Life cycle analysis integration into open-source numerical models (LiAISON)

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Code based LCA frameworks: LiAISON-ReEDS, LiAISON-GCAM and LiAISON-IMAGE

* Novel database with *ecoinvent* default plus varied NREL model entries
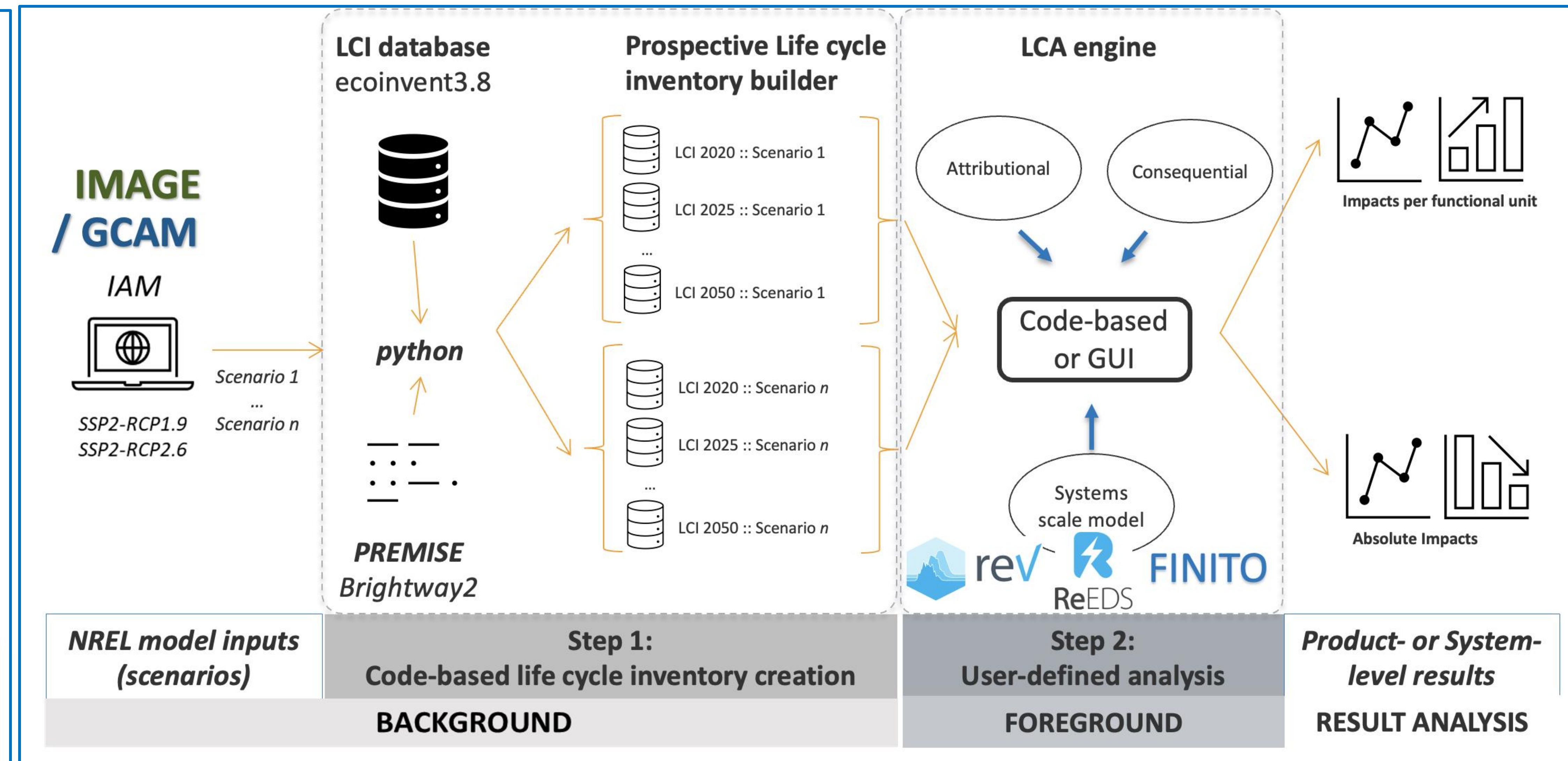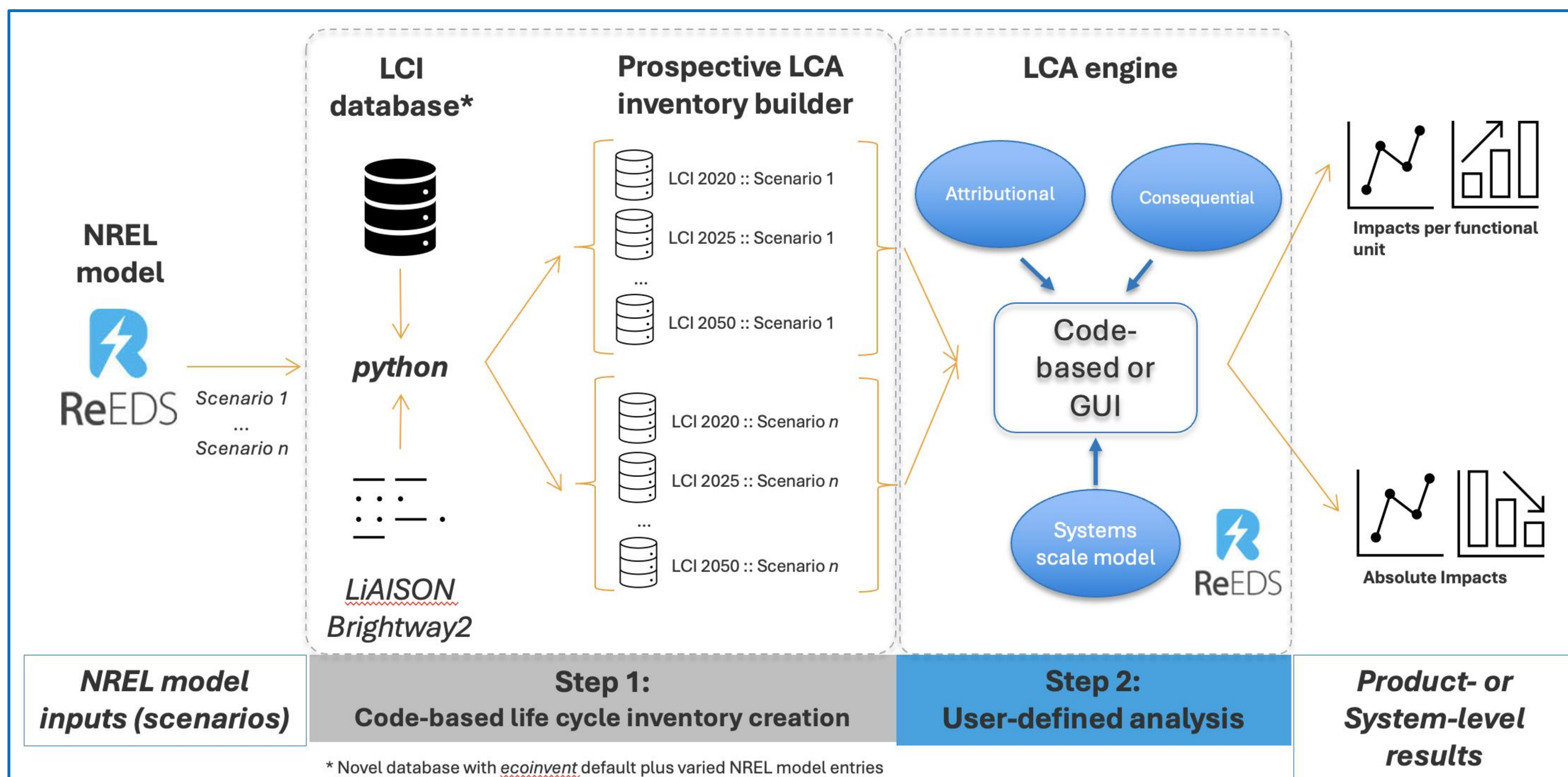
Introduction and Methodology

