

Development of National LCA Database Roadmaps, including further Development of the Technical Helpdesk for National LCA Databases

Deliverable D 3.1: General guidelines and recommendations for establishing roadmaps aimed at national LCA database development

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Development of National LCA Database Roadmaps

Deliverable D 3.1: guidelines and recommendations for establishing LCA database roadmaps

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Preface

Background

The availability of, and access to, life cycle assessment (LCA) data is a cornerstone of Sustainable Consumption and Production (SCP), one of the United Nations' *Sustainable Development Goals (SGD 12)*. However, the availability of local, high-quality LCA data is in many countries limited or non-existing and the assessment of impacts from policies and product choices are difficult to estimate by governments, businesses and individuals. The project *Resource Efficiency through Application of Life cycle thinking (REAL)*¹ is implemented by the UN Environment through the Life Cycle Initiative² and funded by the European Commission. The overall goal of the REAL project is to integrate resource efficiency in global value chains by using life cycle data on environmental impacts. One of the components of the project is aimed at supporting the development of life cycle databases, enhancing access to databases as well as furthering their interoperability. The present project on the '*Development of National LCA Database Roadmaps*' addresses this component of REAL. Running from October 2018 until August 2019, the project is led by theecoinvent Association in Switzerland and includes project partners (listed below) from Brazil, Ecuador, India, South Africa, Sri Lanka, and Uganda.

The objective of the present project was set to develop national LCA database roadmaps in different countries, as well as to advance data and database availability in those countries that have already reached a sufficient level of maturity. In addition, the project should contribute to the development of the *Technical Helpdesk for National LCA Databases*,³ which aims to support database development globally and help national databases ensure interoperability with other data sources.

In the first phase of the project, the national project partners carried out baseline assessments of the current status of LCA in each country, considering data availability and the existence of any previous LCA database initiatives, as well as stakeholder mapping and engagement. In parallel, the *International Working Group (IWG)* – comprised of representatives from each participating country, the European Commission, and UN Environment – prepared these guidelines and recommendations for establishing roadmaps aimed at national LCA database development. The guidelines supported the *National Database Working Groups (NDWGs)* – composed of key actors and stakeholders of the local LCA community – in their task to establish national database roadmaps during the second project phase.

The end-points of the present project are the finalization and dissemination of the roadmap reports and the planning/initiation of first roadmap implementation activities. Where feasible, the project encompassed data-related activities for harmonization and connection of available data to the *Global LCA Data Access (GLAD) network*.⁴ Contributions to the *Technical Helpdesk for*

¹ www.unenvironment.org/explore-topics/resource-efficiency/what-we-do/life-cycle-initiative/real-project

² www.lifecycleinitiative.org/

³ <http://spaces.oneplanetnetwork.org/lcahelpdesk>

⁴ www.unenvironment.org/explore-topics/resource-efficiency/what-we-do/life-cycle-initiative/global-lca-data-access-network

National LCA Databases were rather limited during the project activities, instead an extensive list of information material from the project will be shared on the *Technical Helpdesk* upon formal acceptance of the final roadmap reports. A first version of these guidelines and recommendations were elaborated in the initial phase, and it was subsequently revised and expanded by adding the experiences and insights gained from the roadmap processes towards the end of the project.

The consortium and national project coordinators:

- **Project lead:** ecoinvent Association, Switzerland [Dr. Carl Vadenbo]
- **Brazil:** Universidade Tecnológica Federal do Paraná [Prof. Cássia Ugaya]
- **Ecuador:** Escuela Superior Politécnica del Litoral [Prof. Ángel Ramírez]; Escuela Politécnica Nacional; Ministry of Environment; Conservación Internacional Ecuador
- **India:** National Environmental Engineering Research Institute [Dr. Rajesh Biniwale]; Confederation of Indian Industry; Dr. Sanjeevan Bajaj, independent consultant
- **South Africa:** University of Cape Town [A-Prof. Pippa Notten]
- **Sri Lanka:** National Cleaner Production Centre Sri Lanka [Mr. Samantha Kumarasena]
- **Uganda:** Uganda LCA Network [Mr. Paul Walakira]

What is an LCI/LCA database?

The *Shonan Global Guidance Principles* (UNEP 2011)⁵ describes the difference between a life cycle inventory (LCI) database and a dataset library as follows (p.86):

“An LCI database is a system intended to organize, store, and retrieve large amounts of digital LCI datasets easily. It consists of an organized collection of LCI datasets that completely or partially conform to a common set of criteria including methodology, format, review, and nomenclature. The database will allow for interconnection of individual datasets to create LCI models. The computed results can be used with identified life cycle impact assessment (LCIA) methods for cycle assessment (LCA). Databases are managed using database management systems, which store database contents, allowing data creation and maintenance, search, and other access. In contrast, a dataset library is a collection of datasets that may not conform to common criteria and do not allow for interconnections and common applications for LCA or LCIA purposes.”

In this context, a dataset should be understood as *“a document or file with the life cycle information or a specified quantitative reference (reference flow, functional unit, or other references, e.g., product, site, process) including descriptive metadata and quantitative LCIA or LCA data (various sources).”* In addition, UNEP (2016, p. 57) noted that recent developments have led to the creation of data hubs and networks of databases, e.g., the openLCA nexus⁶ and

⁵ UNEP (2011) *Global guidance principles for life cycle assessment databases - A basis for greener processes and products*. United Nations Environment Programme, UNEP. ISBN: 978-92-807-3174-3

⁶ <https://nexus.openlca.org/>

the ELCD/LCDN.⁷ Meanwhile, the GLAD network⁸ can also be added to this list. Whereas a data network consists of more than two interlinked initiatives for improved data management, a data hub is an access point for data from different data providers (such as LCA databases). For the present project and in these guidelines, we follow the aforementioned definition of a database. It is, however, acknowledged that the path to developing a national LCA *database* may include a stage as a *dataset library*. For example, to serve as a common repository for existing LCA data during the conception of a consistent database. This is reflected in the roadmaps for developing national LCA databases established within the project, i.e., the goal of these roadmaps extends beyond the mere creation and sharing of a collection of unmanaged or inconsistent LCA data.

One of the main challenges for national LCA database initiatives is the compilation of essential background data for key economic sectors, while ensuring appropriate regional representativeness. It is therefore crucial to understand the degree of representativeness required by key stakeholders. Efforts to compile regionalised LCA data also serve to establish and develop local expertise on life cycle thinking and approaches. The importance of such expertise extends far beyond the application of LCA (in its narrow sense) by also supporting broader sustainable development initiatives. It is therefore highly advisable to raise awareness of these benefits at all levels of government and to other stakeholders.

LCA databases aim to support a variety of audiences, including government, the private sector, NGOs and academia/research.⁹ Users include policymakers and analysts, researchers, LCA software and tool developers, LCA practitioners and environmental sustainability experts, manufacturers, industry, and industry associations, as well as organizations and individuals engaged in product assessments, the development of standards, certification and product labelling, and product, process, and system development.

Target audience and intended use of this document

This guidance document aims to cover all aspects that need to be considered when undertaking projects related to the development of national LCA databases and incorporates insights from previous national LCA database development efforts to guide a successful process. It provides an outline of the process to be followed for establishing a roadmap, providing a clear path towards achieving a national LCA database, and also provides guidance on how to identify and involve key stakeholders. As such, the intended audience of this document includes entities aspiring to drive national LCA database development in their own countries or regions. It is assumed that readers and users of this document possess a good knowledge of the LCA methodology and LCA databases.

