

Development of an online Life Cycle Sustainability Assessment tool for WAAM-built products

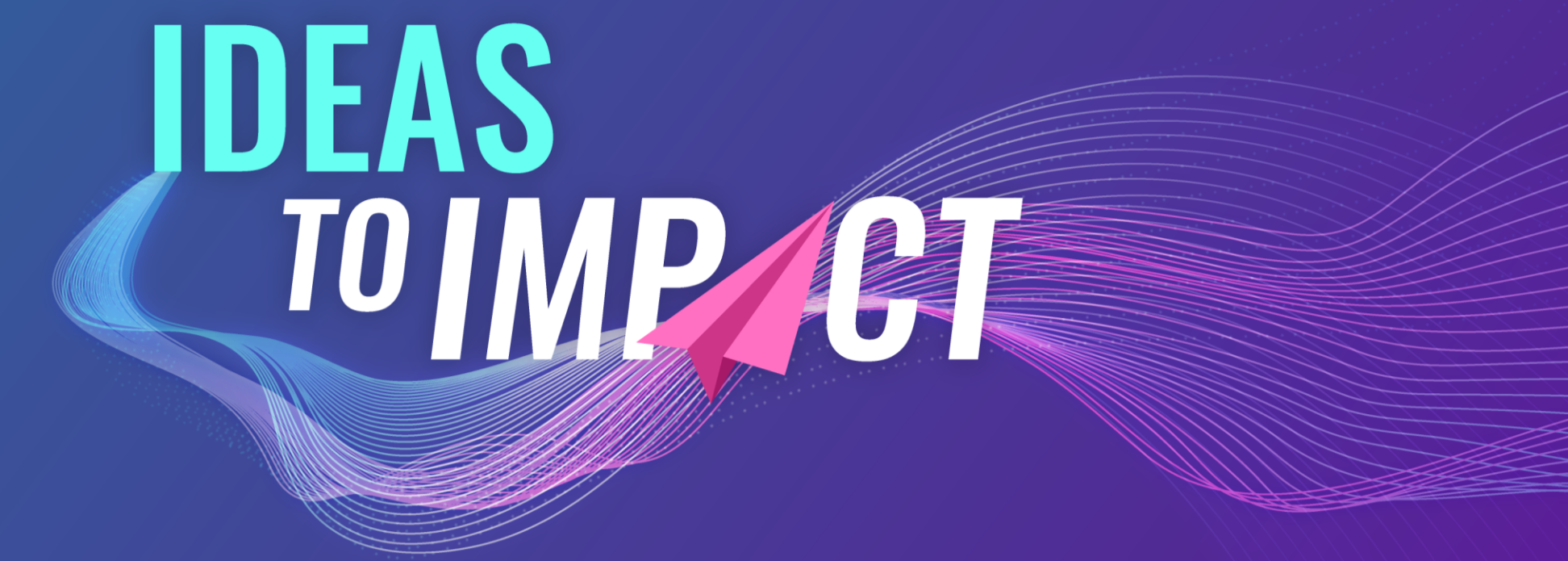


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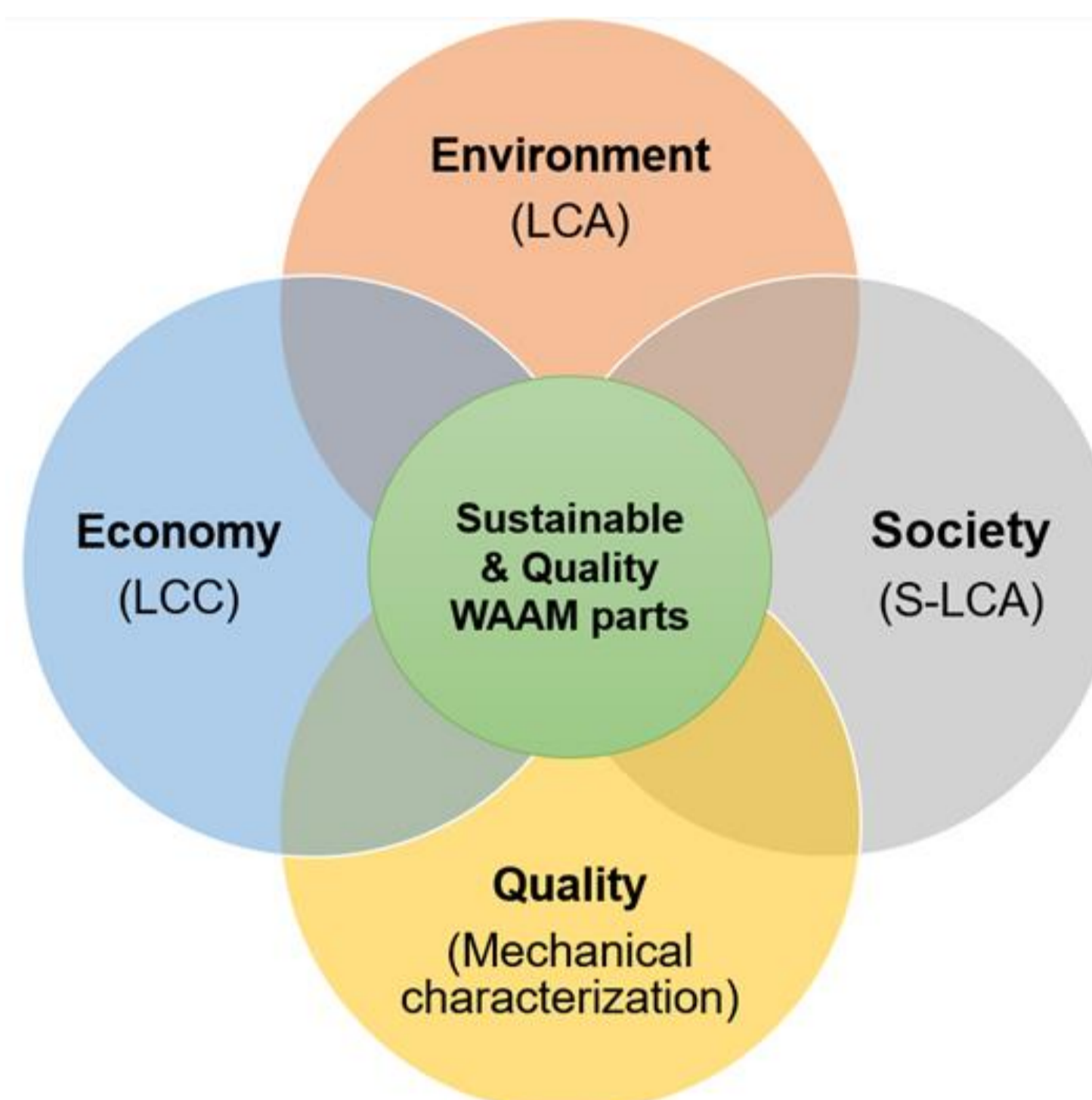
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Background & Motivation

Wire arc Additive Manufacturing (WAAM) is an emerging AM process using wire feedstock and electric arc melting, offering better material efficiency, higher build rates, and low costs. Despite its sustainability potential, research from a Triple-Bottom-Line (environmental, economic, social) perspective is limited. This PhD aims to evaluate WAAM's sustainability using Life Cycle Assessment (LCA), Life Cycle Costing (LCC), and Social Life Cycle Assessment (S-LCA). Furthermore, mechanical and microstructural characterizations must be performed to assess the quality of WAAM parts. Based on these, sustainable process parameters and scenarios will be recommended. An online platform will also be developed to compare WAAM's sustainability with other manufacturing methods, aiding sustainable decision-making in design and manufacturing of products.



