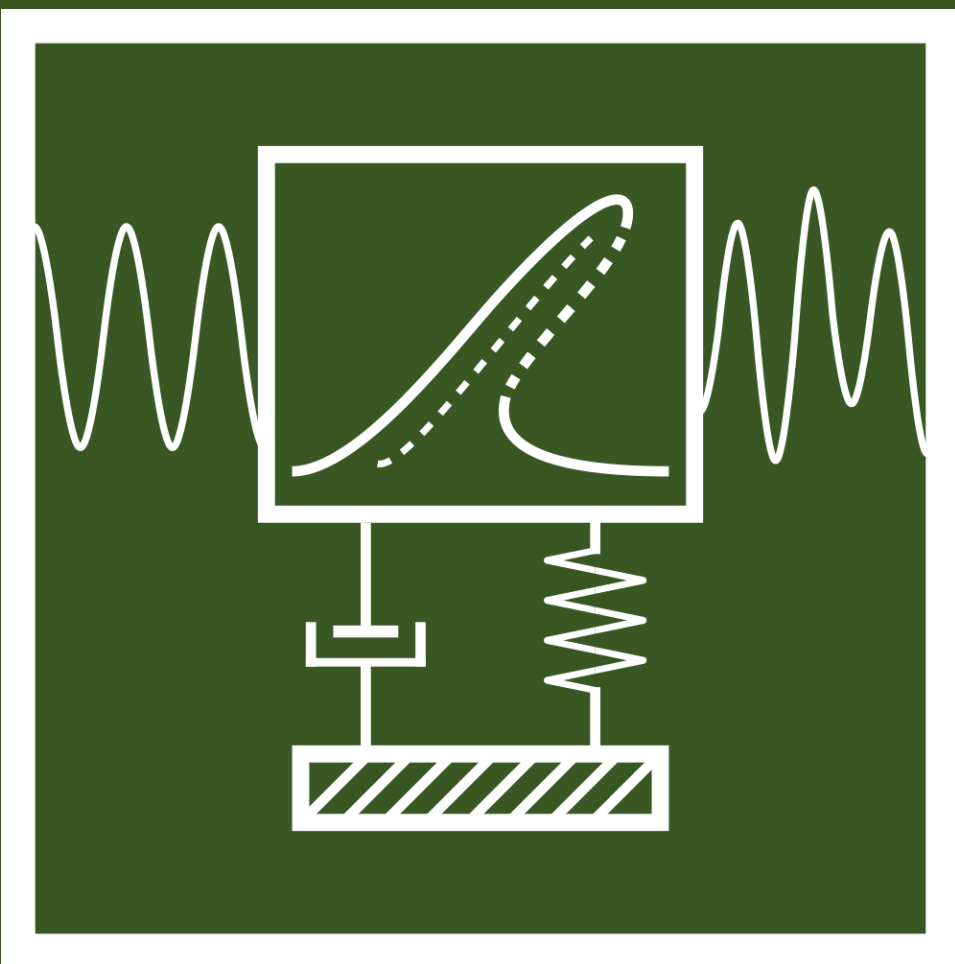


Advanced Composite Hydrogen Storage Tanks: Structural Integrity, Reliability and Future Research Perspectives

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A Abstract

The increasing demand for safe and lightweight hydrogen storage systems has driven the development of advanced composite pressure vessels. This research will investigate the structural behaviour, integrity, and reliability of composite hydrogen storage tanks under relevant loading conditions. Numerical and experimental approaches will be considered to evaluate structural response, damage mechanisms, and factors influencing tank performance. The study aims to contribute towards the development of safer, lighter, and more reliable hydrogen storage structures.

02 Research Overview

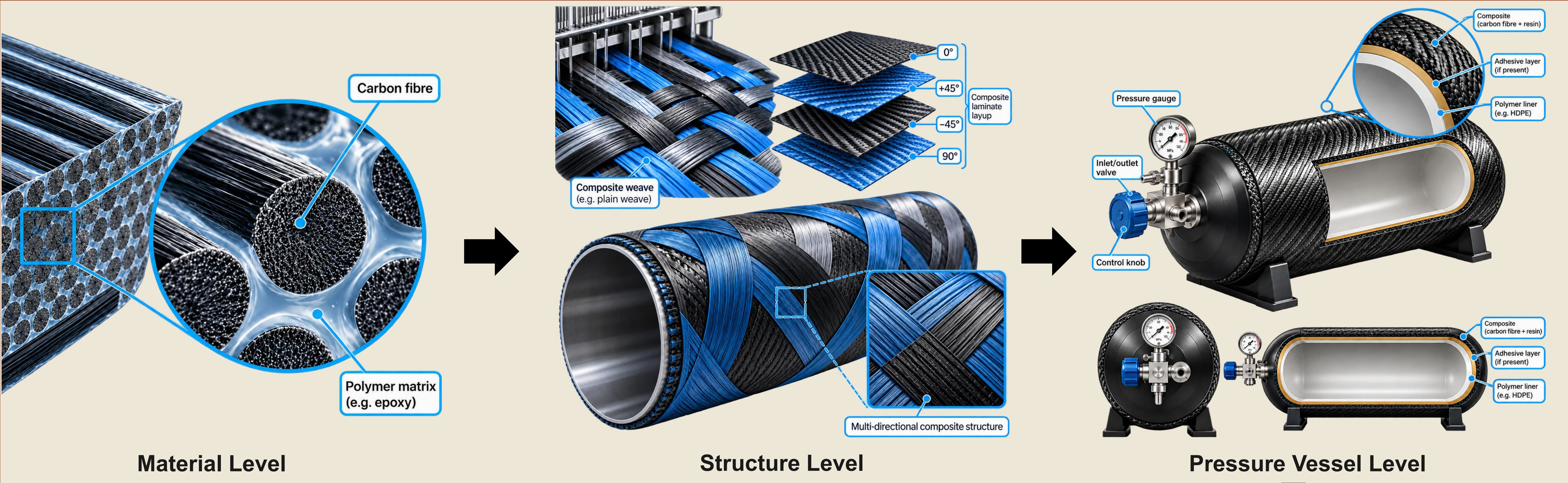
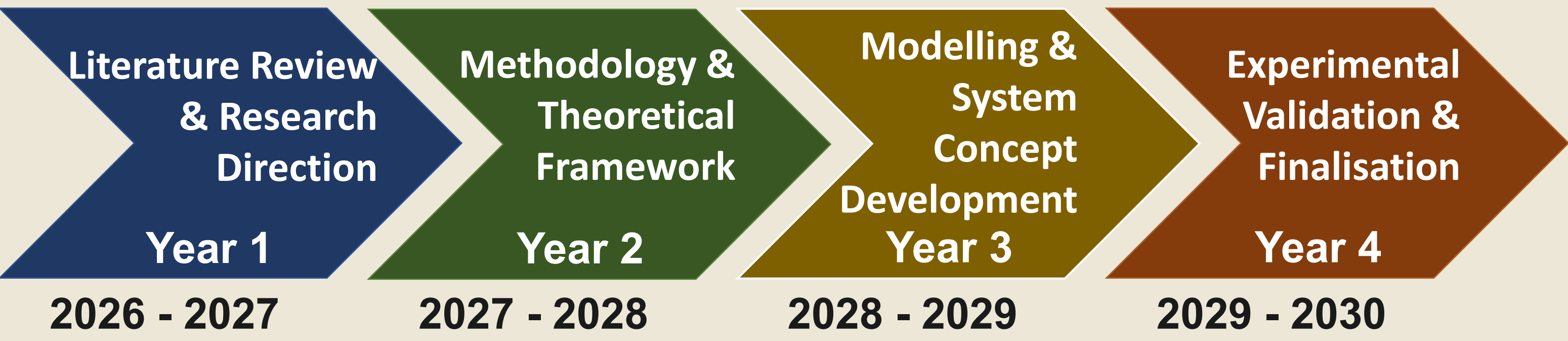


Fig 1. Visual representation of the jump in scale involved in the manufacturing of Hydrogen storage tanks.

03 Four-Year Road Map



04 Expected Results and Impact

1. A comprehensive understanding of current hydrogen storage technologies, composite materials, and existing research, leading to a clearly defined research direction.
2. A suitable methodology established for the theoretical, numerical, analytical, and experimental investigation of composite hydrogen storage systems.
3. Development of a hydrogen storage system concept based on the investigated composite, supported by theoretical and structural analysis.
4. Experimental findings compared with theoretical and numerical results to evaluate the investigated composite storage system and formulate conclusions.

01 Aim and Research Motivation

Aim: Develop and investigate composite materials and structures for Hydrogen storage tanks, combining theoretical analysis, mathematical modelling and experimental validation.

