LCI DATABASE TEMPLATE

ALICIA Project

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DLR – Inst. of Networked Energy Systems
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Agenda

1. Requirements for the structure of an LCI database
2. Proposed Template
3. LCI Networks
4. Demo (using Jupyter Notebook)

Requirements

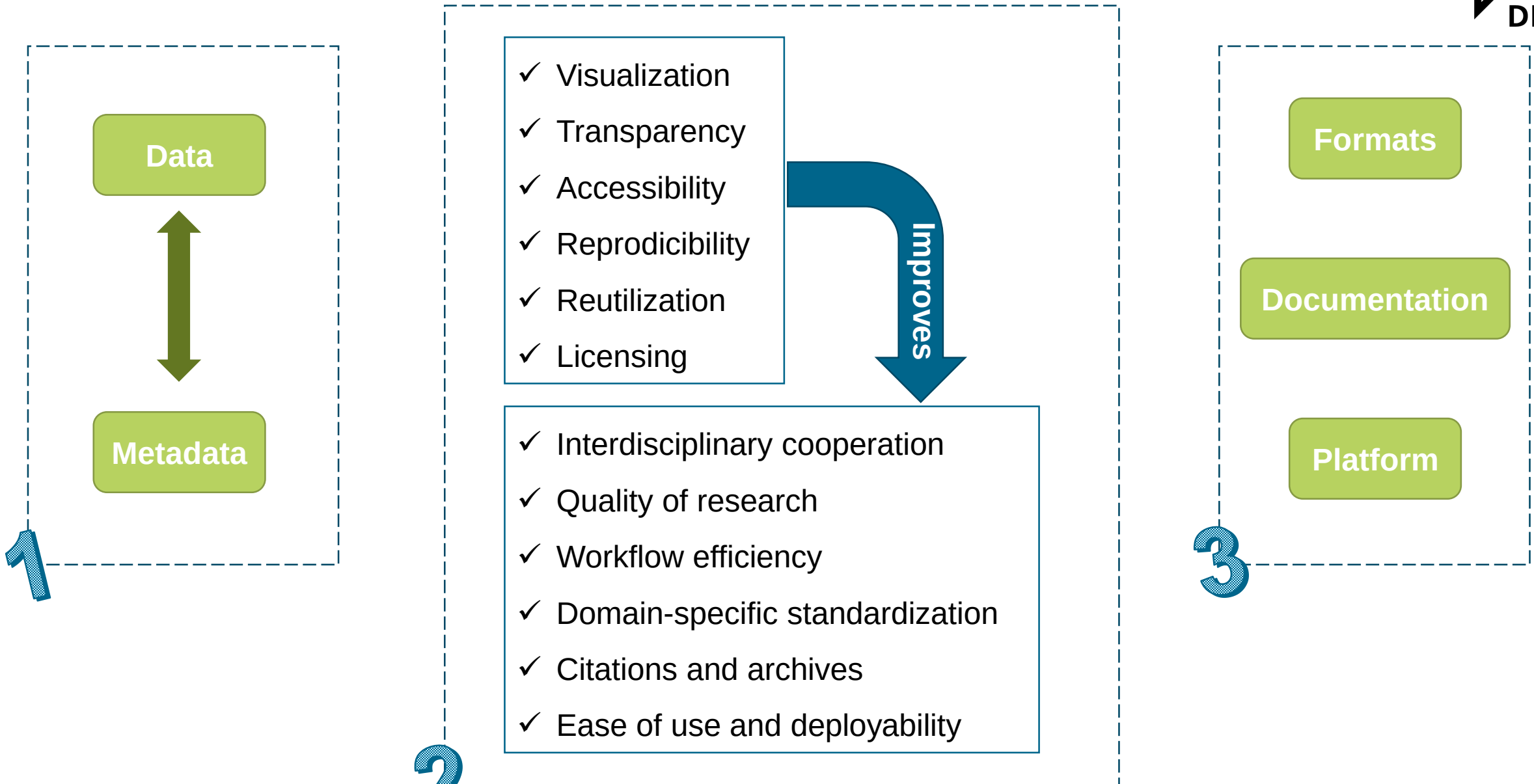
Overview of LCI:

- Life cycle inventory (LCI) is the most resource intensive step amongst the four stages of LCA.
- Involves the *“compilation and quantification of inputs and outputs for a product system throughout its life cycle”*
- Forms the backbone of the current assessment and future research using various tools.

