#ArchitectingAviation

Data Silos in Environmental Life Cycle Impact Assessments - Rethinking Transparency, Accessibility & Reusability of LCA Data

A Generalized Schema to Publish and Share Life Cycle Inventories (LCI): Exemplary Use Case of an Aviation Fuel Supply Chain

Status Quo

Life cycle assessment (LCA) has become one of the most widely used methods for evaluating the environmental impacts of existing and emerging technologies (Fig 1). LCA also shows a growing influence in decision- and policy-making concerning the validation of nascent technologies (such as next-generation commercial aircrafts) for industrial implementation. This assessment also forms the backbone of the results showcased in the ALICIA dashboard.

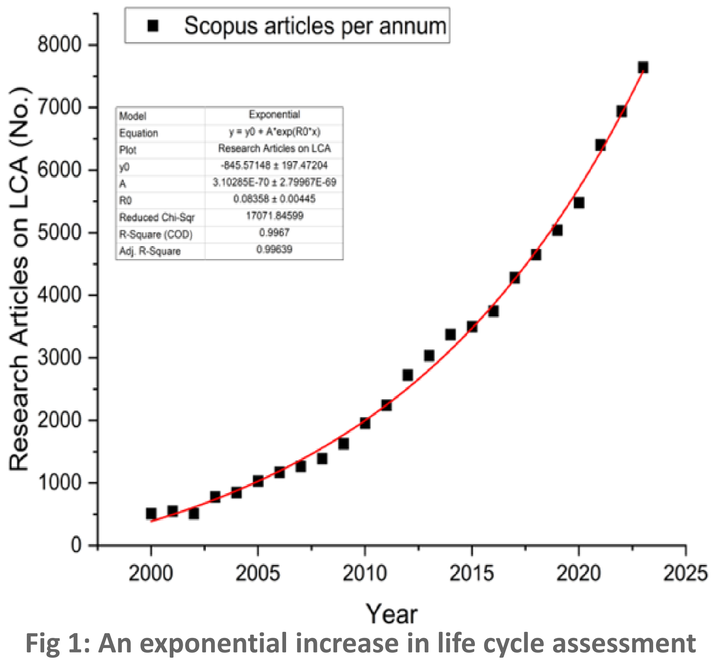

Fig 1: An exponential increase in life cycle assessment reports and investigations in the past 23 Years (data source: Scopus)

Why It Matters?

In LCA, inventory modeling is the most resource-intensive and time-consuming phase, which constitutes data collection, transformations, and compilation of the foreground life cycle inventory (LCI) for a defined product system. Despite open data initiatives, only a small fraction of the studies transparently report the foreground LCI datasets used in calculations. The inventory data is crucial for the reproduction & validation of LCA results. At present, the few inventories that are shared are ambiguous and cryptic lacking structural coherence, metadata, format & provenance. This makes it arduous to reconstruct the inventory to replicate and validate LCA results and/or reuse the data. This leads to a question –

Can LCA results be accepted at face value?

Our Approach

To address this refutability concern in LCA and to enable a FAIR (Findable, Accessible, Interoperable, and Reusable) availability of LCI datasets, a novel structured schema called LCIS, is developed to share foreground inventories originating from non-specialized LCA studies.

The minimalistic design principle behind LCIS aims to prioritize ease of replicability and reusability of inventory data with low resource (time, effort) overheads for the end-users while maintaining machine-accessibility, modularity, and sufficiency. It is built on top of existing data standards and structures used in other areas of research while adapting to the needs of the heterogeneous data found in LCAs.