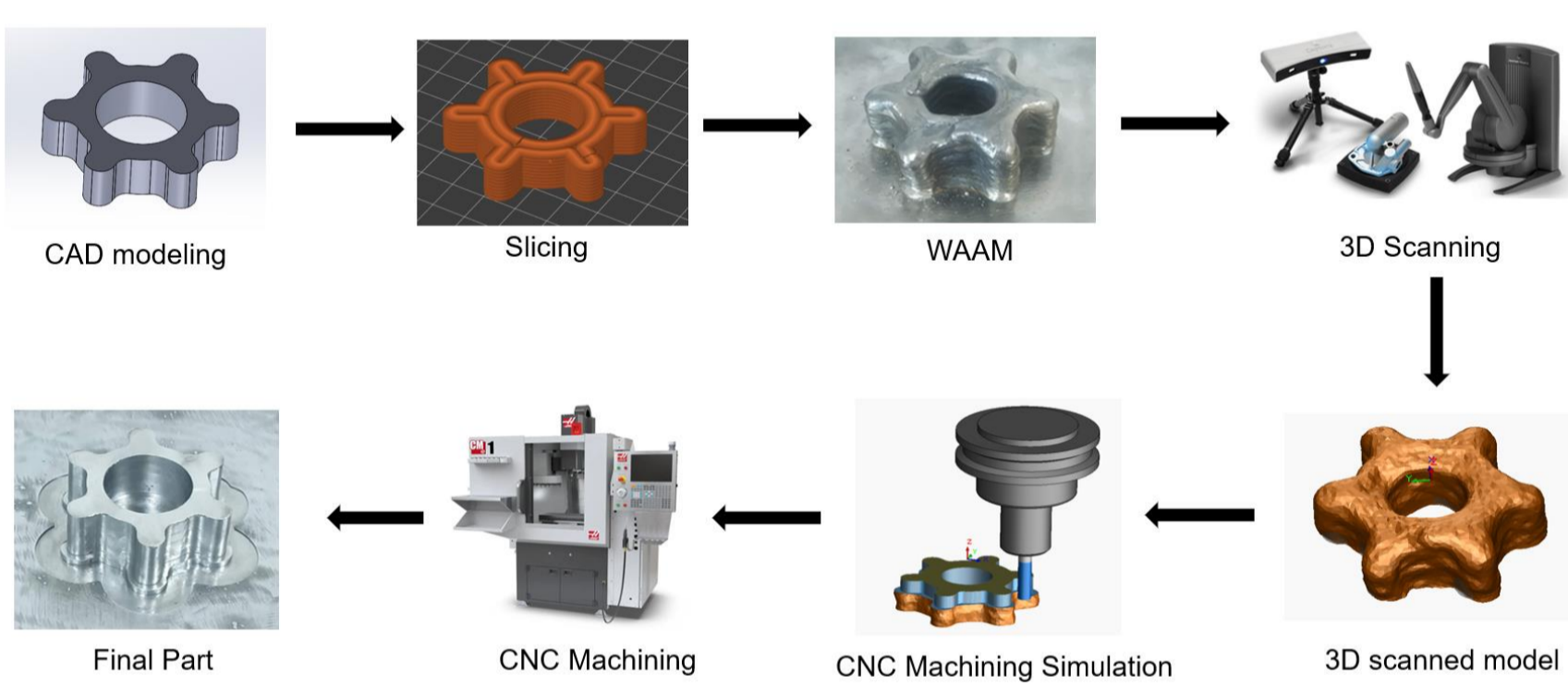
PhD Overview- Life Cycle Sustainability Assessment of WAAM