Dimensions of LCI:

- Data: from modelling of the life cycle inventory (for a given product system)
- Data about this data (Metadata): structured information about the LCI data (what, who, when, licencing, validity, etc.). Provides **context** to the LCI
- The software interface: software framework used for aggregation of the LCI and subsequent calculations.

Requirements – Top-level prerequisites



Requirements – a closer look!

Detailed Requirements

- Detailed metadata and revision tracking for databases
- Non-proprietary file formats and standardized/organized for machine readability.
- Structured code: modularity, documentation, version control, descriptive naming scheme, error handling, minimal code duplication, refactoring, abstraction
- Ease of adoption, deployment, and minimal entry barriers – reliance on existing tools.
- LCI must be **F A I R** – **Findable**, **Accessible**, **Interoperable** & **Reusable** – and **Extensible**

Limitations (Context of Brightway)

- Nested data are precluded from csv and xlsx datasets. Necessitates data conversions
- Rapid development of BW framework can induce code-incompatibility during project lifetime.
- Limitations in database matching within Brightway imports and exports.
- Lack of holistic visualization (graphical modelling) of complex product systems

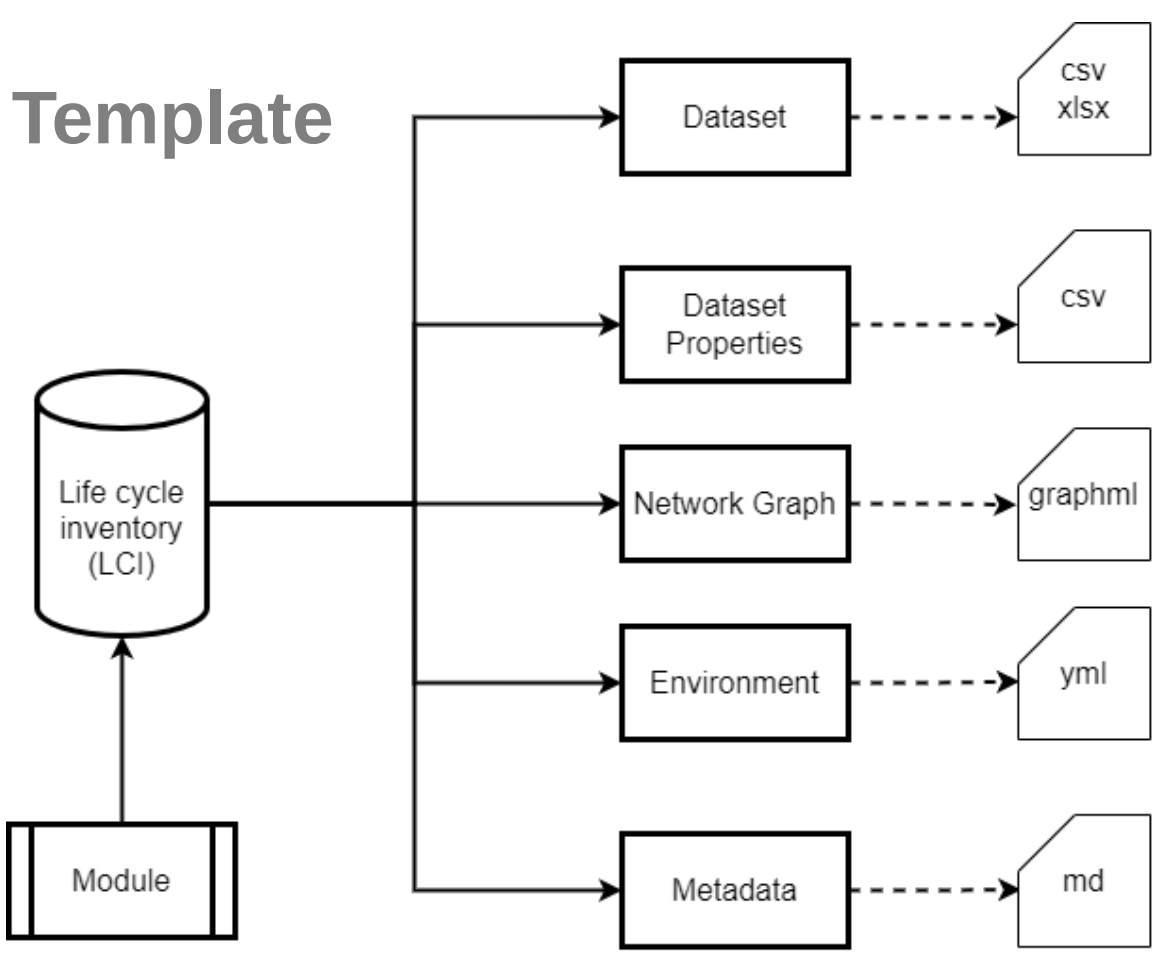
Template - Definitions

- Module: system or group of systems in aircraft or procedures in operations (as in ATA)
  - Dataset: the collected LCI inventory for a module. Genarated in csv and formatted excel schema.
  - Dataset properties: the overview of info on the dataset. For imports and comparison using python.
  - Network: the directed network graph of the dataset. Inherits all the relational information.
  - Environment: configuration file for re-creating the conda environment.
  - Metadata: the structured collection of data about the dataset.

Project: the parent research work containing all the modules under investigation

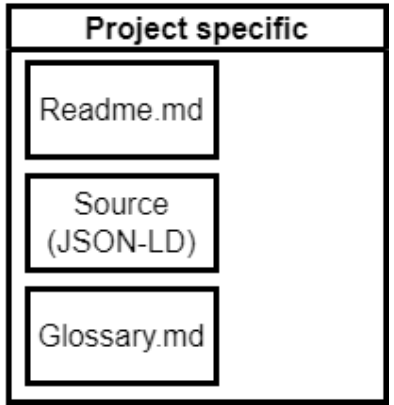
- Readme: contains the information about the research project
- Glossary: project-specific and non-general LCA terminologies
- Source: the database in JSON-LD format as raw data for platform-independent cross-compatibility

