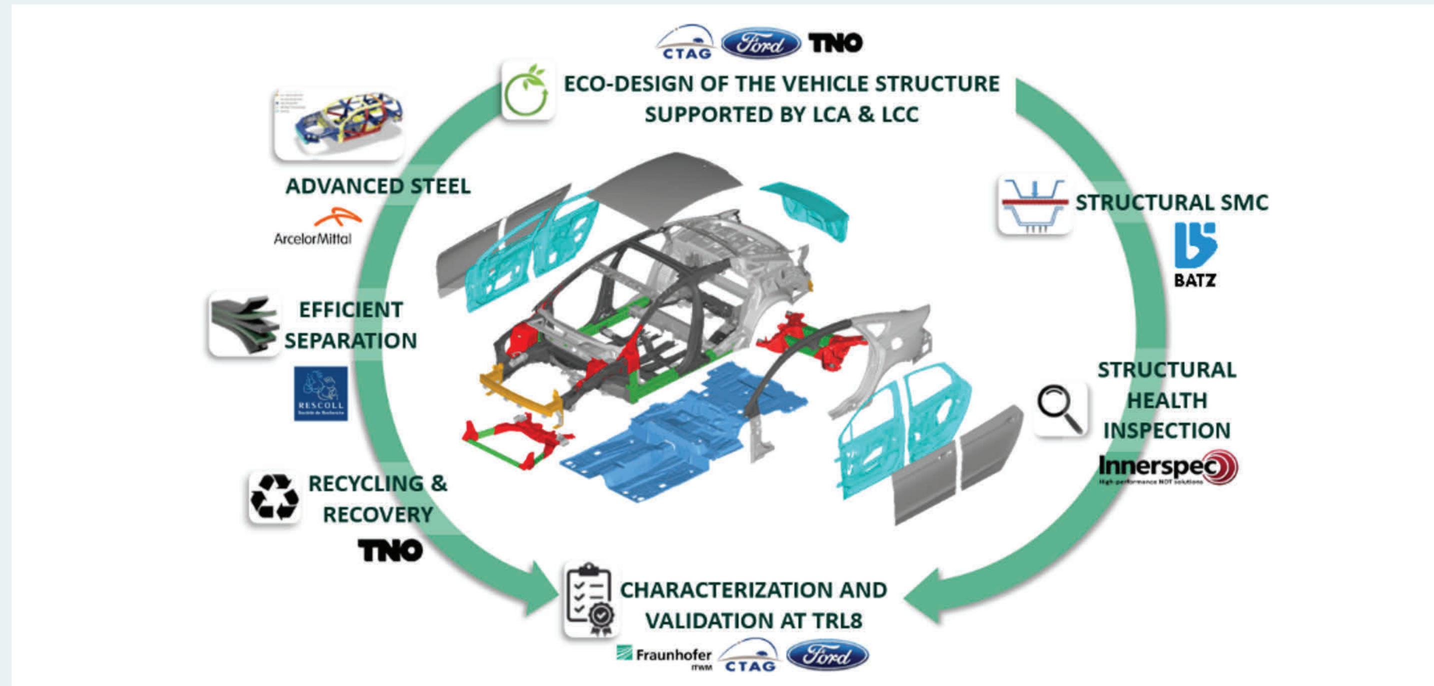
Life ALMA – Advanced Light MAterials and processes for the eco-design of electric vehicles

Alma

1. Overview and Motivation

ALMA is an EU project which commenced in 2021 and comprises nine partners from four different EU countries.



Goal

To develop a novel electric vehicle structure for a passenger car, featuring ***reduced weight and environmental impact*** due to the integration of a ***circular approach*** throughout the entire life cycle. A critical aspect of this project involves employing eco-design principles to re-envision the vehicle's architecture and body structure to achieve a ***longer service life*** and minimize waste and pollution.

2. Methodology and main contributions

Ecodesign:

a FORD Mondeo ICEV model was chosen as a design baseline and turned into a BEV while still retaining the original set of materials. Subsequent redesign and material selection iterations led to the development of the novel multi-material ALMA BEV concept (unibody configuration for the platform and FWD strategy for the drivetrain). Several iterative loops using CAD and CAE tools were performed to virtually validate the design concepts against six different crash and NVH scenarios. Eco-design principles were incorporated from the early concept stages, integrating approaches like Design for Assembly and Disassembly (DFA/DFD), Design for Recycling (DFR), and functional integration of separate parts into a single structure.