Research Motivation: Hydrogen is difficult to store because its low volumetric energy density requires either high-pressure compression (typically 150–700 bar) or cryogenic liquefaction, while its small molecular size also increases the risk of leakage and material degradation [1]. Composite tanks address this by combining high-strength fibres for structural loading with a polymer liner for gas containment, offering a high strength-to-weight ratio [2]. Current Type III and Type IV tanks use carbon-fibre reinforcement around metallic or polymeric liners and are already established in transport and other high-pressure applications [1]. Research is now moving toward advanced composite systems, including nanomodified resins, thermoplastic composites, and linerless Type V pressure vessels, with the aim of further reducing weight and improving structural performance and manufacturability [1, 2]. These developments create a need for continued research into composite materials, their structural behaviour, and their integration into hydrogen storage systems [2, 3].

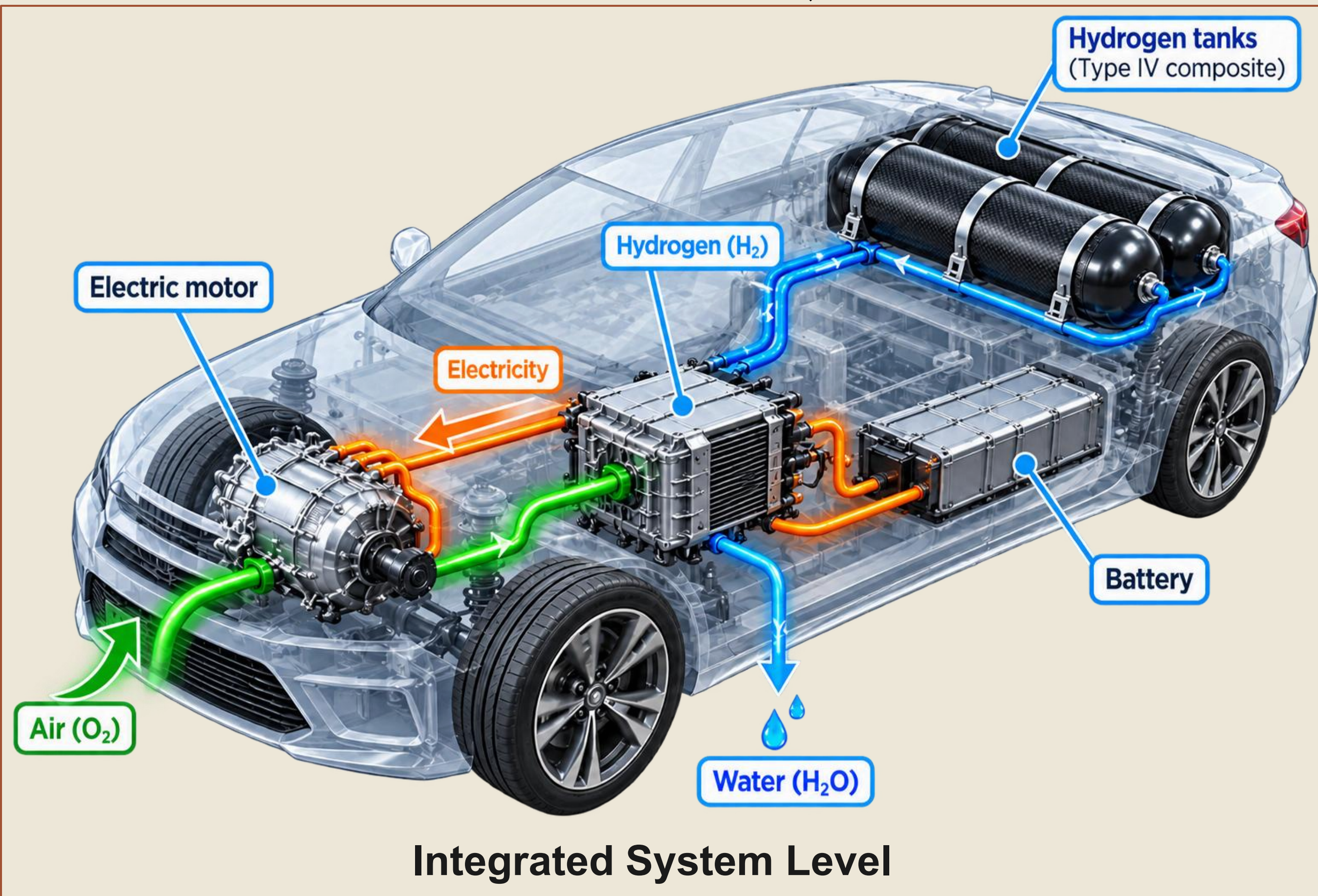


Fig 2. Complete system-level integration of the Hydrogen storage tank inside a hybrid vehicle.

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