⁷ <http://eplca.jrc.ec.europa.eu/LCDN/>

⁸ <https://www.globalcadataaccess.org/>

⁹ Please refer to ‘*The business case for life-cycle thinking*’ by UN Environment and the Life Cycle Initiative for a compilation success stories from diverse businesses around the world:
https://www.lifecycleinitiative.org/wp-content/uploads/2019/03/unep_nairobi_V7-LR.pdf

The capabilities required for establishing and maintaining a national LCA database are inherently multi-disciplinary, i.e. ranging from mobilizing funding sources and designing governance mechanisms to possessing technical knowledge (e.g. on data formats and IT requirements). As such, certain sections of the document may have more relevance than others to the different actors involved in LCA database development. In general, however, the document is aimed at technical users with LCA knowledge (e.g. a consultant) who is guiding a national database development process. The document is not intended for all potential stakeholders in a database roadmapping project (e.g., a government agency representative without technical LCA database knowledge), and it is expected to be the responsibility of the project lead to interpret and explain the salient information in the guidelines to such stakeholders in familiar language. Furthermore, the document does not go into detailed technical aspects that would not be in the realm of an LCA technical lead, e.g. IT requirements for web-hosting a database. It would be expected that the database roadmap project leads would team up with/hire experts with the requisite knowledge of such aspects.

The roadmap process

The following section outlines the steps conceptualized and undertaken in the present project for developing national database roadmaps through extensive stakeholder consultation and a high degree of inclusiveness in the process. The actual sequence of these steps can be adapted (at least to some extent) to suit the needs and preferences of the actors involved.

1. *Baseline assessment and stakeholder mapping and engagement*

Understanding the status, needs and main users of LCA in the country are an essential starting point. Broad stakeholder engagement in the roadmap process is instrumental to ensuring the wide participation that is needed further down the line in the database development process. Stakeholder engagement should include all stakeholder groups that will fulfil different roles or carry any stake in the database project, such as government agencies for governance, hosting and/or funding; researchers and consultants as experts in inventory modelling and technical aspects; public and private sector companies and industry associations as data providers and project funders; and NGOs/civil society as facilitators and safeguarding interests (especially for the uptake of, and harmonisation with, impact assessment developments). Note also that all these groups are potential users of the final LCA database.

2. *Establish a national database working group*

Following on from stakeholder engagement, a National Database Working Group (NDWG) should be established. The NDWG should have broad stakeholder representation but not be so large as to become unmanageable. A small working group alongside a wider advisory group (e.g., stakeholders acting in an advisory and/or a reviewer capacity) is recommended. It is also advisable to invite to the NDWG the people and organizations who are expected to contribute funds and/or put in the effort to implement initial activities envisaged for the development of national LCA data at an early stage of the process.

3. *Determine level of ambition*

The NDWG should determine early on whether the ambition is to set up a fully functional, financially viable national LCA database (similar to other background databases) or a repository of consistent datasets supported by grant funds or donations. The level of ambition should align with estimated costs and the ability of the main implementing agency to raise funds in the foreseeable future to cover those costs. The experience of successful global LCA database providers indicates that it may take several years for such databases to become financially viable and, until that point, dataset development may need to depend on grants and/or public funding.

4. *Plan the roadmapping process*

NDWG members should be committed to a pre-defined number of meetings/engagements and an overall project plan should be developed (comprising, amongst other things, a meeting schedule and timeline for a first draft, review, final draft and launch of the roadmap). For this step, the general structure of the roadmap process

must be defined, including the method or approach to be used for the consultations and roadmap formulation. The most suitable setup depends on the national context and, hence, may vary from one case to another. Different approaches, such as surveys/questionnaires, brainstorming sessions, facilitated workshops or the Delphi method, or a combination thereof, may be used to ensure inclusiveness and establish broad consensus and stakeholder acceptance for the finalised roadmap.

5. *Develop the roadmap - vision and goals*

A first step in establishing a roadmap to guide the LCA database development is to determine a vision and clear understanding of the purpose of the national database. We propose that the formulation should take place in an inclusive setting within the NDWG and possibly based on consultations with the wider stakeholder community. A set of concrete goals should then be developed, the purpose of which being to ensure the achievement of the defined vision. Through this, a clear picture of the requirements of the national database should emerge.

6. *Develop the roadmap - action plans*

Once clear goals have been established, pathways to achieving these goals can be developed. The action plans should include the following: a clearly defined and prioritised list of deliverables and tasks, as well as a timeline for their completion; descriptions of the roles and responsibilities of the project team; and an overview of review and quality control mechanisms. The aim should be for a manageable process in which progress can be easily tracked and stakeholders can be kept engaged.

7. *Draft the roadmap*

The vision, goals, action plans, roles and responsibilities and timelines should be compiled into a single, comprehensive draft reference document for the roadmap project (the “roadmap”). All available resources, such as these guidelines, experiences from other national database initiatives, and the Technical Helpdesk for National LCA Databases should be used to ensure all relevant aspects are covered in the roadmap.

8. *Review the roadmap and obtain stakeholder support*

Local stakeholders and international experts should be invited to review the draft roadmap. This review process may encompass a review of the draft document and/or workshops or webinars with stakeholders. Written and verbal feedback should be compiled in a single document alongside recommendations. As wide a dissemination of the draft roadmap into the local LCA user community as possible is encouraged to increase a sense of ownership of the national database process, which will potentially lead to greater collaboration and use of the database going forwards.

9. *Revise and finalise the roadmap*

Based on the stakeholder and expert inputs received the roadmap should be revised and the document finalised. As part of this step, a dissemination plan for the roadmap should be developed. Clear summaries, possibly aimed at different stakeholder groups, could help with dissemination. Immediate next steps should be made explicit in the summaries.

10. *Disseminate the roadmap and execute first steps*

The roadmap is launched, e.g. through a workshop event at which interested stakeholders can volunteer to participate, and a publication/dissemination platform is released, through which interested stakeholders can access the database. If possible, first implementation steps should be communicated at the event or on the platform (e.g., first collection of core datasets or pilot studies) so as to demonstrate actual momentum on the project and spur further actions.

Elements of a roadmap for national LCA database development

Vision and goals

In order to create effective roadmaps for the development of national LCA databases, it is necessary to understand the context and motivation for having the database and the needs of its potential users. There are many perspectives that can be reflected in the vision and strategy of the roadmap, but the important thing is to make sure that they exist and are understood by the stakeholders. The ultimate vision for the national LCA database development builds on a purpose and the problem or challenges at hand, and it depicts what it would mean to fulfil that purpose and to solve those problems..

The vision is critical for strategy definition and execution. A vision statement encapsulates the future of the process and serves as the framework for strategic and operational planning. Following on from a clear, carefully considered vision, a set of concrete goals should be developed so as to be able to achieve the vision. Through the vision and goals a clear picture of the requirements of the national database should emerge.

Strategic goals should ideally be specific, measurable, achievable, relevant, and time-bound, and should reflect a realistic assessment of the current situation and projected scenario. They should be objective statements – no more than two to three sentences each – that clarify the goal's intent and meaning. In order to create 'strategic goal statements' that clarify intent, it is recommended to answer these kinds of questions: Will the LCA database support public policies that comply with the SDGs? Is the LCA database going to support environmental performance improvements in the country/organization? What other uses should the database support?

It is worth making a particular effort to ensure that the vision and goals capture the particular context and needs of the country, and are agreed upon by stakeholders. The vision is the 'selling-point' of the database, and if it does not resonate with the stakeholders, the roadmap is unlikely to progress (especially if funding is to be sought on the back of the roadmap). For example, it was clear that policymakers in South Africa would find no resonance with the vision and goals if they did not explicitly address South Africa's need for social development as well. To that end, it is also useful to precede the vision with a 'preamble' or statement that positions the need for a national LCA database.