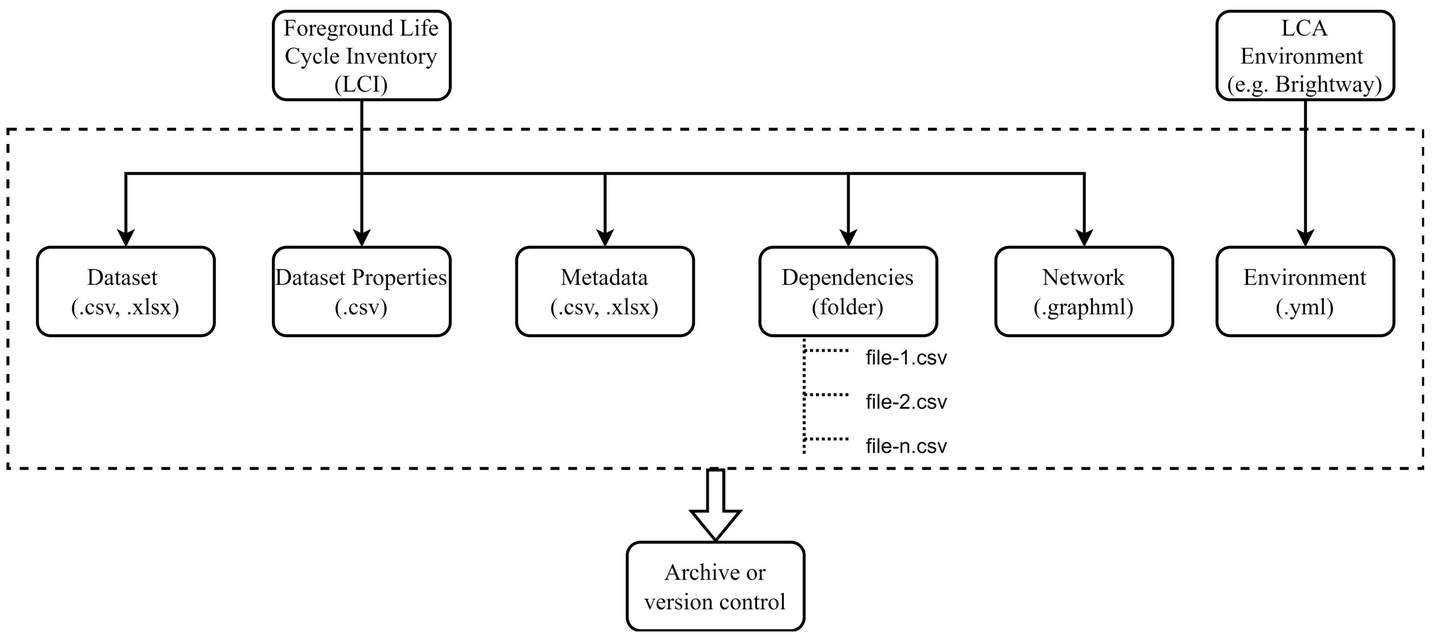

Fig 2: The various components of a life cycle inventory according to the proposed inventory schema (LCIS). These files can then be compressed (e.g. zip format) and shared via online repositories or as part of publications.

The Schema

According to LCIS, a foreground inventory of a defined product system is shared as a collection of five components, namely Dataset, Dataset Properties, Metadata, Dependencies, and Network, along with an environment file (Fig 2). An open-source tool for the conversion of foreground LCIs according to the specifications of this schema is written in Python based on the Brightway framework. The inventory for the exemplary use case of an aviation fuel supply chain, which is shared according to this schema is shown in Fig 3.

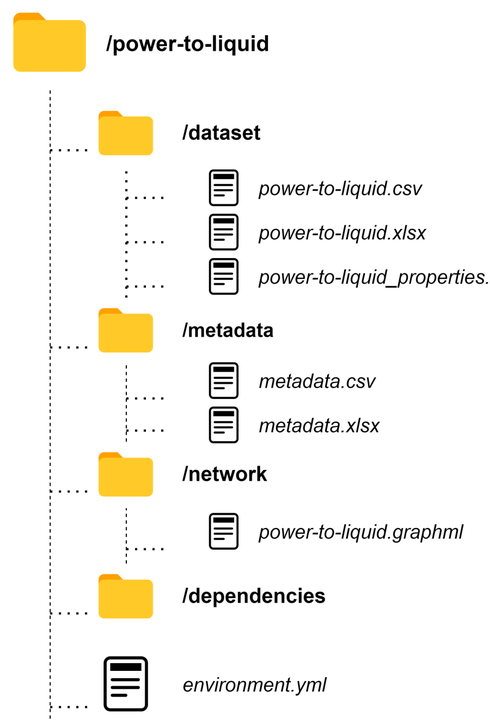

Fig 3: A foreground life cycle inventory of an aviation fuel supply chain (power-to-liquid SAF route) that is shared according to the proposed schema, LCIS.

More Information

Journal Preprint:
hal.science/hal-04652703v1

GitHub Repository:
github.com/rahulrameshnair/lcis

What's Next?

- Installable tool and simple user interface for logging the metadata.
- Improve tool interoperability with more LCA software such as OpenLCA.
- Extend LCIS to specialized approaches such as prospective LCAs.
- A federated open-access repository for sharing and tracking inventories through Project ReLICS.

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