Aims and Objectives

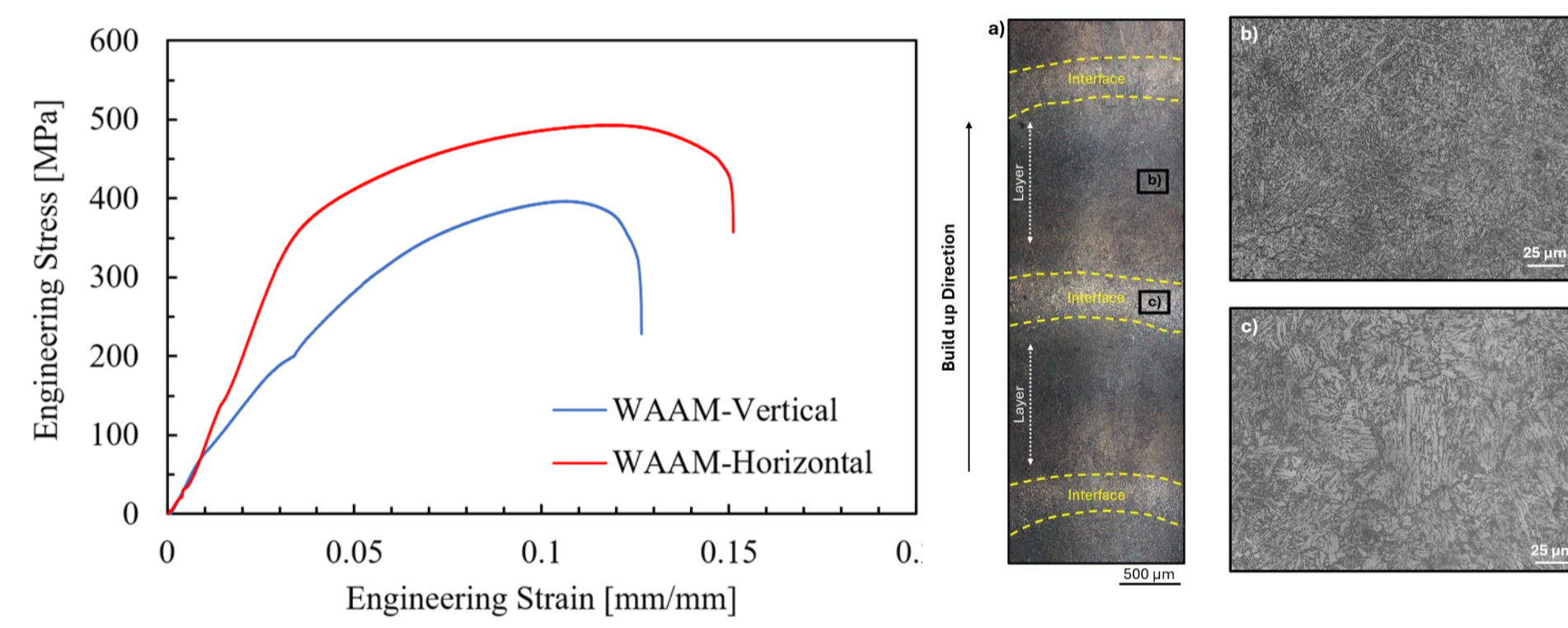
- Develop LCA, LCC, and S-LCA models for WAAM to predict environmental, economic, and social impacts.
- Characterize the mechanical properties of WAAM-fabricated parts.
- Compare WAAM's sustainability with conventional processes (CNC machining) and other additive manufacturing methods (Laser Powder Bed Fusion).
- Identify process parameters for sustainable WAAM production
- Create an open-access platform integrating LCA, LCC, and S-LCA for assessing sustainability across various manufacturing methods.