Governance and management

While many may think of a database as a static deliverable, it is important to realise that LCA data will need to be maintained and updated over time to stay relevant, due to changes in the technologies and processes that are represented. The long-term management of the database should thus be planned from the beginning. The management of the database should work towards achieving consistency among datasets and adherence to quality requirements and

rules, whilst it is also necessary to clearly define the roles and responsibilities of those managing and using the database and plan for its sustainability (UNEP 2011). Nevertheless, and as mentioned in the preface, there is also the possibility of data libraries,¹¹ which might be decentralised and without any directly controlling entity. In this document, we deal primarily with databases that are actively managed and impose specific requirements on datasets to be included.

Governance and management of the database need to be clearly defined. The governance structure entails the roles, relationships, authorities/mandates, and responsibilities of the organisations involved and of the database entities, like a board, steering committee, expert group or advisory/stakeholder council. A national database may have one or more of these structures, e.g. a steering committee and advisory council, to oversee the overall direction and management structures of the database. For instance, Australia, US LCI and theecoinvent Association all have councils in some guise (also termed advisory committee or board). In the US case, the advisory committee gives technical and financial guidance. It is recommended that the board or advisory council include members from the different stakeholder groups active in LCA in the country, e.g. government, industry, academia and civil society, as a way to ensure that the database considers the needs of the different stakeholder groups.

The database management team is typically responsible for database development, content management, maintenance, and updating (or at least the coordination thereof; databases often work with external data providers and reviewers). There are three main functions or activities that need to be fulfilled: IT, data review and quality control (again, assuming that data collection is an activity mainly performed externally or by member institutions), and fundraising (see Figure 1). As an option, a council can be added to oversee and give advice on the execution of these three activities.

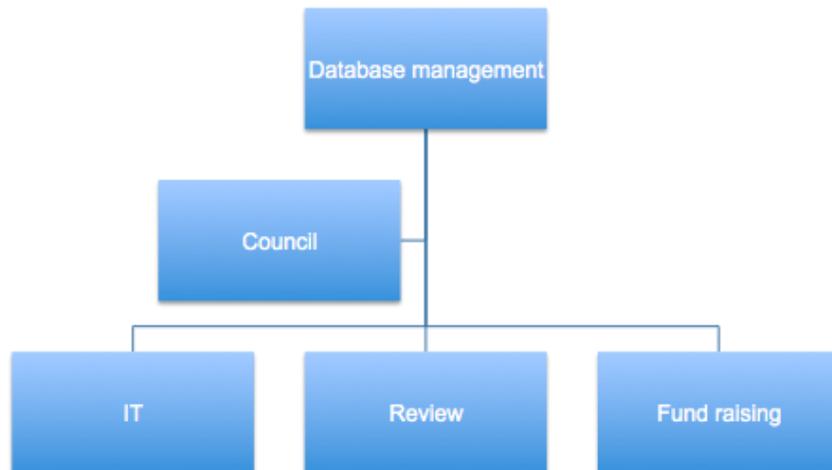


Figure 1: Example of a governing structure for an LCA Database

¹¹ See details of Scenarios L, C and I in UNEP (2011).

The IT manager is responsible for the infrastructure of the database, guaranteeing the availability, usability, integrity and security of data. It is recommended that the IT team also be responsible for the interoperability of the database with data networks/hubs (see section on Data Format and database interoperability below).

During the design of the database, a number of high-level technical definitions are needed: i) inventory and system modelling support (e.g. for dealing with multifunctionality) ; ii) impact methods supported/offered; iii) data quality requirements; iv) format, nomenclature, interoperability and level of documentation required; and v) validation and reviewing procedures for new data submissions, and of the integrity of the database as a whole (see UNEP 2011 for principles of databases, and ISO 14040/44/48 and the section on data quality requirements and review, below). How the design is conducted may differ among databases, e.g., it may be led by an expert or group of experts and reviewed by an advisory committee. Once operational, the review manager is responsible for the application of the requirements for datasets to be included in the database and the process by which datasets are approved for inclusion.

The service level to be offered (whether database access is offered for free or a fee) in terms of support to users/customers, resellers, LCA software providers, LCIA method developers, etc. needs to be decided upon for all of the aforementioned stakeholders. The demand and, hence, also the capacity required for support to users is difficult to predict but should not be underestimated. It is therefore crucial to clearly define and communicate the service level that users and other stakeholders can expect from the database management. Databases may decide to offer a basic service level for free but charge a fee for further activities.

Lastly, but no less importantly, an LCA database demands procedures and capacity for datasets to be developed and maintained/updated. In this regard, budgets must be established such that they guarantee the availability of funds necessary for the viability of the database (see section on Funds and Financing below).

Once the responsibilities are defined, it is recommended that an action plan is defined, covering goals and targets, schedule, responsibilities, resources needed, monitoring indicators, and funding sources. A systematic approach using the plan-do-check-act (PDCA) management method can support the achievement of an effective LCA database and ensure improvement along the way.

Funds and financing

Potential costs related to establishing an LCA database are to fund the people involved for operational and management purposes, as well as capacity building, database development and updating and reviewing of datasets. There are several possibilities for funding and financing databases, from public to private and various combinations thereof. Several LCA databases were established predominantly through public funding, e.g., AusLCI in Australia, SICV in Brazil, the ecoinvent LCI database in Switzerland, or the national database initiatives in Malaysia, Peru and Thailand). There are also several LCA databases that are privately funded, e.g., through data sales or licence fees, often by corporations or consultants with a background in sustainability. In developing and emerging countries, seed money for capacity building has been

provided by the European Commission as well as individual donor countries/organisations for various projects implemented by, for example, UN Environment, the Life Cycle Initiative, standardisation institutes, theecoinvent Association, LCA consultants and international experts, etc.

It is recommended for the initial phase of national LCA database development to focus on identifying the specific needs of one or a few key user or stakeholder groups, and to deploy the resources available to respond to their needs. With the main objective 'to set the wheels in motion', this requires maintaining a certain degree of flexibility in terms of who will be the initial or primary user of the database. National self-sufficiency should not be a core objective, especially not in the early phase. Connectivity to other databases is commonly much appreciated by users. There is a number of global background LCA databases available to this end, which can serve to provide supplementary data for sectors not covered or on parts of supply chains outside the national boundaries. For this to work satisfactorily, though, data interoperability is imperative.

The needs of certain user groups for free access to the database can be an argument for public funding. However, that does not contradict a parallel commercial model (e.g., based on licensing) for other user groups. It is important to keep in mind that if there is value created by the database, then someone should be willing to raise funds for its provision. That key group/sector should be the focus in the beginning to create value where it is most (urgently) needed. This will, in turn, create further opportunities as life cycle thinking/indicators are adopted in other sectors. Subsequent efforts should strive to increase the base of LCA users, nationally (e.g. through the promotion and application of LCA in policy formulation and decision making). Demonstrating the value created by the LCA database through monitoring of indicator results (e.g. usage of the database, sustainability benefits in the region, sustainable innovations achieved, etc.) will also help build support for it.

Human resources

Human resources are needed both for information technology, as well as for developing and reviewing datasets and the database as a whole. The establishment of standards and guidelines also requires expertise and effort. The number of people involved in the provision of data to an LCA database depends on its goal and scope. Databases that are mostly based on secondary data usually depend less on human resources to this end than those focused on collecting and processing primary data. In terms of dataset development, it might also be possible to capitalize on human resources not directly related to the database, e.g. academic and other LCA projects generating datasets that can be worked into compatible datasets.

The IT team needs to understand the goal of the database and identify and develop solutions to support it. Having capable people in this team is essential to fulfil the principles for LCA databases listed by UNEP and SETAC (2011): accessibility, accountability, assurance, completeness, consistency, exchangeability, materiality, practicality, quality, relevance, reproducibility and transparency. Furthermore, it is necessary for the IT team to work with the dataset developers and reviewers to ensure that these principles are fulfilled.