Advanced structural materials:

advanced High-Strength Steel (AHSS), low-density grade steels, steel/plastic laminates and advanced SMCs. In some instances, multiple alternative materials for the same component were available, requiring a more in-depth analysis.

Advanced joining and diagnose technologies:

structural debondable adhesives that are triggered using heat and an integrated Health Monitoring System (HMS) based on ultrasounds for damage detection and diagnosis, were implemented to ensure the overall environmental performance and circularity of the vehicle.

Recycling and recovery options for the End-of-Life:

short-term scenario based on thermo-chemical conversion (pyrolysis) and long-term based on solvolysis.

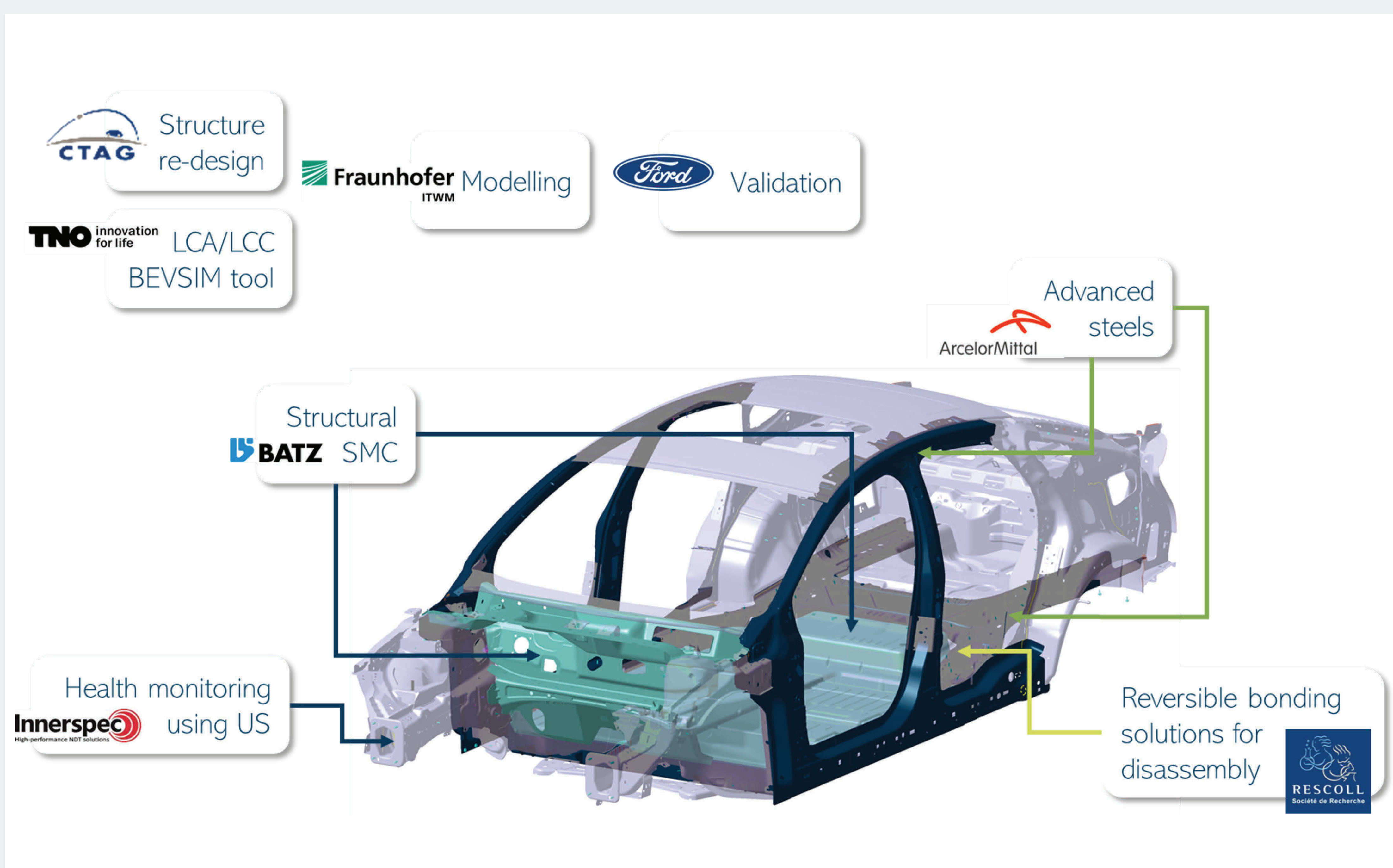
Final Bill of Materials (BOM):

organized into four groups based on distinct design strategies: i) unmodified components; ii) steel components with optimized thickness due to the use of AHSS, hot forming steels, and hybrid grades while maintaining the same geometry; iii) steel components with functional integration, utilizing AHSS and hybrid grades; and iv) SMC components, primarily focusing on the dash panel and battery lid.