Methodology

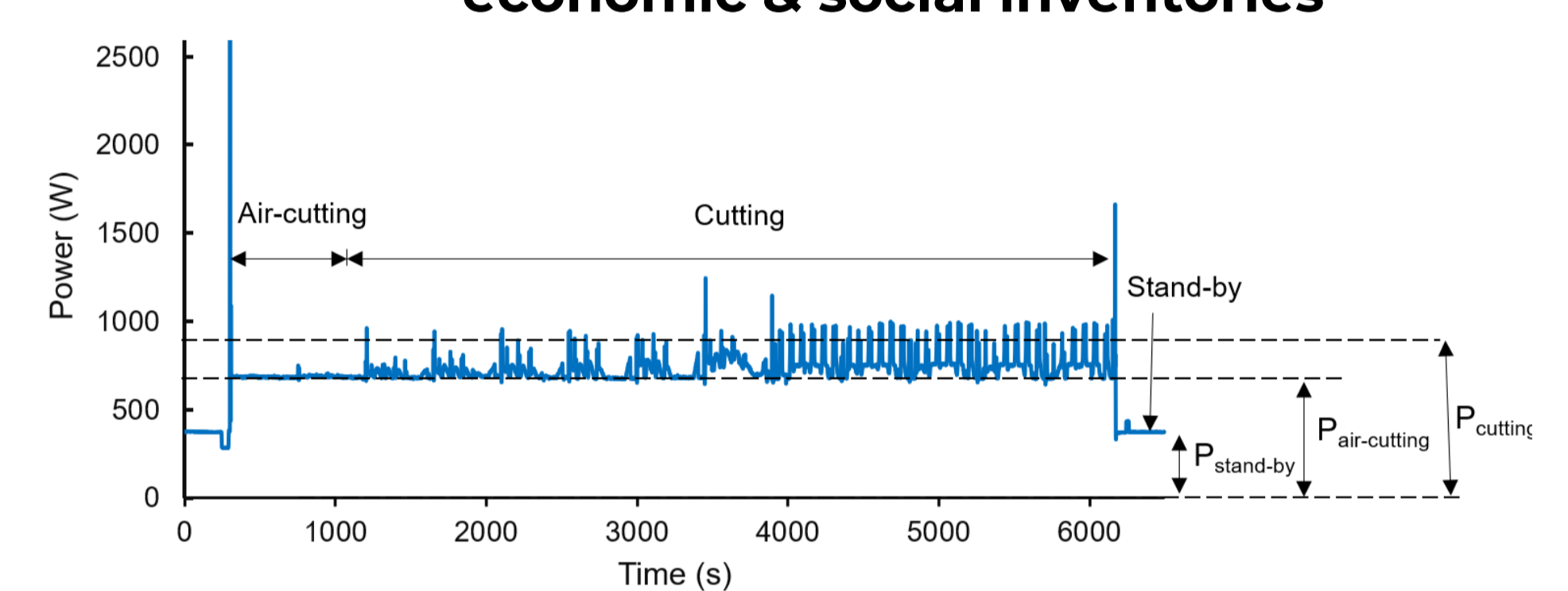
1. WAAM process development