- The LiAISON framework automates prospective life cycle assessment by connecting inventory reading, PREMISE, creation of modified inventories, modifying existing activities, creating new activities, LCA calculations, regional, efficiency sensitivity analysis and monte carlo analysis.

- The primary use of this framework is to combine life cycle analysis with large scale simulation models, like material flow models to track the flow of recycled plastics, decommissioned wind blades, solar cells etc. These simulation models require hundreds/thousands of LCA calculations of activities contained in the background inventory as well as new foreground activities.

- The foreground activities might have varying energy and material requirements for the same quantity of reference product as the simulation runs, requiring new technosphere matrix creation.

- Connections of material and energy demands of the foreground inventory from the background inventory required to be established automatically.

- LCA practitioners at NREL require a framework that can perform LCA smoothly and efficiently with minimum effort.

- While prospective LCA has been achieved via PREMISE, several other sector specific forecasting models need to be connected to ecoinvent for LCA. For example, ReEDS is a electricity sector specific capacity expansion model.

- The LiAISON provide LCA practitioners a powerful framework to perform prospective and automated LCA calculations via a plug-and-play python module.

Analysis and case studies

Exploring life cycle impacts of alternative industrial heat sources in the US

Exploring equality and sustainability trade-offs of energy transition outcomes in the United States in 2050

Need: Community-level decision making to assess potential tradeoffs across energy futures; and reinform future energy system model runs given specific priorities

Current approach: Code-based cradle-to-grave LCA post-processing scenarios with regional level detail (balancing area)

Next steps: Census-track level detail; MCDA to account for local preferences; review of optimization algorithm

Collaboration with NREL Flagship tools provides regionally explicit impacts

Life cycle impact assessment method: RECIPE – Global Warming kgCO2eq. Functional unit: Total generation of electricity in the US (disaggregated by state)

Top and bottom legends have different scale

Unpublished results – Please do not cite or distribute

References

Lamers, Patrick, et al. "Linking life cycle and integrated assessment modeling to evaluate technologies in an evolving system context: a power-to-hydrogen case study for the United States." *Environmental Science & Technology* 57.6 (2023): 2464-2473.

Goforth, Teagan, et al. "Exploring equality and sustainability trade-offs of energy transition outcomes in the United States in 2050." *Applied Energy* 367 (2024): 123376.

https://github.com/tjlca/gcam_liaison_integration

https://github.com/polca/premise

https://github.com/NREL/LiAISON