Proposed Template



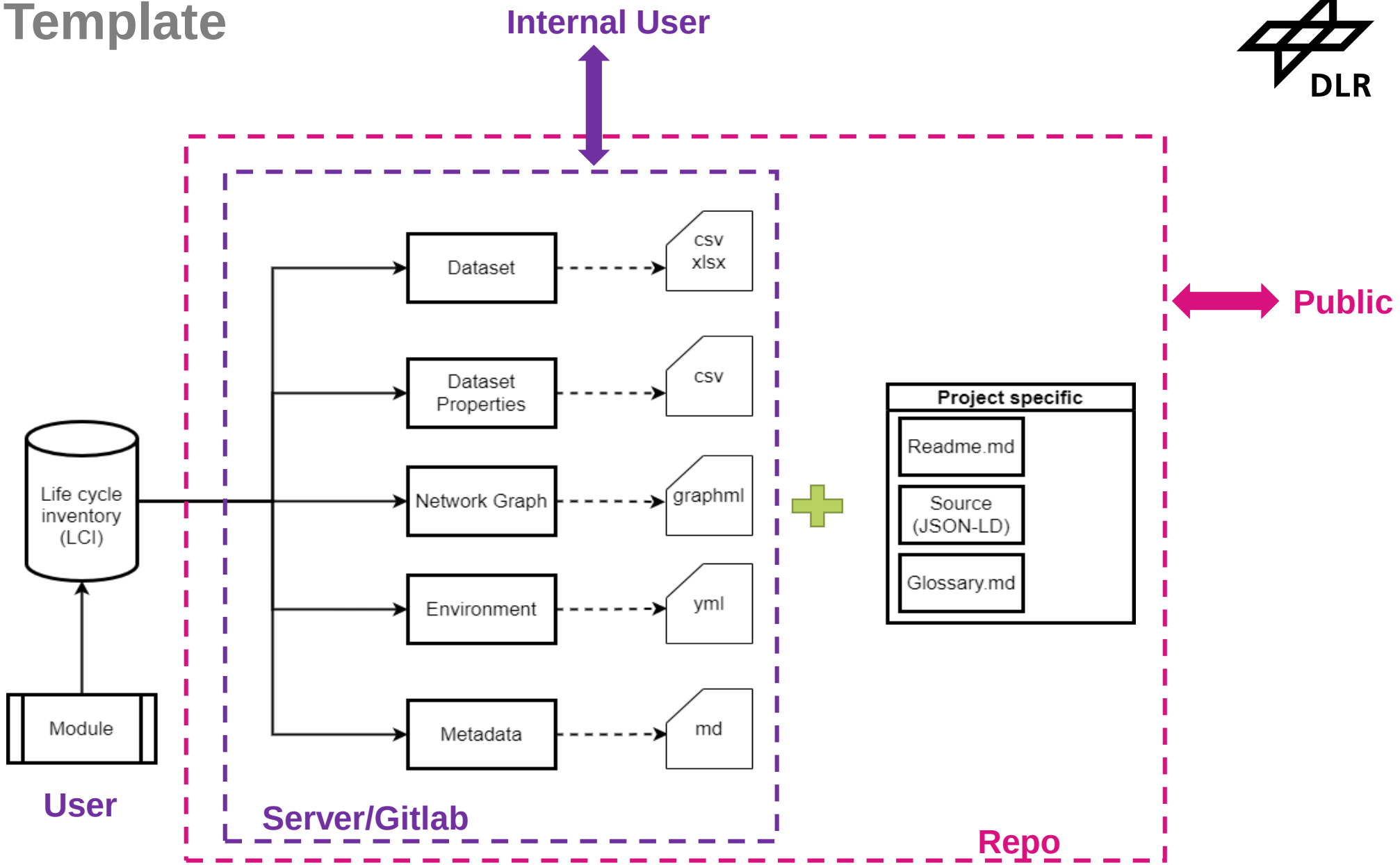
Design & data loading

Testing & Revision



End-of-project (publishing/ Interoperability)

Proposed Template



Hydrogendataset

Edit | Code

Open **Chougule, Komal Mallesh** requested to merge `hydrogendataset` into `main` 23 hours ago

Overview 0 | Commits 9 | **Changes 11**

Mark as done

Compare **main** and **latest version**

11 files +417 −361

Search (e.g. *.vue) (Ctrl+P)