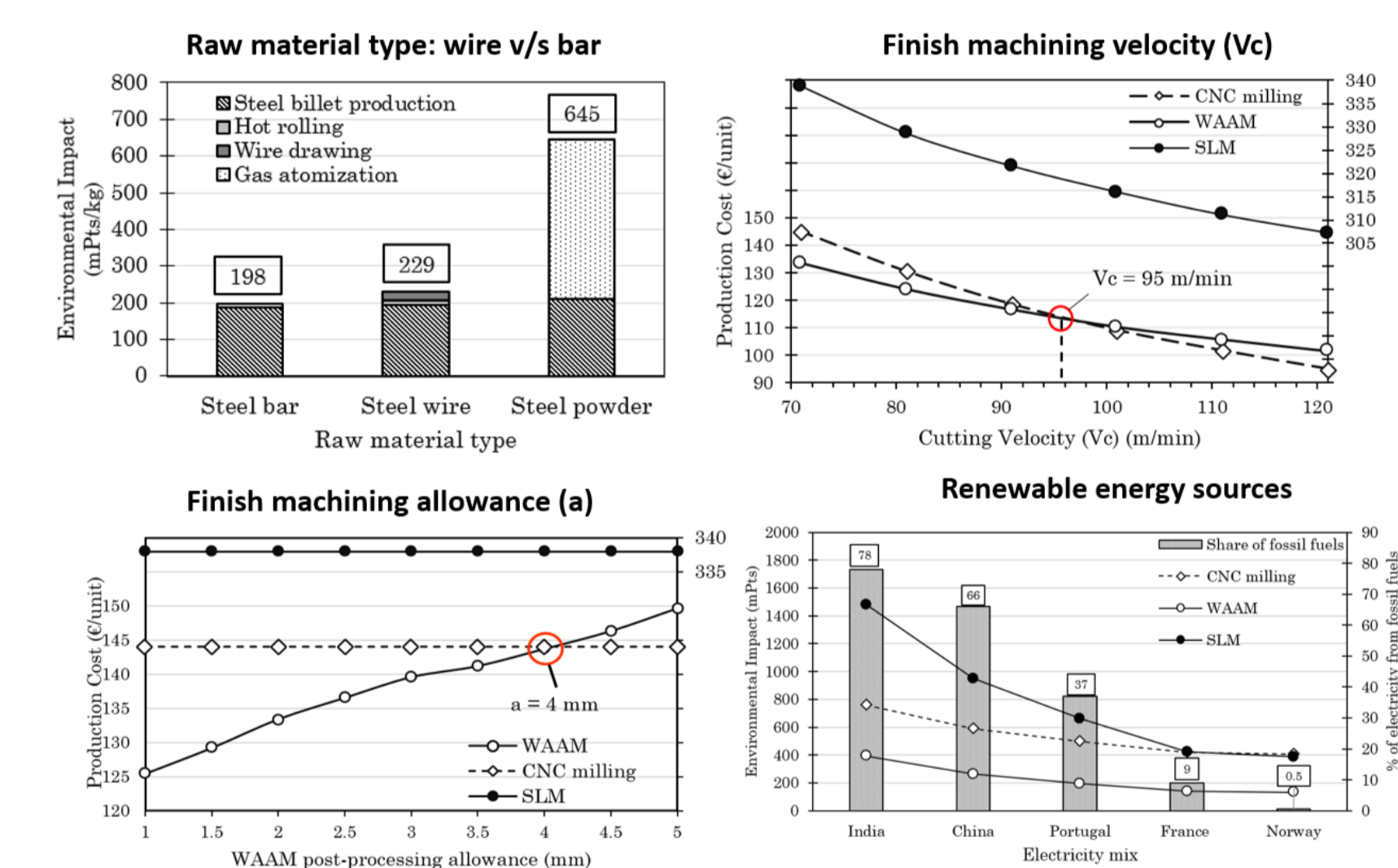
2. Mechanical & microstructural characterization