3. Main results and conclusions

Novel EV multi-material platform design ***made to be reused and recycled*** that boasts a ***mass reduction of 146 kg***, which translates to a ***26% weight reduction*** compared to the baseline BEV.

Another innovative aspect of the project was the development of a web-based sustainability assessment tool called ***BEVSIM*** *(Battery Electric Vehicle Sustainability Impact Assessment Model)*. BEVSIM can perform life cycle hotspot analysis and impact assessments, circularity assessments, and economic impact analyses (LCC).



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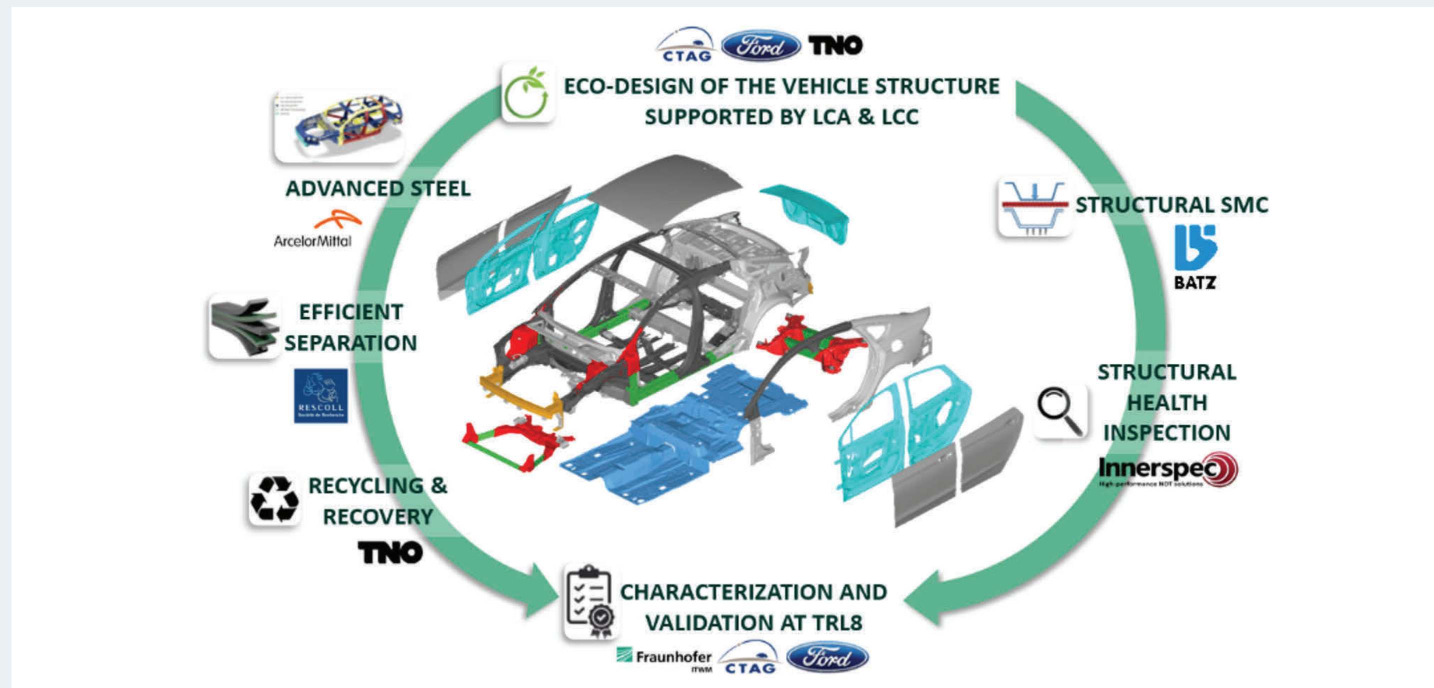

