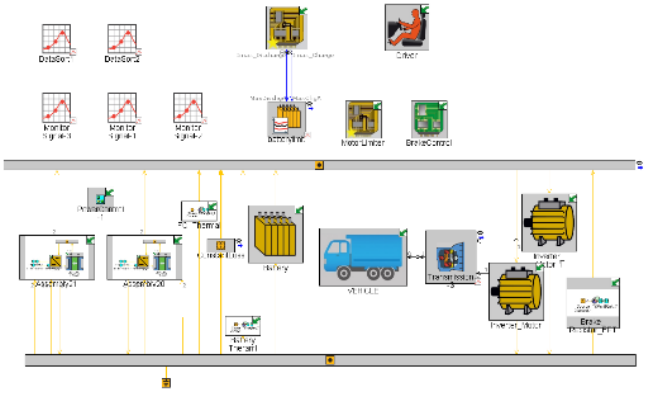
THE ROLE OF SIMULATION IN DEVELOPING A FUEL CELL POWERTRAIN CONFIGURATION OPTIMIZED FOR CLASS-8 TRUCKS

As the first entrant to the Class-8 fuel cell propelled trucks, Nikola Corporation has to innovate and find new ways to solve the unique challenges of the fuel cell technology by looking at it through a new lens.

Christian Appel, the Global Chief Engineer, FCEV, and Propulsion Engineering at Nikola Corporation gave an inspiring keynote presentation showing the role of simulation in efficiently developing fuel cell powered trucks. GT-SUITE solutions support the development starting from the early design stage of the powertrain with architecture sizing, controls and thermal management optimization.

As a consequent step vehicle driving scenario are implemented to optimize the energy consumption and the refueling stations locations.



Fully integrated Fuel Cell Propelled

KEY TAKEAWAYS:

- Both fuel cell and battery vehicle will complement each other depending on the application.
- Simulation is a key enabler to drive maturity and market awareness of the technology in a short period of time.
- For electric vehicles it is important to investigate all the different phenomenon at once to have an accurate representation of the real system performance.
- Simulation offers the ability to develop technology at lower cost, time, and minimum risk from the initial stages of development until the final product launch.

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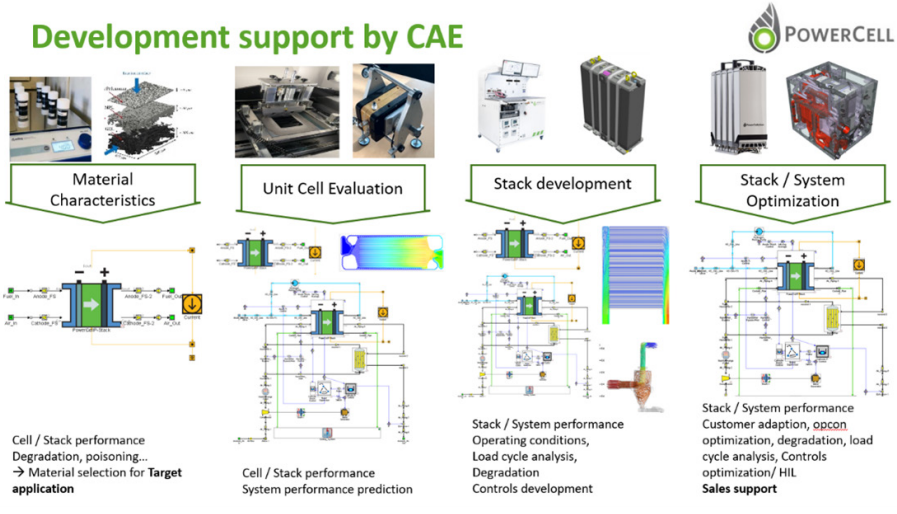
SIMULATION AS MEANS TO BETTER UNDERSTAND CUSTOMER REQUIREMENTS AND DRIVE MAXIMUM CUSTOMER SATISFACTION

The leading fuel cell stack and system supplier PowerCell decided to leverage the value of digitization throughout the development cycle from the cell material characterization and the stack performance prediction to the balance of plant system optimization. This approach allows not only to test the performance of the design but to investigate many scenarios using the integrated optimizer solution. The outcome is clear: find the best performing design that satisfies most customer requirements, do it faster and more efficiently than in the conventional approach.



PowerCell R&D Application Digitization

KEY TAKEAWAYS:

- Customer focus from early development until integration in the final application of the user.
- Development and adaption of key characteristics to customer needs.
- Early prediction of stack performance based on single cell testing.
- Support stack testing and analysis.
- Virtual optimization and test design to reduce testing effort.
- System optimization to balance performance, efficiency, and lifetime while responding to customer use cycles.

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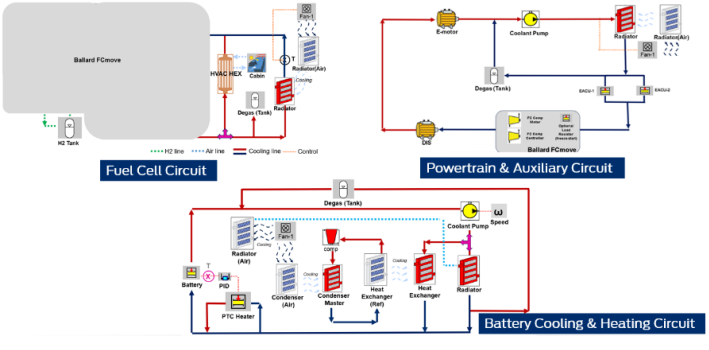
OPTIMIZING THE THERMAL MANAGEMENT SYSTEM OF A FUEL CELL TRUCK USING SIMULATION

Not only is thermal management a key influencer to maintain the optimal efficiency of a fuel cell system but it's also a key influencer for durability and impacts controls development. Elif GÖZEN and Sencer BOLU from Ford Otosan gave a complete presentation about thermal management model development & fuel cell powertrain optimization in coach application in the context of the EU funded CoacHyfied project.

The presentation highlighted the complex thermal management system of an FCEV and how such a system can be easily built and calibrated in GT-SUITE to a high level of accuracy. These models are now being used in the project for system optimization studies.



HEV Complete Powertrain Thermal

KEY TAKEAWAYS:

- GT-SUITE tools for simulation and analysis allows the users to model the full electric powertrain including e-motor, battery and fuel cell in high fidelity without compromise. This includes a full vehicle simulation in transient conditions.
- Simulation and optimization of the hybridization control strategy at an early stage in the project where prototypes might not be available yet.
- The changes in the transition criteria and battery capasity lead to a decrease in total energy and therefore hydrogen consumption.

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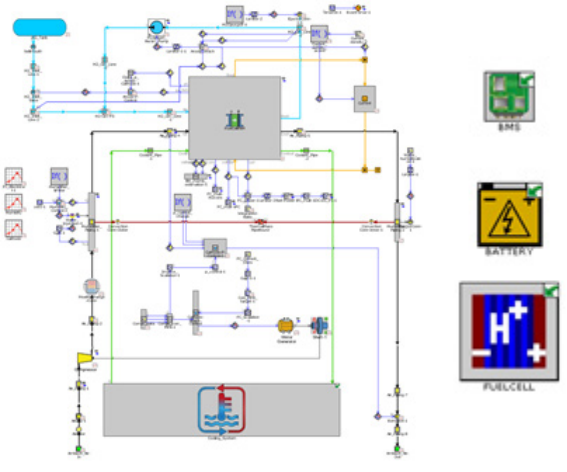
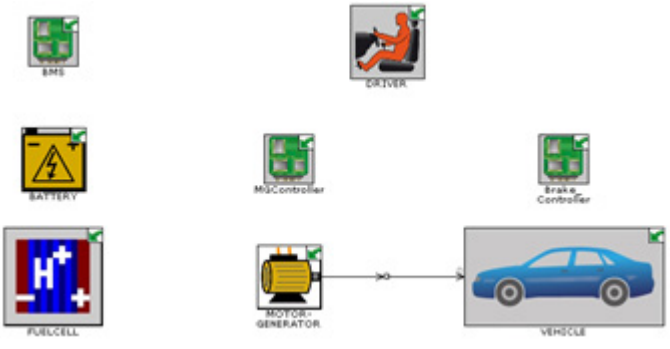
FUEL CELL RANGE EXTENDER STRATEGY INVESTIGATION

Finding ways to extend the range of the vehicle by coupling fuel cells and batteries can be a valuable solution to overcome the refueling station challenge. Still, range-extending techniques can stress the fuel cell leading to increased aging of the stack or resulting in more H2 consumption.

That's why Marcos Lopez-Juarez, from Universitat Politècnica de València, CMT – Motores Térmicos, and his team decided to evaluate the variation in H2 consumption of an FCREx vehicle when modifying the FC system sizing and imposing dynamic limitations. Another focus was on evaluating the fuel cell stack durability of an FCREx vehicle when changing the fuel cell system sizing or imposing dynamic limitations. The goal is to elaborate design recommendations for FCREx vehicles to maximize durability and minimize H2 consumption for passenger cars.



Holistic Multi-Physics Balance of Plant



HEV Complete Model

KEY TAKEAWAYS:

- Dynamic limitations imply higher durability, higher H2 consumption (OPEX ↑), and no change in production costs (CAPEX =)
- Increasing FC stack power implies higher durability, lower H2 consumption (OPEX ↓), and increased production costs (CAPEX ↑)
- Similar performance and durability were found at high dynamic restrictions no matter the FC maximum power.
- Suggested design is 80 kW FC with |di/dt| limited to 0.01 A/cm2s or |di/dt| corresponding to target life to minimize H2 consumption, maximize durability, and enhance system flexibility.

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CLICK REFERENCES:

FUEL CELL MODELING WITH GT SOLUTIONS

FUEL CELL ELECTRIC VEHICLE MODELING WITH GT SOLUTIONS

HYDROGEN MOBILITY SYSTEMS SIMULATION

TRAININGS & SEMINARS

IF YOU'RE INTERESTED TO LEARN MORE

As the leading powertrain digital agnostic platform, Gamma Technologies is committed to supporting the industry with best-in-class digitization solutions from early design specification to system integration and virtual calibration.

In GT-SUITE version 2022 remarkable enhancements and new capabilities for fuel cell systems modeling are available, from predictive electrochemistry modeling to real-time capable models for virtual calibration, solid oxide fuel cell technology modeling, and many more. Those will be covered in the next blog post so stay tuned for more insights.

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