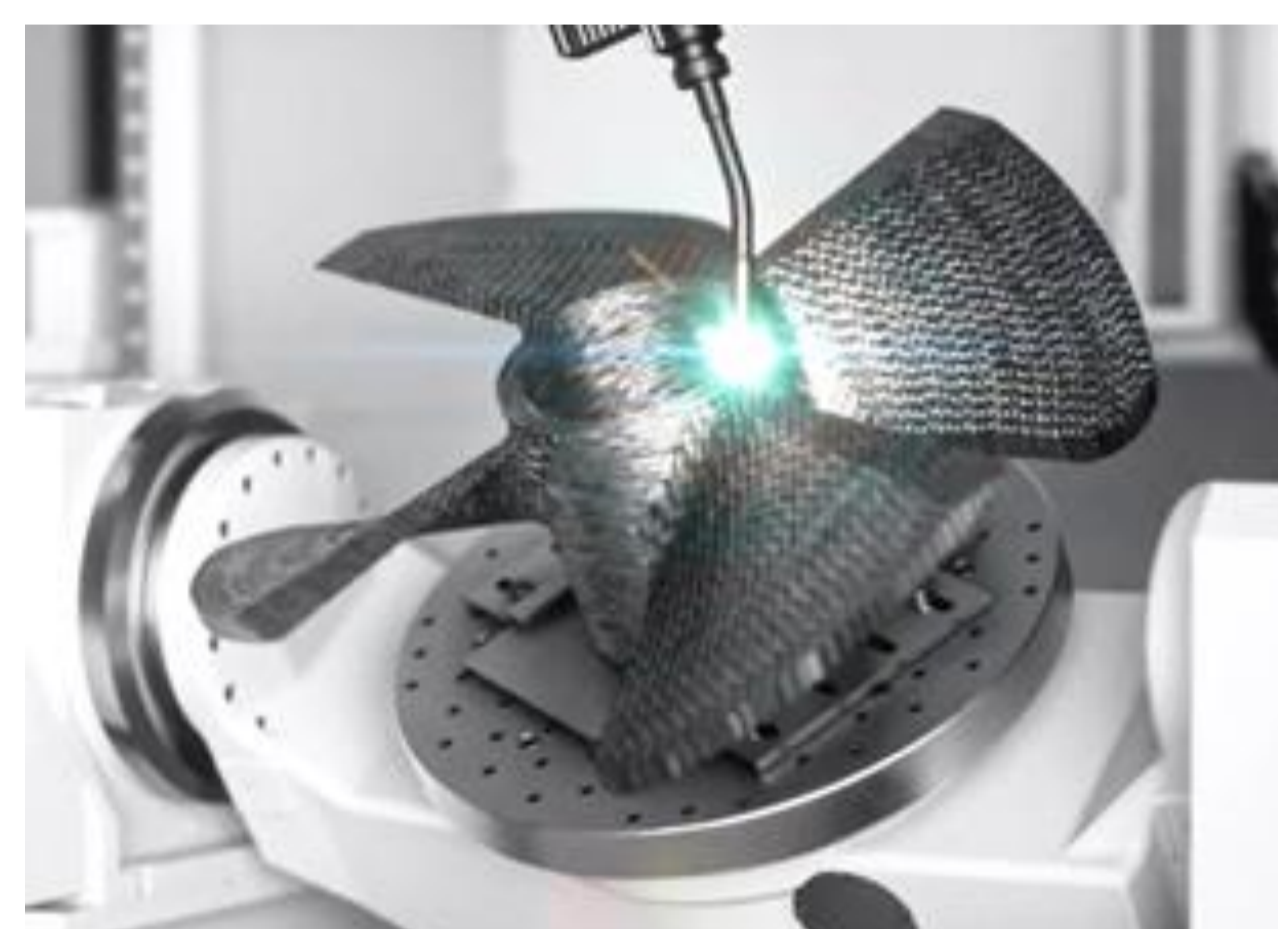
3. Life cycle inventory analysis- environmental, economic & social inventories