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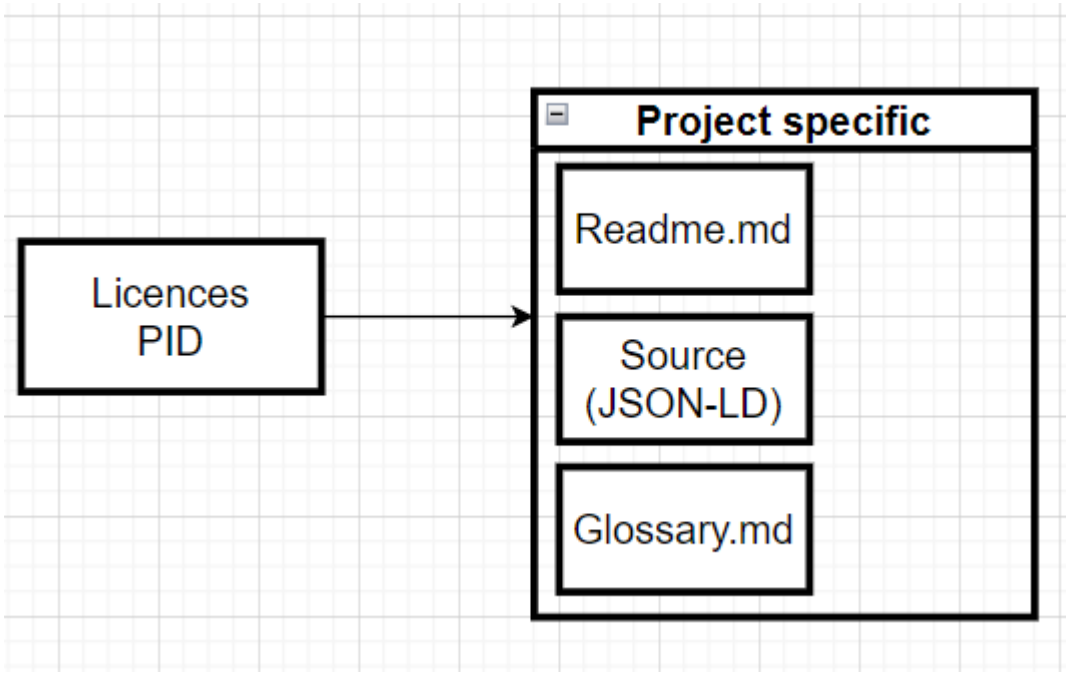
Dr.-In

Template - Advantages

- Human-readable datasets (quick editing and importing via activity browser) & metadata
- Version control and logging using Git
- Lower technical hurdles in accessing the bw platform (minimal use of python). Implemented via self-contained packages with 2 front-facing jupyter notebooks.
- Detailed metadata, terminologies and glossary for reviewing, sharing, archiving & publishing.
- Availability of datasets in formats easily parseable by existing python packages (programmatic mutability of data)
- Customizable visualization of complex systems/components using directed network graphs
- Python code:
  - Modular and structured to facilitate feature updates
  - Standard packages and minimal dependencies.
  - Well documented (room for improvement)

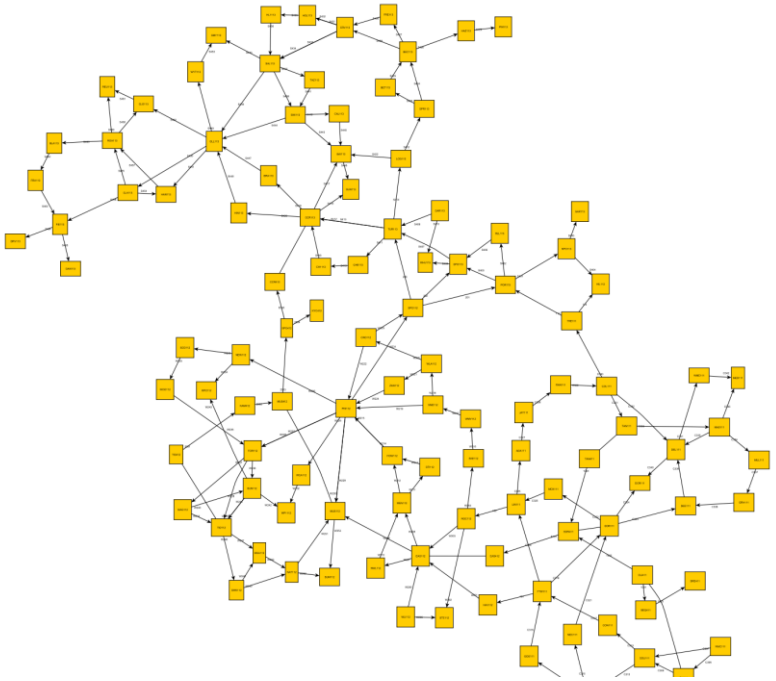
Template – Final steps

- Project-specific LCI glossary
- Detailed context of the project to highlight the boundary conditions of the LCI
- The source LCI as JSON-LD for useability in platforms other than Brightway (openlca, simapro)
- Funding information, licenses and persistent identifiers (for compatibility with research data repos such as ERC)

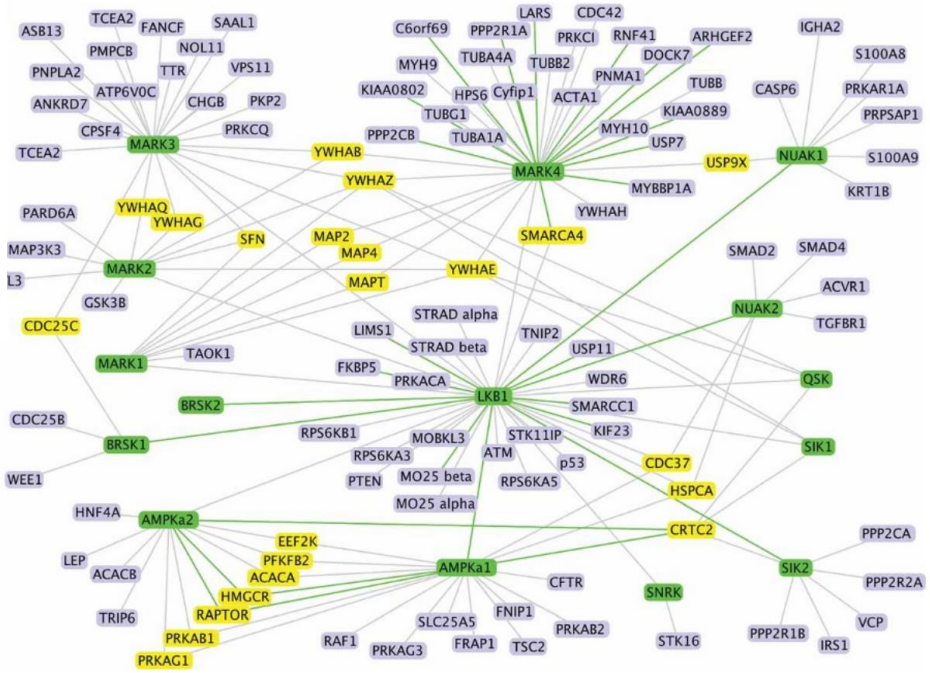


Note: comments related to citations (within individual exchanges and/or activities) should only use DOI or PIDs

Where is network theory usually used?