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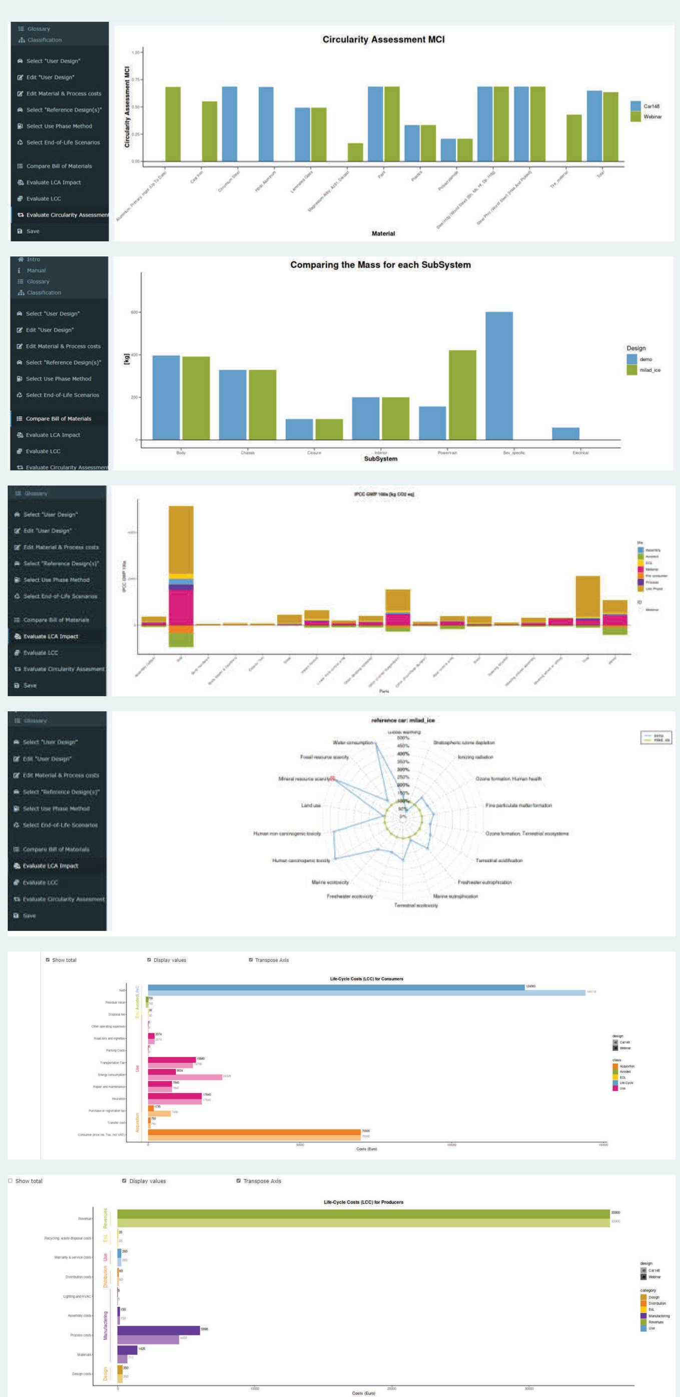

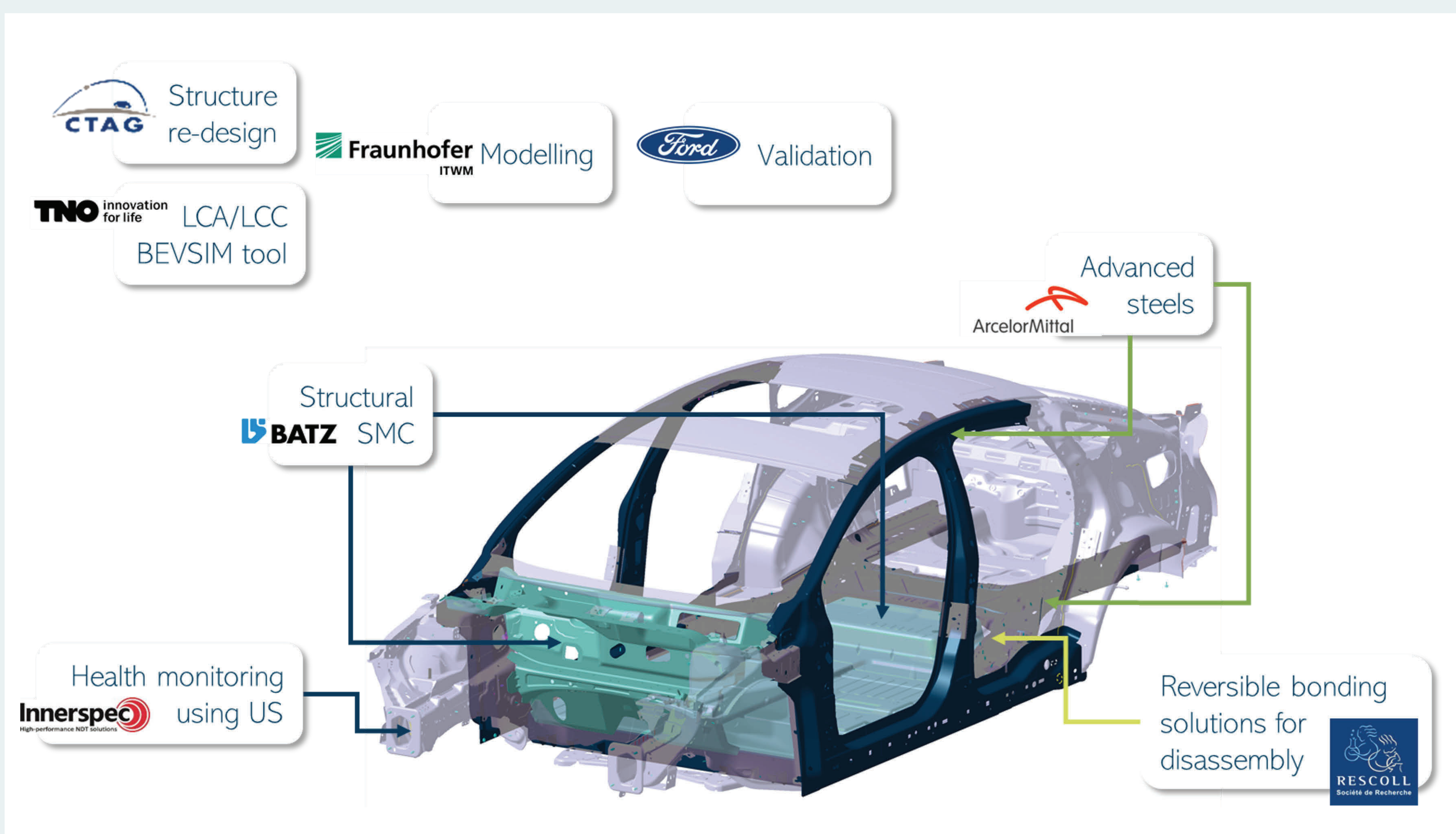

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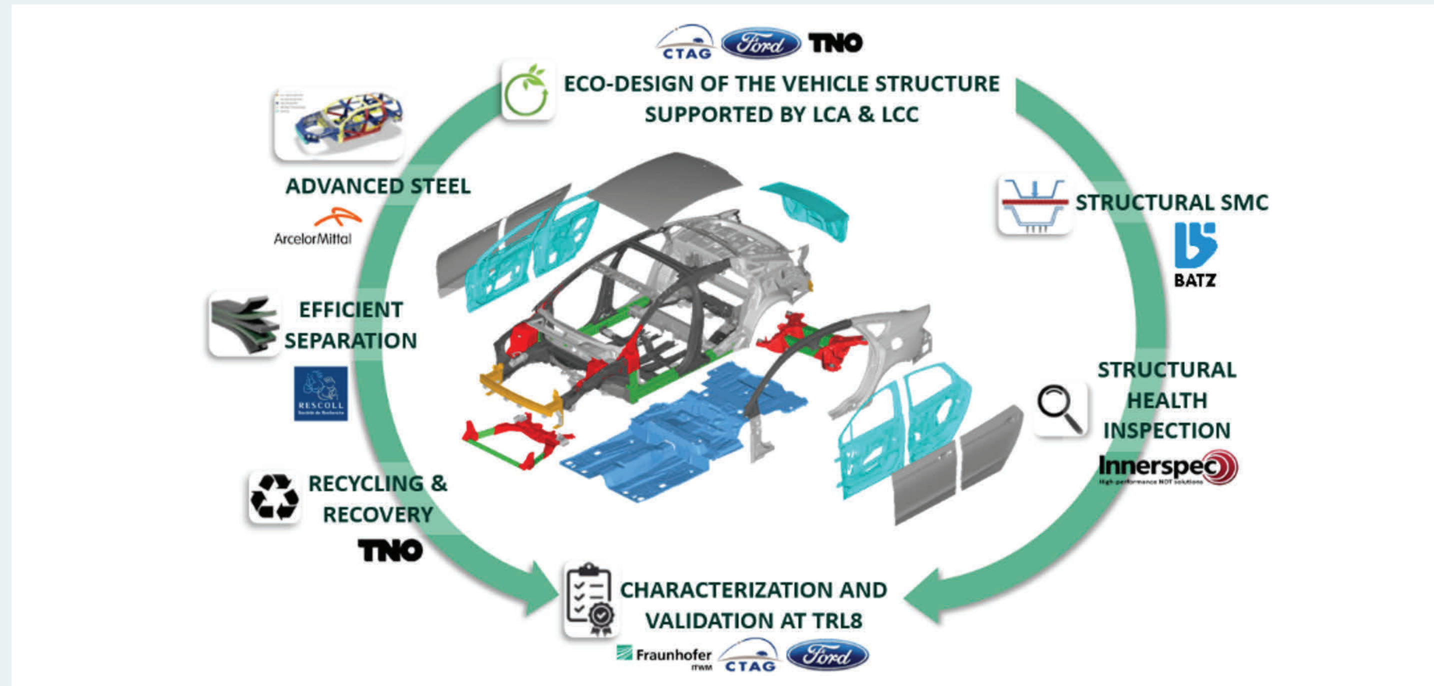

