eMobility & Energy Management

Development for Sustainable Mobility on 3DEXPERIENCE Platform

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Abstract

Due to the rapid shift towards vehicles partially or fully powered by electricity (eMobility), Dassault Systèmes has developed an Industry Solution Experience to address new challenges of electrification and energy management.

Our goal is to demonstrate how to apply the precepts of Model-Based Systems Engineering (MBSE) and to converge towards a virtual twin in a zero-prototype approach.

Keywords: eMobility, virtual twin, Modelica, MBSE, battery, EV, simulation

1 Introduction

In the race towards sustainable mobility (reduction of CO_2 footprint, design for recycling …), the massive shift towards eMobility has already begun. Acknowledging the fact that personal vehicles are one of the major sources of CO_2 emissions, and consumers are encouraged to adopt electric vehicles due to their significantly lower CO_2 output, more and more countries are coming up with a roadmap to ban ICE vehicles.

Along with that push from policy and regulations, the OEMs are now providing a more mature offering and are ready to ramp up for mass production.

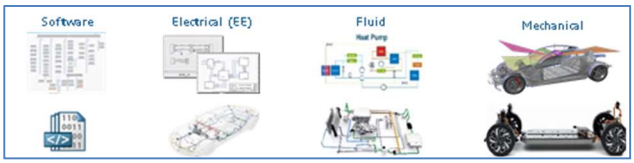
By 2026, we expect EVs to oversell ICE on the European market, and by 2030 we are looking at around 85 million EVs for Europe only.

2 Towards Sustainable Mobility

We cannot complete such an ambitious paradigm change by only focusing on vehicles. A holistic approach combining Energy, Vehicle and Mobility Service, is required to reach our goals of sustainable mobility.

- Energy: consider the complete energy stream, including production, transportation, storage and distribution
- Vehicle: increase vehicle energy efficiency (less loss); and improve vehicle performance (range, charging time, …)
- Mobility Service: take into account all services contributing to the reduction of CO_2 in usage: smart charging and Vehicle to Grid, optimization of route planning taken into account location, speed and availability to charging points

It is no more enough to optimize battery, propulsion and thermal systems separately.
It is now admitted that a significant gain will come from the optimization of the whole energy chain integration and control command.

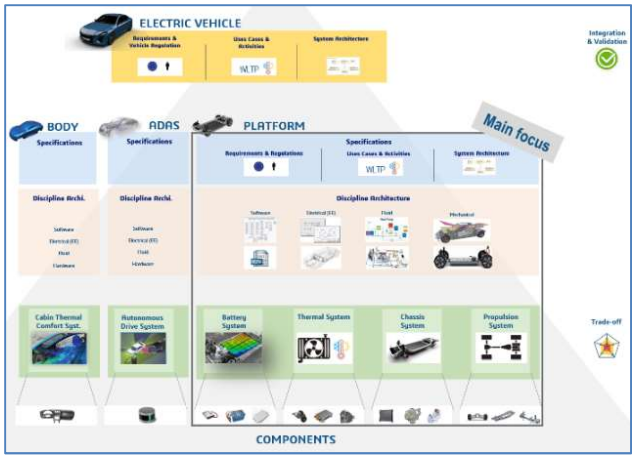


To do so, we must combine all relevant disciplines (fluidics, mechanical, electrical & electronics and software) from the initial stages to talk a common language across departments with traceable continuity from architecture level to hardware and software designs.

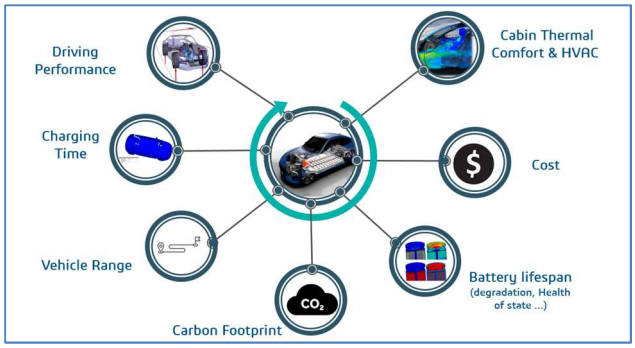
3 Efficient Multi-Energy Platform

The 3DEXPERIENCE Platform can help to tackle those challenges. Not only are we providing some of the best-in-class tools for 1D and 3D simulation, they are also integrated in one single platform, along with complete PLM, powerful data analytics, all this to help you make the right decisions, backed by science and data evidence.

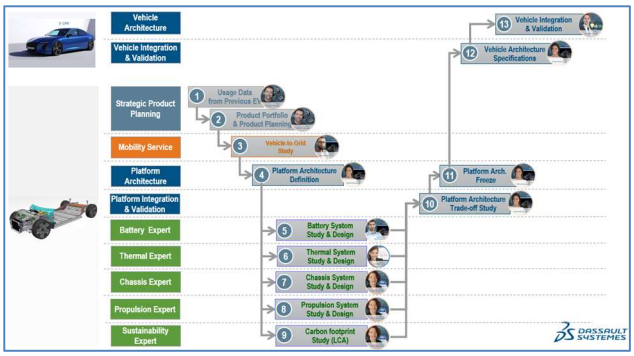
A more concrete manifestation of this thought process is a Dassault Systèmes Industry Solution Experience (ISE) developed specifically for this use case, named Efficient Multi-Energy Platform. By leveraging all Dassault Systèmes has to offer in its solution portfolio, we wish to offer and end-to-end integrated solution that brings value to our customers in all relevant stages of the development.



Efficient Multi-Energy Platform has of course a very strong modeling and simulation focus, since eventually complex 1D and 3D will be key elements within the design process (from battery system to powertrain, including chassis, thermal systems, …).
One of key industrial challenges being to find the best compromise for all performance metrics.



Nevertheless, this should not lessen the importance of the other key functionalities covered by this Industry Solution Experience:



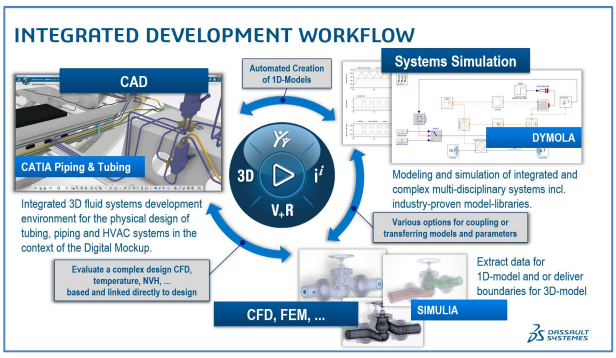
- Data intelligence: analysis of EV operational data from an Energy Management standpoint, simulation result analytics (decision making)
- Environmental footprint and Life Cycle Assessment

Smart electricity grid management with Vehicle-to-Grid is also an important lever toward decarbonization.

4 Simulation framework

As written above, several key parts of this ISE involve complex simulations. Some of them like chassis system study for instance, rely heavily on 3D structural analysis, in order to investigate the impact on complex geometries of nonlinear plastic deformations. However, most of the simulation activity is instead leveraging the Modelica language. Because those tasks require investigating at the same time multiple physical domains with tight interactions (electrical, mechanical, thermal, control…) to provide relevant results, Modelica, as an equation-based and multi-discipline oriented language, is a natural fit for those.

Dassault Systèmes is already known for developing Dymola, one of the main Modelica tools on the market. In addition to this stand-alone version, Dassault Systèmes also decided to enrich its 3DEXPERIENCE Platform by integrating the Dymola kernel and positioning Modelica as a simulation backbone, in order to enable simulation in as many areas as possible. Not only can we take advantage of the Dymola technology for its own merits, but we can also benefit from the new synergies made possible by the 3DEXPERIENCE Platform.



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In the move towards the Digital Twin, many models and diagrams that were just static until now came to life thanks to the Modelica language. We make use of another open standard as well, the Functional Mock-up Interface (FMI), when the need to integrate external models or complex 3D simulations in our workflow occurs.

5 Take-away

With this solution, we aim at accelerating the energy transition by designing, simulating and optimizing the Digital Twin of the eMobility, from battery to platform and vehicle. The ultimate target being to reach Zero Prototype, through virtual vehicle development.

This is possible by:

- combining software, electrical and mechanical architectures in a unique collaborative environment with digital traceability and continuity
- managing assets in a consistent way for all vehicle engineering and study in evolution and configuration
- assessing product performance combining ADAS and energy management
- managing legacy data and solution in an Opened platform
- handling vehicle complexity by embracing Systems Engineering concepts and methods, thanks to an integrated business and science platform