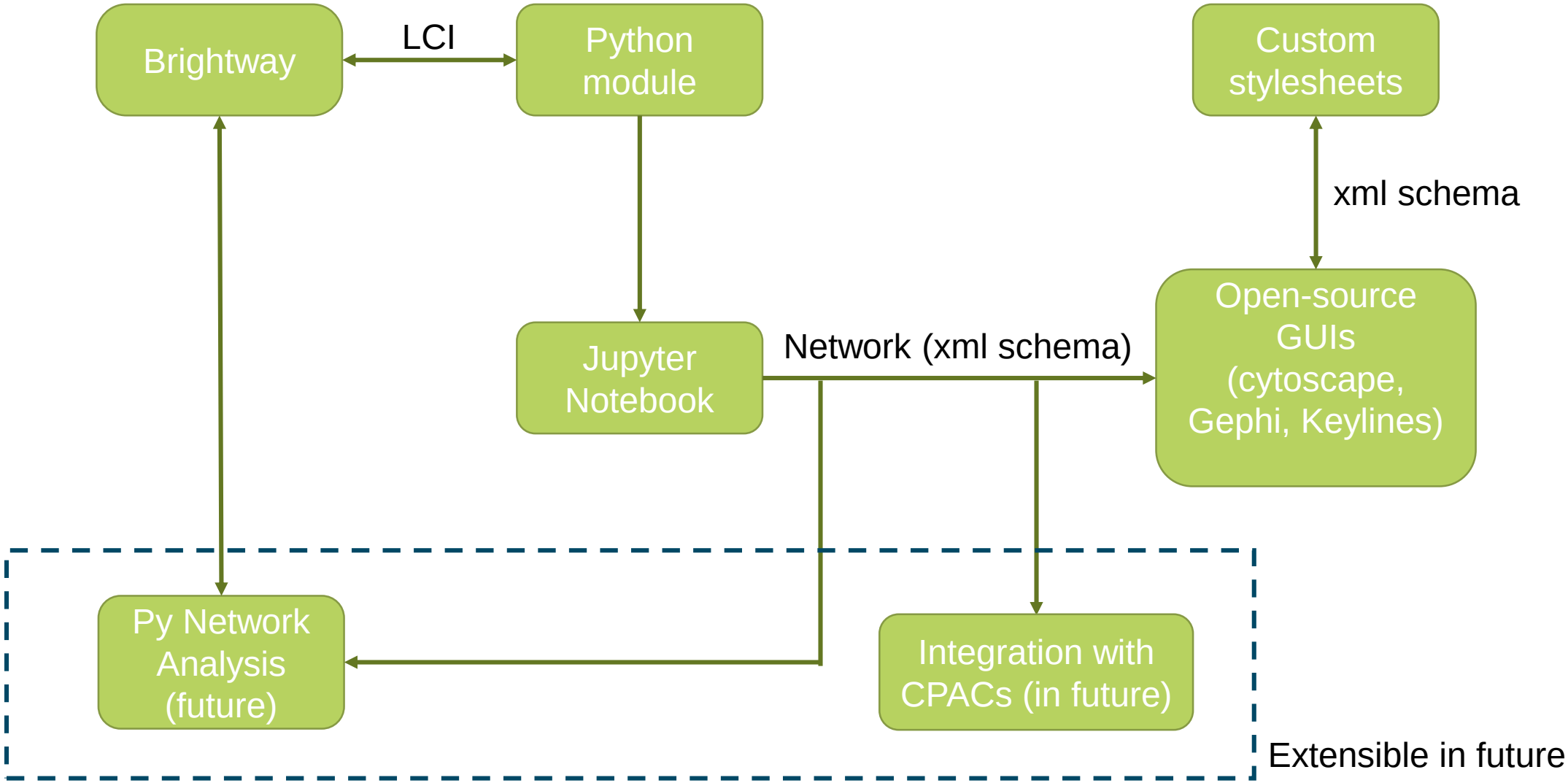
Modelling power grids
E.g. doi: 10.1038/s41598-022-22268-z



Protein interactions
E.g. doi: 10.1038/NMETH.1282

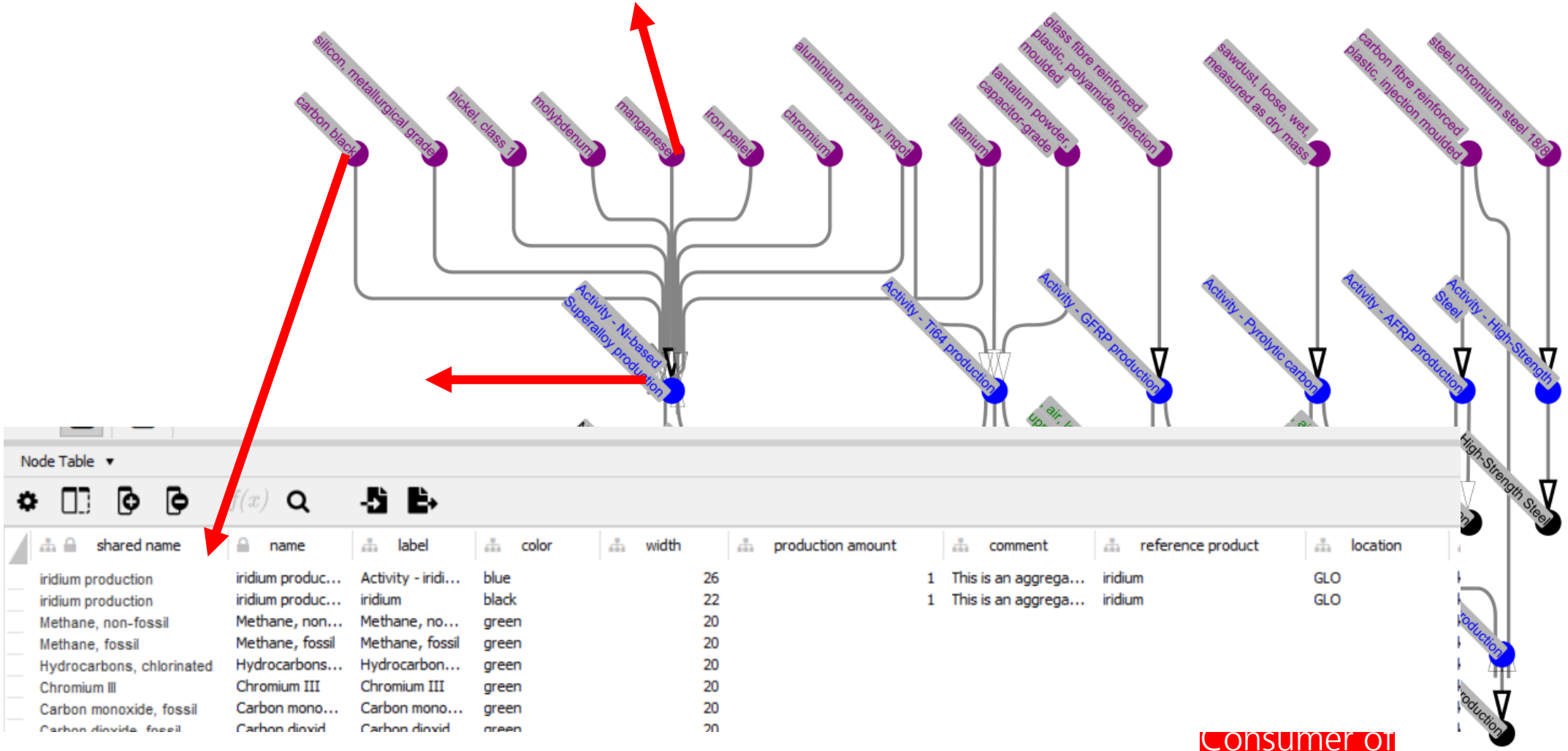
Other applications include study of neural networks, supply chain management, transportation systems, social sciences etc.

Template – overview of workflow



Example Network Graph of a Materials LCI

Technosphere flows



shared name	name	label	color	width	production amount	comment	reference product	location
iridium production	iridium produc...	Activity - iridi...	blue	26	1	This is an aggrega...	iridium	GLO
iridium production	iridium produc...	iridium	black	22	1	This is an aggrega...	iridium	GLO
Methane, non-fossil	Methane, non...	Methane, no...	green	20				
Methane, fossil	Methane, fossil	Methane, fossil	green	20				
Hydrocarbons, chlorinated	Hydrocarbons...	Hydrocarbon...	green	20				
Chromium III	Chromium III	Chromium III	green	20				
Carbon monoxide, fossil	Carbon mono...	Carbon mono...	green	20				

Consumer of Pyrolytic carbon

References

- Helmholtz Metadata Collaboration (https://helmholtz-metadaten.de/en)
- Danish e-infrastructure consortium (https://www.howtofair.dk/)
- Brightway documentation (https://docs.brightway.dev/)

Thank you

Dr.-Ing Rahul Ramesh Nair, DLR-VE