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Virtual Component and System Integration for Efficient Electrified Vehicle Development

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Introduction

Further increased electrification/hybridization of vehicle powertrains is indispensable to successfully master the upcoming challenges related to the 2030 EU fleet-wide average CO_2 emission targets. The goal of the VISION-xEV project is to unveil and demonstrate a consistent modelling and simulation-based methodology for component development and system integration. This will support virtual prototyping from component to sub-system to powertrain/vehicle level aimed at an efficient and effective development of future electrified/hybrid vehicles.

Objectives

- Innovative scalable simulation models of the electrified/hybrid powertrain components and sub-systems:
  - battery, super-capacitor, e-machine, inverter
  - internal combustion engine, charging system, aftertreatment
  - transmission, driveline
  - thermal management system
- Extended interfaces and co-simulation methods to enable seamless coupling of the individual component and sub-system models
- Strategies and methods for efficient component and sub-system model parameterization
- Comprehensive model validation based on experimental data

Methodology

The high-fidelity and reduced order models as well as the related parameter identification strategies and novel model integration methods are jointly elaborated by the VISION-xEV consortium partners. High simulation accuracy and applicability of both the high-fidelity and reduced order models developed within VISION-xEV is assured by comprehensive validation adopting experimental data.

The newly developed models are implemented into the partners' modelling platforms, in-house research codes and commercial software tools.

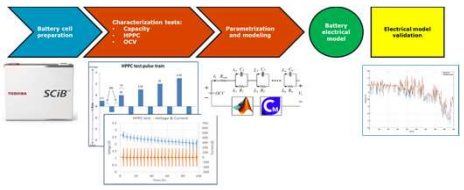
Specific emphasize is on ensuring numerically stable and robust solutions together with enabling ease of use and flexible exchange of models and model variants among the different stakeholders. A major focus is on achieving a highest possible degree of modularity and flexibility to ensure model applicability to the large variety of component technologies and future hybrid powertrain architectures.

Demonstration of the validity of the newly developed models of the relevant powertrain components and sub-systems as well as of the elaborated model interfaces and coupling methodologies is achieved by their application to selected use-cases, each comprising typical simulation tasks within the vehicle development process of the VISION-xEV industry partners.

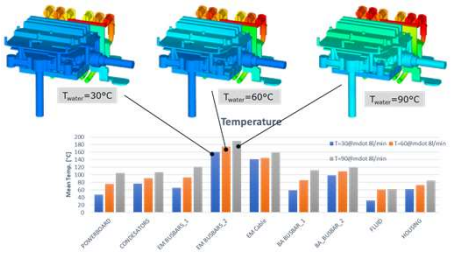
Achievements

- Methods for assessment and design of real-world driving cycles for electrified vehicles
- Experimentally validated electrical and thermal Li-ion battery/capacitor models and related model-order reduction and accelerated parameterization workflows
- Detailed 3D and reduced-order electro-thermal inverter and e-machine models including joint simulation and experiment based parameterization and validation methodology
- Advanced exergy and power-based models and methods for TC performance assessment under different flow scenarios
- Fast gas-path simulation solver and co-simulation methodology for flexible coupling of engine and aftertreatment simulation tools
- Models of zero flow free convection heat transfer, electrically heated catalysts and phase change material thermal behavior
- Thermal management models and architecture for hybrid powertrains and vehicles

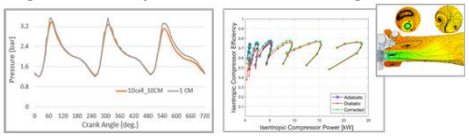
Battery modeling workflow



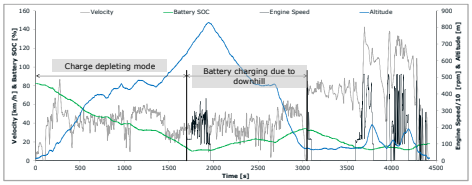
Scalable inverter thermal simulation



Engine and TC performance modeling



PHEV RDE test campaign



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More information

For more information please visit the VISION-xEV web-page www.vision-xev.eu.

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