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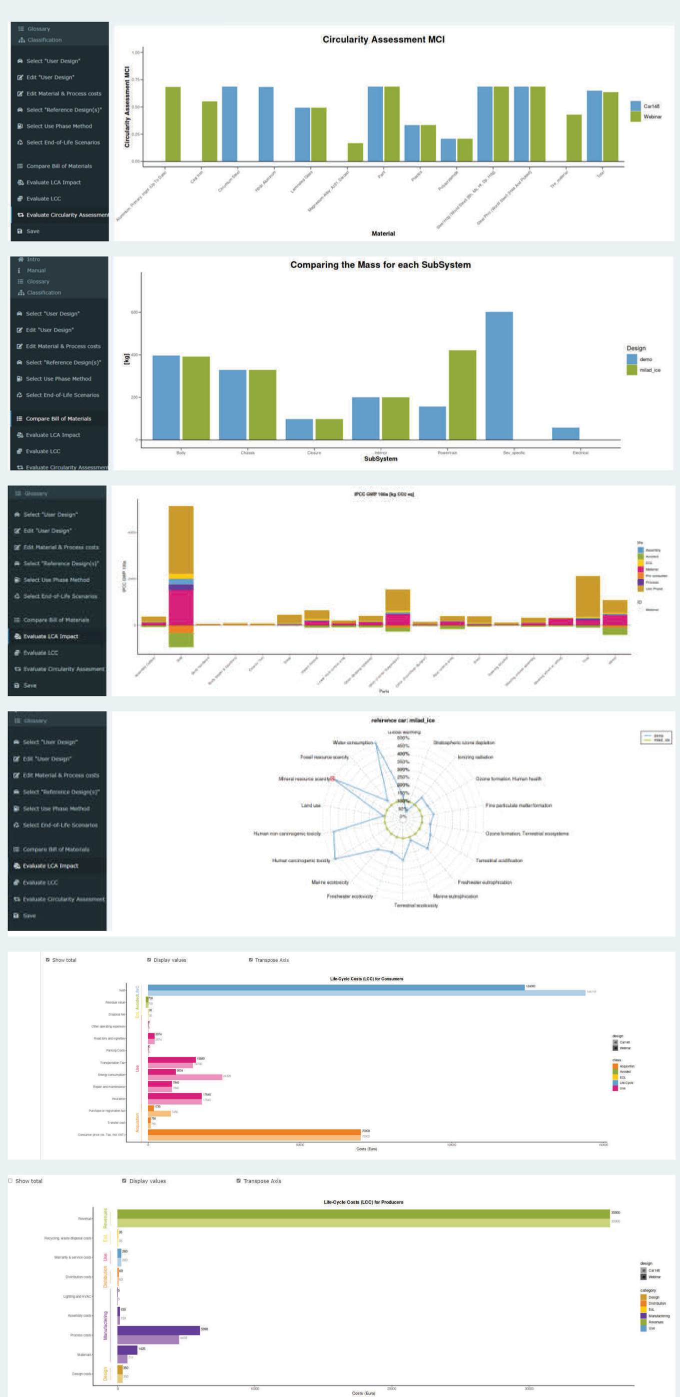

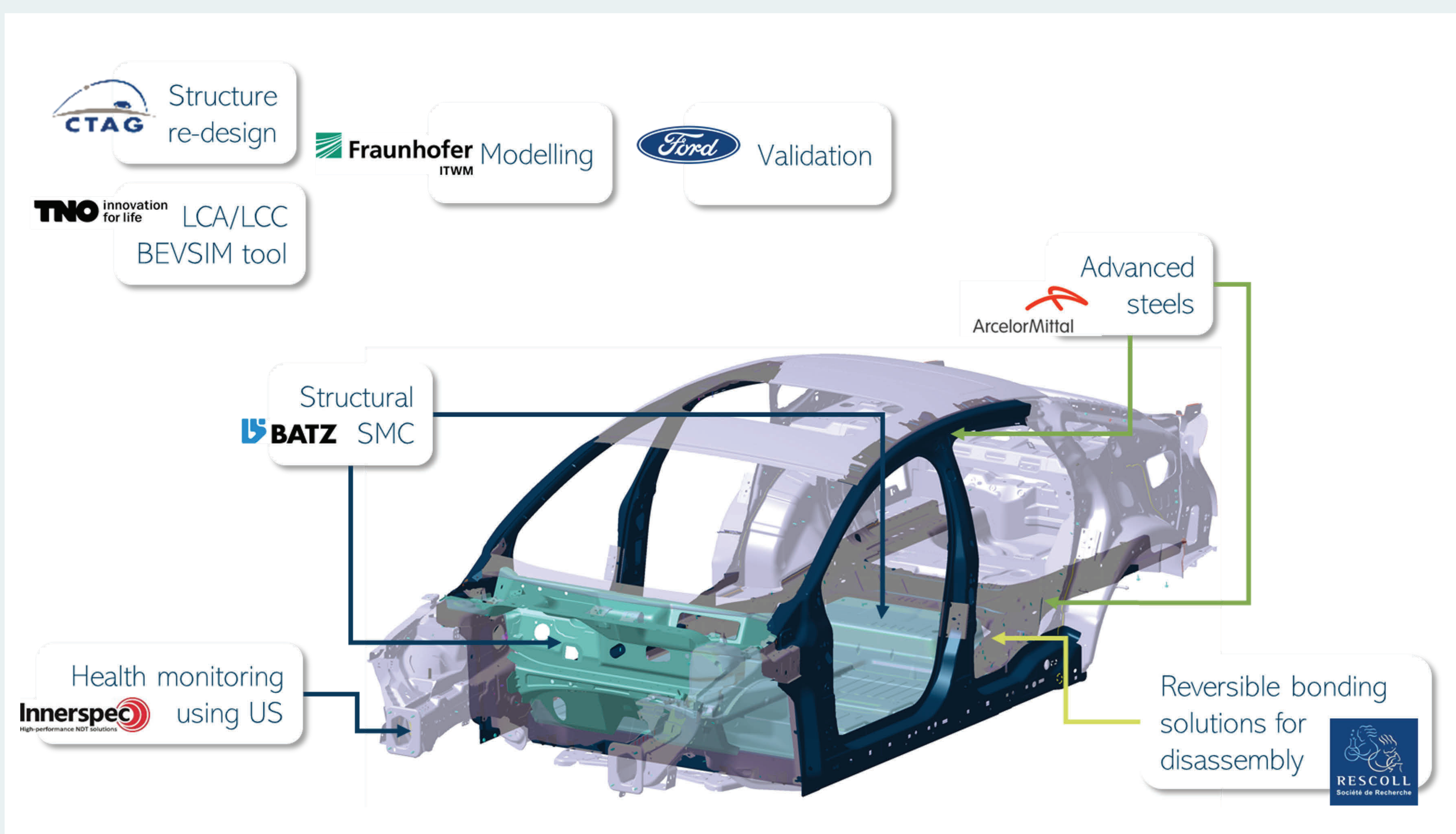

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