As an LCA study requires data on processes spanning many different sectors (e.g. energy, transportation, manufacturing, agriculture, and waste management) and each process has its own specific requirements and set of terminology, each processes needs to be linked to other processes. Research teams from different backgrounds are necessary to establish a common terminology and requirements to guarantee the consistency demanded from a database.

In general, countries embarking on developing national databases should not underestimate the skills and efforts required. At the same time, the human resource needs should not be overestimated. Many existing databases began with very few, and often no, full-time personnel. Working collaboratively, with several organizations providing resources and capacities in-kind at a moderate level, can be successful. In this way, efforts can be readily distributed, and existing skillsets can be combined effectively. Generally, full-time personnel should only be added once needs are clear and are likely to remain in the long-term.

Besides, an LCA database is only as good as the decision making it can support and the number of users it has. In this regard, 'human resources' are also needed externally to the database to form a stabile user-base, so creating demand through capacity building is necessary. Research projects, including those of PhD and Masters-level students are needed to facilitate dataset creation and to explore new ways of analysing and applying the data. The application of LCA has been supported and promoted in several countries by the Life Cycle Initiative since 2002, resulting with the creation of regional LCA networks (e.g. the Ibero-American Life Cycle Network [RICV]). Online training is also available through the Life Cycle Initiative,¹² free of charge, to raise awareness and support knowledge building. The SRI programme (2017-2018) also supporting LCA capacity building efforts in various countries, including Brazil, India and South Africa. In the Brazilian case, several workshops were performed, with their purposes ranging from awareness raising to training provision on more advanced topics in LCI and LCIA modelling.¹³ So far, over 600 people in Brazil have been trained through this project alone, and that number continues to grow.

Database hosting

An LCA database and the LCI data it contain can be useful for many reasons, from supporting public policies to providing consumer information and much more. Consequently, there are responsibilities that come with the hosting of a database. The system must be reliable and secure and at the same time easy to use and access for users. Some existing databases are hosted by government agencies (e.g. in Brazil, Europe, Malaysia, Peru, Thailand and USA), others by NGOs (e.g. Australia) or universities or other research institutes (e.g. in China, Sweden). Theecoinvent LCA database is managed by the ecoinvent Association with the data hosted by an external IT service provider, and the Quebec LCI database is dually hosted by CIRAG and integrated into the ecoinvent database.

The requirements for hosting infrastructure depend mostly on the level of service offered (or intended to be offered). At the simplest end of the spectrum, a zipped archive with all the

¹² www.lifecycleinitiative.org

¹³ www.acvdeaz.org

datasets in a given format and a few explanatory files can be distributed directly or placed on a file-sharing platform. At the other end of the spectrum, a database system, like a Product/Organisation Environmental Footprint (PEF/OEF) node¹⁴ or the ecoQuery system¹⁵, offers various features, such as user management (login, password reset, etc.), a search engine, data visualisation, selective download, etc. It is up to the database manager to define the level of service that is desirable. As soon as the selected option is more complex than a simple archive download, web design and server management knowledge are necessary. The time and resource investment to host a database should not be underestimated, and the description of the user experience should therefore be carefully defined in detail. Working with established solutions can save resources. Setting up nodes, for example, on GLAD is supported with free, open-source software and can serve both hosting and interoperability needs.

Data needs and availability

There can be hundreds or thousands of datasets covering distinct (unit) processes needed for a background LCA database in order to adequately represent important sectors and supply chains. Defining which datasets are needed as a priority is crucial but challenging. The scope of the database content should be planned, and more ambitious scopes should be approached iteratively. The intended uses of the database should be kept in mind during this process as they will help define both the sectoral data needs as well as the data quality requirements.

Defining content goals for a national LCA database can be performed in different ways:

- 1) Covering the most relevant processes or sectors based on their economic contribution;
- 2) Covering the most relevant processes or sectors in an economy based on wide-spread use, e.g. transport and electricity (e.g. the case of China);
- 3) Covering processes of high environmental relevance or concern, e.g. mining, construction and transport (e.g. the case of Quebec);
- 4) Covering processes unique or of particular relevance to the country (e.g. coal-based chemicals and liquid fuels, as in the case of South Africa);
- 5) Considering data availability;
- 6) Other regional criteria.

Once the list of prioritised processes has been defined, the next step is to determine the data availability. Representative data will not always be readily available. One may be faced with one of two possible situations: missing/inaccessible data or data that does not meet the quality requirements/goal of the database. Metadata and documentation needs should also be taken into account.

For the former (missing data), ISO 14044 states that missing data can be replaced by a value with justification or even kept as zero, although this solution would not reflect any contribution in

¹⁴ <http://eplca.jrc.ec.europa.eu/LCDN/contactListEF.xhtml>

¹⁵ <http://ecoquery.ecoinvent.org>

the result. In the latter, information on data quality should be included (see next topic). A sensitivity analysis is recommended in either cases.

There might be some data already available that does not fulfil the requirements of the database and demands more work. In Brazil, for instance, a number of academic LCA studies have been published since the turn of the century. However, data collected in these studies is not yet available at SICV because the value of contributing to a database is not widely recognized by the academic community. Furthermore, during the SRI project, hundreds of datasets were developed that are available freely to SICV but that do not fulfil the format requirements. As a result, it is necessary to find strategies and/or funding for further work that guarantee that these data are incorporated into the database. Working with an established background database and adjusting/updating to the specific country context where most needed can be an effective way to build up a national database. Advances in data interoperability might also make the connection with multiple complementary data sources (nodes) more readily attainable.

Data quality requirements and review

An important principle of a database is that it follows predefined quality requirements to ensure consistency within its data pool. In any data submission, some data might be missing, of poor representation, or a data source may not be reliable, or model outputs may need to be used instead of measured data. As a result, it is important to transparently document the extent to which data fulfils the initial quality requirements. The quality guidelines should clearly distinguish between mandatory requirements and optional aspects. Not all datasets will reach the same level of detail and quality, and the database system should allow for assessing the fitness-of-purpose, e.g., through transparent documentation, meta-information, uncertainty information, and/or data quality indicators. The scope and intended uses of the database will have significant influence on the data quality requirements, which is why the database quality requirements should be carefully defined when designing and setting up the national database.

Examples of database quality requirements can be found for the Life Cycle Data Network (LCDN) (EC-JRC 2016),¹⁶ ecoinvent version 3 (ecoinvent 2013),¹⁷ and QualiData (IBICT, 2016).¹⁸ Once the requirements are established, the process for reviewing needs to be defined, including the steps, responsibilities, inputs and outputs (see Figure 2 for an example of a review process). In the example in Figure 2, the process consists of two main steps: 1) verification that the dataset conforms to the format requirements and 2) verification of the content level. If all requirements are met, the dataset is deemed ready to be published.

¹⁶ http://eplca.jrc.ec.europa.eu/PERMALINK/JRC104371_lb-na-28251-en-c.pdf

¹⁷ www.ecoinvent.org/files/dataqualityguideline_ecoinvent_3_20130506.pdf

¹⁸ <http://acv.ibict.br/wp-content/uploads/2017/05/Qualidata.pdf>

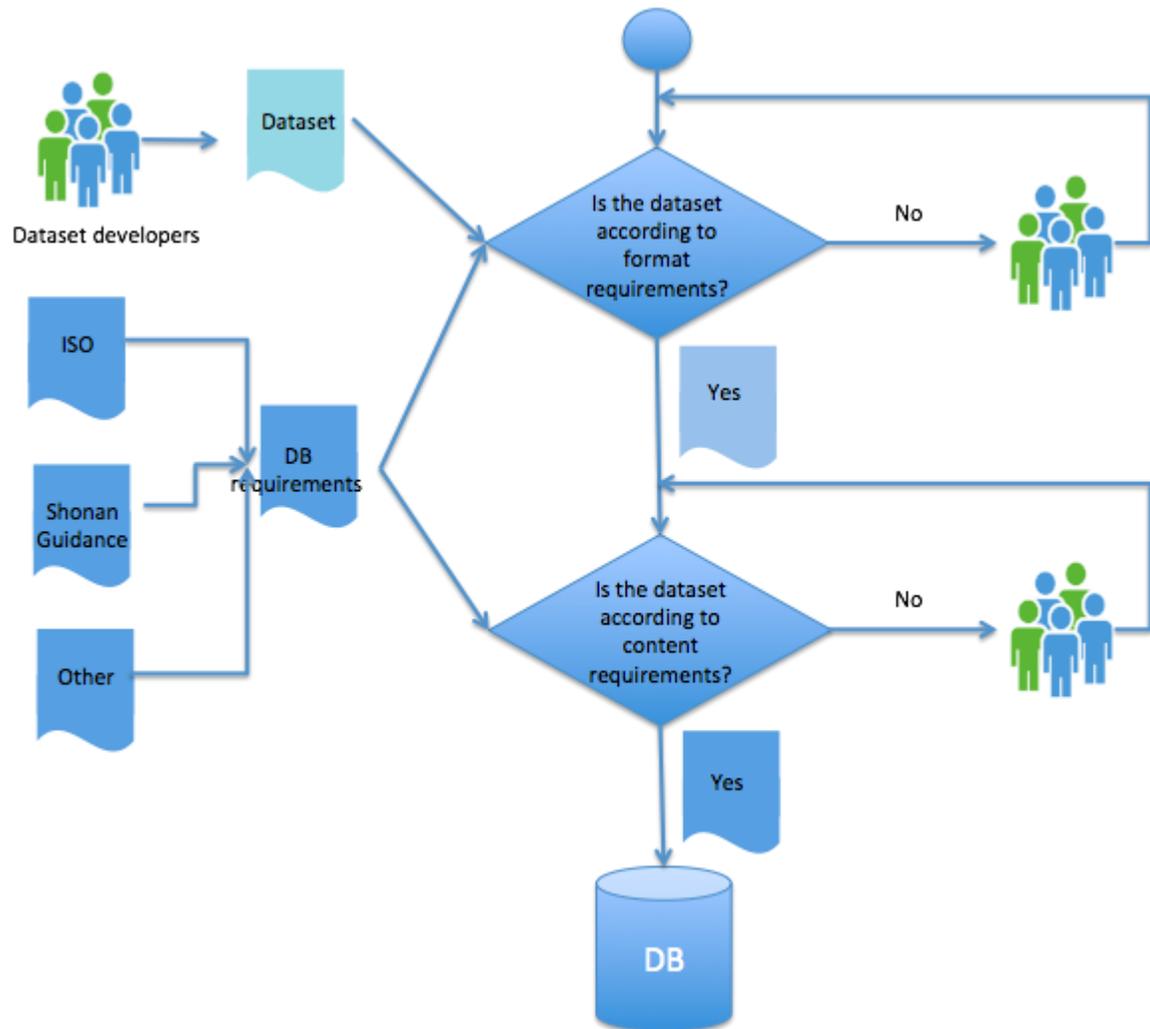


Figure 2: Example of a review process. Abbreviations: DB: database; ISO; International Organization for Standardization

In this context, it is important to also reflect on the needs and requirements for data on individual processes versus higher levels of aggregation. The *Shonan Guidance Principles* for LCA databases recognizes that “*there may be valid technical, business, or practical reasons for having aggregated datasets in an LCI database.*” (UNEP 2011, p. 127) Nevertheless, it is also recommended that unallocated unit process data is provided as far as possible. Unallocated unit processes offer the highest degrees of transparency and flexibility in terms of supporting future updates and different system modelling choices (i.e. for attributional or consequential studies and different allocation methods). Furthermore the added resolution in the dataset allows for performing in-depth contribution and sensitivity analyses that aid in the interpretation of results and lead to better product system understanding. Datasets based on a limited level of aggregation, obtained by averaging data from several production lines/sites/suppliers/regions/technologies/etc. (i.e., horizontal averaging) and/or by covering multiple interlinked sequential processes within the supply chain or over different life cycle phases (i.e., vertical aggregation), can be more convenient to work with due to, for example, reduced complexity and calculation

effort. They may help ensure confidentiality of the underlying data and of individual data sources/providers whilst still offering the benefits of unit processes, as long as the aggregation is not too extensive. Chapter 3 of the *Shonan Guidance Principles* (UNEP 2011) provides extensive guidance on several critical aspects that need to be addressed when considering aggregating process data for LCA dataset development. To ensure credibility, the *Shonan Guidance Principles* also recommend that unit process datasets are reviewed and verified independently prior to their being used to generate aggregated process datasets and that data providers clearly specify and document the motivation and modelling approaches used for the aggregation, as well as the intended use of the datasets.

Data format and database interoperability

A number of life cycle data formats have emerged to manage the large amount of information (including metadata) needed in a dataset for LCA. An ISO standard (ISO/TS 14048¹⁹) was also developed to provide guidance to life cycle developers. The most widely used formats are covered in the subsections below, as it would seem to make most sense that emerging databases adopt one (or ideally supporting several) of these formats.

As processes are linked to several others along the life cycle of a product, collecting data on all the processes is resource intensive. In general, a database operator should expect that the users will use multiple databases and other data sources for their work. While some applications, such as the PEF, require the use of specific data, it is generally becoming more common to see practitioners use multiple data sources. Therefore, there might be databases developed from different groups with distinct formats, despite the ISO/TS 14048 standard.²⁰ In this regard, it is strongly recommended that national databases are prepared to be interoperable with existing ones. Although relying on multiple data sources, enabled by data interoperability, can improve the completeness of the LCA study, it is recommended that the users take care during the interpretation phase due to the possible differences in data quality requirements and system models in different databases.

To exchange data, a standardized data format must be chosen. The ILCD and ecoSpold (v1 and v2) formats represent the two most established data exchange formats. Both ILCD and ecoSpold are compliant with ISO/TS 14048 and are based on Extensible Markup Language (XML). Conversion between these most common data exchange formats is supported by available converters, e.g., in LCA software, the openLCA format converter provided by GreenDelta.²¹ or the converter in the GLAD. This overview of formats also encompasses the relatively novel JSON-LD data exchange format.

¹⁹ ISO/TS 14048:2002 Environmental management -- Life cycle assessment -- Data documentation format.

²⁰ ISO/TS 14048:2002 Environmental management -- Life cycle assessment -- Data documentation format.

²¹ www.openlca.org/format-converter/

ILCD

According to Wolf et al. (2011),²² the development of the International Reference Life Cycle Data System (ILCD) started in 2005 (originally under the name ELCD data format), driven by the need for: i. a data format for the European Reference Life Cycle Database (ELCD), ii. a common format to support data exchange (import and export) of the ELCD reference data sets with other databases and software tools, and iii. a common overall format to be used to exchange LCA datasets among all relevant LCA tools and databases (e.g. for LCA information transfer along supply chains) and for data networks. The ILCD format was developed with this in mind and has evolved since then based on existing practice and through broad consultation between several partners under the coordination of the Joint Research Centre of the European Commission (EC-JRC). The ELCD's function has been superseded by the Life Cycle Data Network (LCDN) which is also based on the ILCD format.²³ The format is also used in the PEF/OEF pilot projects of the European Commission. Detailed documentation of the ILCD format and guidance on the creation of ILCD entry level and Product and Organisation Environmental Footprint (PEF and OEF) data, and for data sharing through LCDN is provided on website of the EC-JRC.²⁴

The ILCD format is supported by most major LCA software applications and it is used, besides the LCDN, by national LCA databases, such as SICV in Brazil, MYLCID in Malaysia, and the Thai National LCI database.

ecoSpold

The ecoSpold format is the result of several iterative evolutions of XML-based data formats for LCA data, beginning in the 1990s. While sometimes associated primarily with theecoinvent database, it is an open-source format, and its most recent version is the ecoSpold v2 format (Meinshausen et al. 2016).²⁵ The ecoSpold format is supported by most major LCA software applications, and it is used, besides for theecoinvent database, by the AusLCI in Australia, PeruLCA in Peru, and the Quebec LCI database in Canada.

JSON-LD

A format based on JavaScript Object Notation for Linked Data (JSON-LD) was developed and implemented by GreenDelta as an alternative to the established formats in XML. Besides the aim to reduce the effort for implementation and remove inconsistencies between the ILCD and ecoSpold formats, other advantages, such as being human-readable and the ease of integration into web-applications, were also put forward as motivation. JSON-LD was implemented as one

²² Wolf, M.A., C. Döpmeier, O. Kusche (2011) The International Reference Life Cycle Data System (ILCD) Format – Basic Concepts and Implementation of Life Cycle Impact Assessment (LCIA) Method Data Sets in *EnviroInfo 2011: Innovations in Sharing Environmental Observations and Information*. Shaker Verlag Aachen, ISBN: 978-3-8440-0451-9

²³ <http://eplca.jrc.ec.europa.eu/LCDN/>

²⁴ <http://eplca.jrc.ec.europa.eu/LCDN/developer.xhtml>

²⁵ Meinshausen, I., P. Müller-Beilschmidt, T. Viere (2016) The EcoSpold 2 format - why a new format? *International Journal of Life Cycle Assessment*, 21(9), 1231–1235. DOI: 10.1007/s11367-014-0789-z

of the formats in openLCA since 2015, but the support of this format in other LCA software is still limited. The JSON-LD data exchange format is directly created from the LCA Collaboration server and is, thus, straightforward to use with GLAD (interoperability is described in the next subsection below).

Interoperability over the Global LCA Data Access (GLAD) network

UN Environment serves as the Secretariat for the Global LCA Data Access (GLAD) network, which strives for better data accessibility and interoperability between different sources of data. The network provides users with an interface to find and access life cycle inventory datasets from different independently operated LCA databases (nodes). The interoperability of data from different nodes and in different formats is achieved through key metadata descriptors, which are required for any dataset linked to GLAD. Furthermore, nodes joining the GLAD network commit to fulfil a minimum set of requirements, including using one of the main exchange formats (ILCD or ecoSpold v2), a common flow nomenclature as well as ensuring that all meta-information of datasets searchable in the network must be in English (as a minimum) and available for free.²⁶

Guidance on how to establish a node and how to link datasets to GLAD, by completing the metadata descriptors for data in either the ILCD or ecoSpold v2 format, is available to dataset providers on the GLAD website.²⁸ It should be noted that the guidance document concludes from two test cases that implementation efforts include the mapping of process datasets to the United Nations Standard Products and Services Code (UNSPSC) categories. It is, therefore, recommended that these requirements be kept in mind when determining the data format to be used and the quality standards to be followed for national LCA databases.

New database initiatives should not underestimate the value of being interoperable with other data sources and the visibility that a platform such as the GLAD network can offer. Users will appreciate any efforts that database providers can make to help them find, import and use LCA data, and GLAD is intended to support and facilitate these processes.

LCA uptake in policymaking

LCA can support public policies based on sustainability as it can be used not only on the product level, but also for the organization, consumer and regional levels (Hellweg and Milà i Canals, 2014)²⁹. In fact, LCA may provide information for sustainable reporting, the identification of processes/sectors that demands improvement and innovation needs, public procurement regulations, and the competitiveness of organizations in restricted markets. Some examples include the establishment of sustainability requirements for biofuels to receive government support in Europe under the Renewable Energy Directive (based on quantified emissions of

²⁶ The full list of requirements is available under the section *Further resources* at the end of this document or from www.globalcadataaccess.org/become-a-dataset-provider

²⁸ www.globalcadataaccess.org/become-a-dataset-provider

²⁹ Hellweg, S., L. Milà i Canals (2016) Emerging approaches, challenges and opportunities in life cycle assessment. *Science*, 344(6188):1109-13. DOI: 10.1126/science.1248361.

greenhouse gases), environmental labelling (Single Market for Green Products in Europe) and incentives for producers with better environmental performance (*RenovaBio* in Brazil).

The development and expansion of national LCA databases ideally goes hand-in-hand with increased use of LCA to support public policy making and regulation. It is therefore strongly recommended to engage and actively involve representatives of the relevant governmental bodies throughout the database roadmap processes and implementation. The representatives of these stakeholder groups can aid formulation of strategies for increased policy uptake through their insights into the policymaking process and their understanding of the political landscape and agenda. This may serve to set the priorities and requirements for data and also to obtain the funds and official support needed to address crucial data gaps.

The following table provides a generalized high-level summary of key aspects of LCA database development over three stages of maturity.

Item	Level of maturity		
	Infancy	Teenage	Adult
Governance	Not formalized		Clear structure with roles and responsibilities defined
Capacity building in LCA	PhD and Master studies	Training	Integrated training in all courses at all levels
Use of LCA	Academic studies	Some cases implemented in organizations	Public (including for policies) and private users
Funding of LCA database	Seed money from international and research agencies	Governmental agencies funding initial activities	Financial stability, independent of external funding
Infrastructure	Working sheets developed by one person/team	Working sheets developed by several groups	Implementation of IT technology
Datasets	Datasets developed for the studies	Non-harmonized datasets available without updates	LCA database, update often
Interoperability	Poor to no data interoperability	Datasets can be used in different platforms, but with some work	LCA database interoperable, connected to GLAD

From roadmap to implementation

Activities and timeline

Once the database roadmap has been established, the next logical step is to progress with its implementation. Each country will have its own unique roadmap and the process for implementing it will also vary among countries. However, the general direction in which implementation activities need to move will be more or less similar. This section provides an overview of the work to be done for taking the roadmap off the drawing board into implementation on the ground, i.e., to initiate the database development. Typically, the following activities have to be undertaken to initiate and progress roadmap implementation.

1. *Approval of roadmap and organisational structure/collaborations to be implemented*

In general, to ensure implementation of any roadmap or plan, the most critical aspect is about clarity on who has ownership or responsibility for progressing on implementation. Since the development of a database requires concerted action by multiple stakeholders, it is critical to identify an empowered agency or a group, such as a task force or working group, that takes responsibility for coordinating among the multiple agencies involved and maintaining momentum. Ideally, the roadmap development exercise should include nomination of, and acceptance by, an agency of this responsibility. In case the roadmap does not make this clear, the actors driving the implementation of the roadmap need to do so. Ownership or responsibility does not mean that all the activities for implementation have to be carried out by the agency taking ownership/responsibility itself. Rather, the agency will be responsible for identifying, coordinating and establishing communication mechanisms among the various actors who will contribute to the development of the database, more like a project manager's role. It is expected that an initial set of data providers and database users will be identified during the roadmap development. Any loose ends in bringing the initial data providers and users on board should also be tied up at this point.

2. *Capacity building*

Members constituting the empowered agency and collaborating agencies/individuals need to be capable of fulfil their roles and responsibilities. While initiating implementation, briefing and capacity building of the main stakeholder groups should be organized to facilitate smooth implementation. In general, capacity building includes assessment of learning needs (content), selection of learning methods (e.g. seminar discussions, hands-on exercises), selection of delivery channels (e.g. face-to-face or virtual), procurement of expert services for content preparation and delivery, and finally delivery of capacity building programs. The main stakeholders whose capacity needs should be developed consist of, at the very least:

- Responsible agency/members of the implementing group
- Data providers
- Data users

3. *Establishment of data collection and storage mechanisms*

The roadmap will contain, at a minimum, an indication of prioritised data and how they might be obtained, e.g. through direct measurements (primary data) or from some existing database or data source (secondary data). Based on the needs of data providers and data users identified in the initial baseline assessment and stakeholder analysis, further decisions can be taken on the remaining aspects and actions taken to implement the decisions. Broad tasks for this activity are identified below:

- Study of user needs and prioritisation of sectors/products
- Determination of functionalities to be provided
- Design and delivery of mechanism to connect data providers
- Design and delivery of mechanism to connect data reviewers
- Design and delivery of mechanism to connect data users

4. *Establishment of customer service procedures/mechanisms*

Some of the decisions regarding data access, e.g. which user group has access to what data and what data are free/not free of charge, would have been touched upon in the roadmap. These decisions will now be formalised so that they can be incorporated into the requirements for the IT platform that will host those data. The key tasks here will be:

- Define access criteria
- Define financial terms
- Marketing and communication to data providers and data users

5. *Selection and development of IT platform*

Based on the above requirements, the IT platform will be conceptualised. It is not necessary to build the platform from scratch, there are many possibilities for collaborating with existing database and service providers to select a configuration that fits in with the strategy and budget for the database development exercise. Illustrative tasks for this activity are listed below:

- Define criteria for selection of IT platform
- Identify platform and procure technical services
- Develop work schedule for platform development
- Design of the pilot platform
- Test launch of platform pilot test
- Improvement and feedback from the test
- Final launch

6. *Establishment of ongoing development/maintenance mechanism/procedures*

The launch of the IT platform needs to be accompanied by activity relating to its ongoing maintenance and evaluation to ensure maximum return on investment. Broadly, this activity will comprise the following tasks:

- Set up of monitoring mechanism to assess implementation success
- Periodic review and course corrections/continuous improvement actions
- Hand over to competent agency/technical help desk for running operations

Risk Management

It is expected that the above activities should start the roadmap implementation process and build sufficient momentum for it to proceed in a sustained manner. However, experience of database development in many countries indicates that there will likely be some difficulties encountered along the way. It would be prudent to be aware of the possible problems so that the implementing agencies do not get caught unaware and can take preventive and/or mitigative actions in good time to keep the process going. Risks to projects can generally be considered to be of technical, managerial, commercial, or external nature. Strategies to cope with negative risks include escalating (i.e., pass on the risk to higher instances in an organisation), avoiding (i.e., the implementation of suitable measure to ensure that risk does not occur), transferring (or sharing risk with a third party, e.g., by purchasing insurance), mitigating (reduce risk or probability and/or risk to acceptable levels through suitable measures), or accepting the risk and creating contingency and/or fall-back plans, accordingly. The following tables summarise some typical risks associated with LCA database development initiatives, along with examples of possible ways to manage these risks and avoid situations that might stall the database development process or render it unproductive. At the highest level, risks could generally be of three types: data content and quality problems, stakeholder commitment issues, and resource constraints.

Content and quality risks

These risks refer to issues on the content of data captured in the database, its availability, adequacy, and usefulness (fitness for purpose). Some pointers to dealing with such risks are given below:

#	Risk	Suggested actions to manage risk
1	Data quality may not be insufficient (incorrect, outdated, etc.)	Defining data quality goals and setting benchmarks to check whether the data meets the data quality requirements. Build data quality assessment and improvement into the data collection strategy, and establish appropriate review mechanism
2	Geographical coverage limitations	Start with most representative data possible and gradually improve data representativeness/ regionalisation. Consider recontextualization of datasets from other data sources (as permissible)
3	Difficulties in collection of, or access to, primary data	Include secondary data sources, (e.g. laboratory measurements, governmental and industrial documents, trade reports and databases, national databases, environmental inventories, consultancies, academic sources, and engineering judgments)

Stakeholder commitment

Under this category, problems that could slow down or stall roadmap implementation due to lack of interest by stakeholders are captured. Some guidance to stimulate commitment of key stakeholders is provided below:

#	Risk	Suggested actions to manage risk
4	Lack of stakeholder involvement	Involve empowered and committed stakeholders right from the beginning of the roadmapping exercise
5	Insufficient support and participation from particular groups (e.g. government, industry and academia)	Undertake a promotional campaign at the outset to raise awareness, educate and motivate key stakeholders with clear messages on the benefits to each group
6	Loss of stakeholder interest over time	Data updates and continuing engagement with stakeholders through periodic interactions/events
7	Apprehensions on misuse of data	Address apprehensions at the outset and resolve open questions about who can access the data and for what purpose
8	Lack of stakeholder interest in using the database	Establish linkages with existing problems that are of concern to stakeholders and remove any bottlenecks in accessing the data (e.g. unduly high cost or cumbersome process)

Resource constraints

In this case, two types of resource constraint can be relevant: funding and expertise. Like most initiatives that benefit multiple stakeholders with diverse interests, it may initially be difficult to get financial commitments to start the work. However, once a critical mass of data is available and the benefits of having the database have been demonstrated, financial contributions may be easier to secure. Also, in the initial stages when LCA activity is new, local experts may not be available to support technical development activities. Such expertise needs to be built in order to avoid reliance on expensive expertise from other countries that, in any case, will need to be supplemented with local contextualisation. A certain proportion of the database development budget should be allocated to developing local capacity. Some of the experts developed in this way could also contribute to the Technical Helpdesk for National LCA Databases activities. These ideas for managing resources are summarized below:

#	Risk	Suggested actions to manage risk
9	Financial constraints in developing and maintaining a national LCA database	Establish business model at the outset and engage agencies that will fund the database development and those that will benefit from it. If the beneficiaries themselves are funding the development, financial commitments are more likely to be forthcoming
10	Insufficient expertise among national stakeholders	Establish linkages for inviting external experts to support and build local capacity. Consult regional and international networks, including the Technical Helpdesk for National LCA Databases

Monitoring progress

Monitoring activities are intended to assess the success of the implementation and to gather information to populate the database and/or make corrections wherever implementation did not progress as anticipated. At the time of roadmap development, criteria for assessing its success should be discussed. In the monitoring phase, these criteria can be articulated in the form of indicators on which periodic assessment can be carried out. In a typical situation, the following indicators may be useful to track and then determine further actions required for improving outcomes from roadmap implementation:

- Meetings and events where the database development work is presented/discussed
- Number of data providers, and database users associated with the project
- Number of datasets becoming available or connected to the GLAD network
- Number of stakeholders engaged or the degree of stakeholder representation within the project
- Trends in number of requests for data coming in
- User satisfaction level assessment (e.g. through surveys)

Further resources

The Technical Helpdesk for LCA Databases

The Technical Helpdesk for LCA Databases³⁰ is a forum hosted under The One Planet Network³¹, the network of the 10 Year Framework of Programmes on Sustainable Consumption and Production. Gathering LCA data experts, developers of new national databases, managers of existing databases, and other interested individuals, the Technical Helpdesk provides stakeholders wishing to establish and operate LCA databases with both training and support by international experts. The Technical Helpdesk has been established to facilitate communication among experts and stakeholders and to provide key informational resources and guidance on responsible management practices and technical requirements for database setup and operation.

The consortium of the present project is committed to contributing to the development of the Technical Helpdesk, e.g. by uploading and sharing relevant project outputs (such as this document and the finalised roadmap reports) and actively participating in the discussions on the forum with experiences and insights from the respective countries. The project-internal discussions among consortium members were not raised in parallel on the Technical Helpdesk during the project. In retrospect, some project activities, most notably the initial survey of existing national database initiatives or the more fundamental contemplation on the 'niche' and business case for national LCA databases, could very well have benefited from the inputs of the Technical Helpdesk community. To this end, the Technical Helpdesk could increase its relevance by compiling and maintaining a 'directory' of national LCA database initiatives (including information about governance, management and hosting institution, scope, stage of development, and main contact). Extensive representation of such database initiatives and providers on the Technical Helpdesk would also be highly desirable. Going forward from the present project, it might be relevant to follow up on the actual implementation of the national database roadmaps periodically in the months and years to come, in order to disseminate promising solutions, unforeseen pitfalls, and lessons-learned to the wider stakeholder community to the Technical Helpdesk community.

Guidelines

- GLAD (2018) Supporting document for nodes interested to join GLAD. UN Environment/Global LCA Data Access Network, GLAD. Available at: <https://www.globalcadataaccess.org/uploads/Guidance%20for%20GLAD%20metadata%20descriptors.pdf>
- Oliveira Rodrigues, T., E. Toshio Sugawara, D.A. Lopes Silva, M. I. S. Folegatti Matsuura, T.E. Nunes Braga, C. M. Lie Ugaya (2016) Guia Qualidata - Requisitos de

³⁰ <http://spaces.oneplanetnetwork.org/lcahelpdesk>

³¹ <https://www.oneplanetnetwork.org/>

qualidade de conjuntos de dados para o Banco Nacional de Inventários do Ciclo de Vida (in Portuguese). Instituto Brasileiro de Informação em Ciência e Tecnologia, IBICT. Available from: <http://acv.ibict.br/wp-content/uploads/2017/05/Qualidata.pdf>

- Simone, F., O. Kusche, L. Zampori (2016) Life Cycle Data Network — Handbook for data developers and providers. JRC Technical Reports, EUR 28251. Joint Research Centre of the European Commission. Available at: http://eplca.jrc.ec.europa.eu/PERMALINK/JRC104371_lb-na-28251-en-c.pdf
- UNEP (2011) Global guidance principles for life cycle assessment databases - A basis for greener processes and products. United Nations Environment Programme, UNEP. Available at: <https://www.lifecycleinitiative.org/wp-content/uploads/2012/12/2011%20-%20Global%20Guidance%20Principles.pdf>
- UNEP (2016) Opportunities for national life cycle network creation and expansion around the world. United Nations Environment Programme, UNEP. Available at: http://www.oneplanetnetwork.org/sites/default/files/unep-lci_mapping-publication-9.10.16-web.pdf
- Weidema B.P., C. Bauer, R. Hischier, C. Mutel, T. Nemecek, J. Reinhard, C.O. Vadenbo, G. Wernet (2013) Overview and methodology. Data quality guideline for the ecoinvent database version 3. Ecoinvent Report 1(v3). St. Gallen, Switzerland; The ecoinvent Centre. Available at: https://www.ecoinvent.org/files/dataqualityguideline_ecoinvent_3_20130506.pdf
- Wolf, M.A. (2014) White paper: National LCA databases - Status and ways towards interoperability. maki Consulting. Berlin, Germany. Available at: https://maki-consulting.com/wp-content/uploads/2013/05/2014_National-LCA-databases_White-paper_maki-Consulting_final_clean.pdf

LCA database roadmaps from other countries

- MTEC (2017) Thai national LCI database. National Metal and Materials Technology Center, MTEC. Available at: http://spaces.oneplanetnetwork.org/system/files/8b_database_roadmapping_key_considerations_thailand_11-17.pdf
- NREL (2009) U.S. life cycle inventory database roadmap. National Renewable Energy Laboratory, NREL. Available from: <https://www.nrel.gov/docs/fy09osti/45153.pdf>
- Carlson, R. and A-C. Palsson (1998) Establishment of CPM's LCA database - project report. CPM report 1998:3. Chalmers University of Technology. Göteborg, Sweden. Available at: <http://cpmdatabase.cpm.chalmers.se/AboutDatabase.htm>

Case studies and national/regional accounts

- Bajaj, S., Gupta, S., Shenoy, M. (2016) Report of consultations with key stakeholders on 'Readiness for development of Indian LCA database'. Federation of Indian Chambers of Commerce and Industry (FICCI). Available at: <http://www.indialca.com/pdf/2016-indian-lca-database-project-report.pdf>
- Chomkham Sri, K. T. Mungcharoen, C. Yuvaniyama (2017) 10-year experience with the Thai national LCI database: case study of "refinery products. *The International Journal of Life Cycle Assessment*, 22(11):1760–1770. DOI: 10.1007/s11367-016-1160-3
- Harding, K., Basson, L., Brent, A., Freidlich, E., Mbohwa, C., Notten, P., Pineo, C., Ruiters, L.-H., von Blottnitz, H. and Janse van Vuuren, P. (2015) Status and prospects of life-cycle assessment in South Africa, LCM 2015. Available at: https://www.researchgate.net/publication/281292750_Status_and_prospects_of_life-cycle_assessment_in_South_Africa
- Lesage, P. and Samson, R. (2013). The Quebec Life Cycle Inventory Database Project. *The International Journal of Life Cycle Assessment*, 21:1282–1289. DOI: 10.1007/s11367-013-0593-1
- Valdivia, S., G. Sonnemann, L. Milà i Canals (2017) LCA mainstreaming conditions in Latin America—based on learnings from 2005 to 2014. *The International Journal of Life Cycle Assessment*, 22:485–491. DOI: 10.1007/s11367-016-1142-5

GLAD node requirements

Nodes joining the GLAD network commit to:³²

- Minimum requirements for dataset documentation: The Node commits to work towards enhanced data access and interoperability by providing the minimum metadata descriptors to enable search by users, as well as by using the agreed nomenclature mapping made available by the Network. The use of a common data exchange format and flow nomenclature is encouraged.
- The Node commits to use the Network API [application programming interface] to enable the search of its dataset metadata descriptors, but the Node is free to develop its own solutions to participate in the Network, within the given network principles.
- In order to establish interoperability between datasets within the Network, the Node commits to the use of a common data exchange format and flow nomenclature (refer to Table 1 on the Web).³³
- Freely accessible metadata: All metadata for each dataset that is searchable in the Network must be available for free (no charge to consult dataset's metadata).

³² From www.globalcadataaccess.org/become-a-dataset-provider [assessed on 2018-12-12]

³³ www.globalcadataaccess.org/uploads/Table%201-proposed%20metadata%20descriptors.pdf

Development of National LCA Database Roadmaps

Deliverable D 3.1: guidelines and recommendations for establishing LCA database roadmaps

- Dataset providers are responsible for the operation of their own node and maintain full control over their node as well as the data hosted on the node. For paid databases, actual transaction should occur between the users and the individual nodes.
- License policies: Each node can have its own license policy establishing what Users can do with the datasets provided through their node. However, use of datasets accessed from other nodes may have their own license policies. Thus, license conditions need to be clear and transparent.
- Registered Nodes need to be available online, or at least post the metadata values of their datasets online and offer access to metadata descriptors for free.
- Dataset providers must demonstrate willingness and effort to present datasets with GLAD metadata and nomenclature conventions to the extent possible. GLAD reserves the right to restrict access to providers not participating in good faith according to the principles of the Network.
- Language: The Node commits to making metadata available in English as a minimum, in addition to another language if desired
- Due Diligence: The Nodes provide access to datasets that are in line with GLAD principles to the best of their knowledge and fully documented.