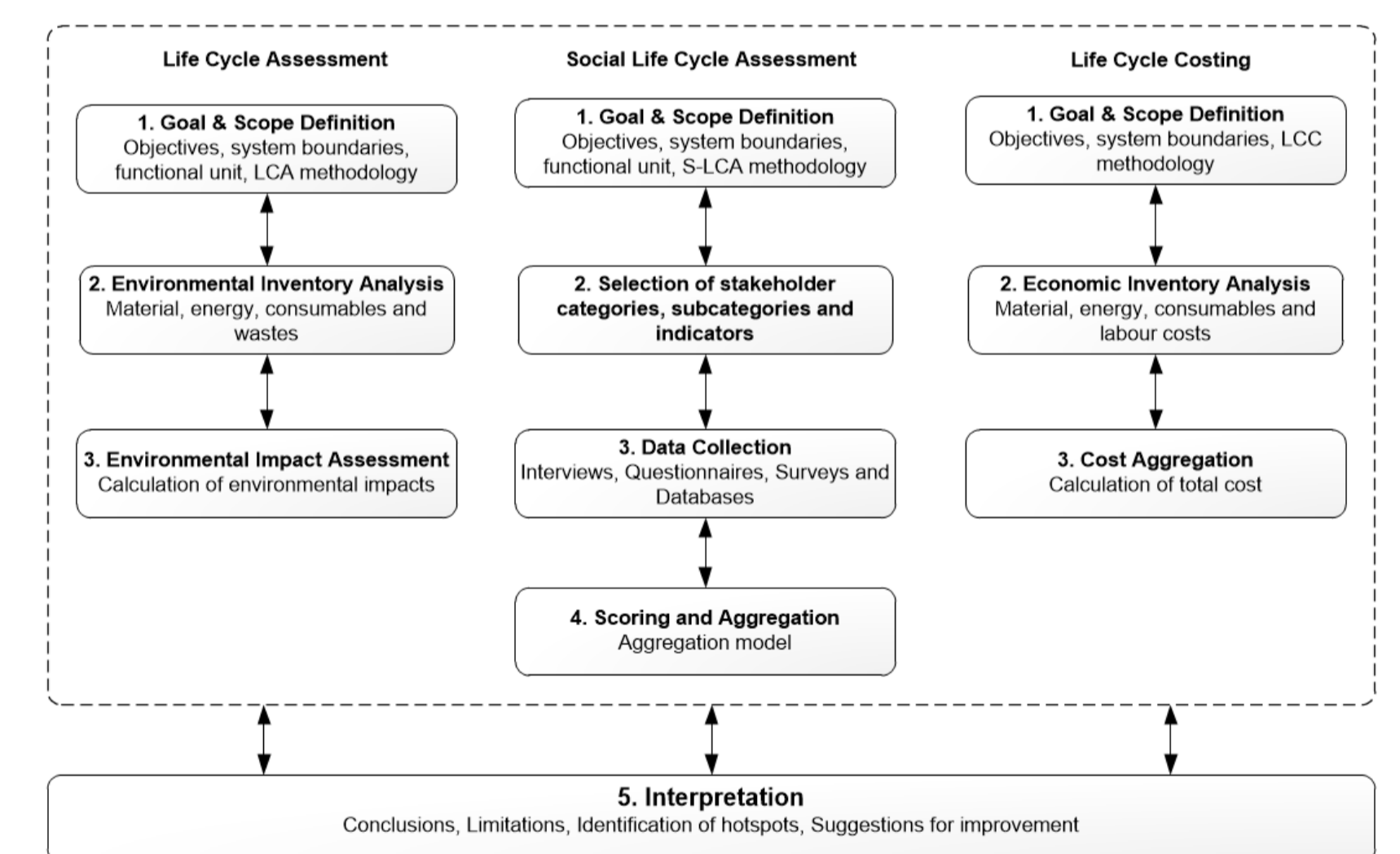
6. Sustainable WAAM production scenarios



5. Validation through industrial case studies



4. LCA, LCC & S-LCA models formulation



Preliminary Results

An interactive LCSA tool was developed by compiling databases and creating LCA, LCC, and S-LCA models, allowing non-experts from SMEs to compare the sustainability of WAAM and CNC machining. Validated by existing studies, the tool predicts environmental and economic impacts with a 15% error margin. Its internet accessibility democratizes sustainability assessments, enabling stakeholders to perform LCSAs economically and time effectively.



Future Work & Conclusion

This study presents an online tool for performing LCSA of WAAM products, integrating LCA, LCC, and S-LCA models. Tailored databases and models allow non-experts to assess and compare the sustainability impacts of WAAM versus traditional CNC machining by entering basic product and process parameters. The tool enables users to explore different scenarios, optimizing eco-design, product, and process decisions. The tool is especially beneficial for SMEs lacking resources for comprehensive LCSA, promoting widespread adoption by offering easy access via the Internet. This fosters early-stage sustainability analysis in product development, improving practices throughout the lifecycle of WAAM products. Further development is needed to expand LCSA tools for other manufacturing processes and enrich databases with more materials, cost data, and social indicators.

Funded by:

