JRC TECHNICAL REPORTS

Roadmap for the European Platform on Life Cycle Assessment: facilitating data collection and sustainability assessments for policy and business

Version 1.0
December 2013

Report EUR 26379 EN

Joint Research Centre

European Commission
Joint Research Centre (JRC)
Institute for Environment and Sustainability

Contact information
David Pennington
Address: Joint Research Centre, Via Enrico Fermi 2749, TP 270, 21027 Ispra (VA), Italy
E-mail: lca@jrc.ec.europa.eu
Tel.: +39 0332 78 5880
Fax: +39 0332 78 6645
http://lct.jrc.ec.europa.eu/
http://www.jrc.ec.europa.eu/

This publication is a book coming out as Reference Report by the JRC of the European Commission.

JRC 85205
EUR 26379
ISBN 978-92-79-34880-8
ISSN 1831-9424
DOI: 10.2788/47216

Luxembourg: Publications Office of the European Union, 2013

Roadmap for the European Platform on Life Cycle Assessment: facilitating data collection and sustainability assessments for policy and business

Editors:

Simone Fazio, Marco Recchioni, Camillo De Camillis, Fabrice Mathieux, David Pennington.

Authors (alphabetical order) :

Karen Allacker, Fulvio Ardente, Lorenzo Benini, Camillo De Camillis, Simone Fazio, Malgorzata Goralczyk, Lucia Mancini, Rana Pant, Marco Recchioni, Serenella Sala, Erwin M. Schau.

SUGGESTED CITATION

European Commission. 2013. Roadmap for the European Platform on Life Cycle Assessment: facilitating data collection and sustainability assessments for policy and business. Simone Fazio, Marco Recchioni, Camillo De Camillis, Fabrice Mathieux, David Pennington, Karen Allacker, Fulvio Ardente, Lorenzo Benini, Malgorzata Goralczyk, Lucia Mancini, Rana Pant, Serenella Sala, Erwin M. Schau. European Commission, Joint Research Centre, Institute for Environment and Sustainability.

Contents

Executive Summary

After its debut in the European Commission's Integrated Product Policy[1] (COM (2003)302) as the "*best framework for assessing the potential environmental impacts of products*", Life Cycle Assessment (LCA) has become increasingly essential in support of community policies and business. Focus has been primarily on establishing agreed methods, both within Europe and internationally. The EC's European Platform on LCA has continued to address the equally essential issue of data availability, coherence, and quality assurance. This Roadmap document summarises the requirements of several key EC policy developments in the context of vital support needs from this Platform, presenting different options for further development.

LCA has become an important approach to boost smart, sustainable and inclusive growth in the EU. As an example, in the context of the Europe 2020 Flagship Initiative "A Resource Efficient Europe"[2], the European Commission developed its recommendations in the Single Market for Green Products Communication[3] for the Product Environmental Footprint (PEF) Guide and the Organisation Environmental Footprint (OEF) Guides[4]. These methodologies reflect a vital milestone in the aim to increase coherence and quality in the assessment of environmental performance of products and organisations, facilitating governments and business stakeholders in that sense. Other prominent applications include in support of the Waste Framework Directive, the Ecodesign Directive, EU Ecolabel and EU GPP, the Raw Materials Initiative, the Bio economy Strategy, as well as providing a more advanced basis for indicators and targets accounting for the burdens of EU imports and exports to help focus policies and research funding. Life Cycle Thinking is essential in modern decision making in business and policy. Commonly implemented through Life Cycle Assessment, it is increasingly necessary to quantify the benefits and burdens associated with products, both goods and services, that occur in their supply chains, during use, as well as at the end-of-their lives. This helps to avoid the shifting of burdens between different geographic regions and impacts.

Within this framework, the European Platform on Life Cycle Assessment (EPLCA), developed by the JRC, together with DG-Environment, represents the reference point for data and methods essential to implementing Life Cycle based approaches.. The Platform promotes the availability of data and information, with a focus on coherence and quality assurance.

Although methodology development is advancing fast, including the provision of authoritative requirements by the European Commission, the availability of coherent, quality-assured life cycle data and studies still represent a more major challenge to mainstream use of LCA and associated environmental footprint methods in business and in policy.

To date, the European Platform has facilitated several notable developments:

- The International Reference Life Cycle Data System Data Network (ILCD DN); to be launched in early 2014, aims at providing a globally usable infrastructure for consistent and quality assured life cycle data.
- The European Reference Life Cycle Database (ELCD); comprises of Life Cycle emissions and resource consumption Inventory (LCI) data from front-running EU-level business associations and other sources for key materials, energy carriers, transport, and waste management, to be used as source for secondary data.

[1] COM (2003) 302
[2] COM (2011) 21
[3] COM (2013) 196
[4] European Commission Recommendation (2013/179/EU)

- The International Reference Life Cycle Data System (ILCD) Handbook; is a series of technical guidance documents that provide practice-oriented guidance on LCA; providing a key input to the Environmental Footprint developments, as well as complementary support in relation to data and other application needs.
- The Resource Directory (RD); provides a structured repository for several types of life cycle-based documents and studies, as well as a world-wide list of life cycle support software packages and databases from suppliers/developers, and service providers.
- The Life Cycle Thinking (LCT) Forum; acts as reference point for scholars and practitioners to discuss and share experiences on methods, data, events, etc. This tool is expected to be revised and released as a structured online public forum in the near future, in order to facilitate topic-oriented information exchange.
- The Advisory Groups with business stakeholders and software developers; aim at improving the usefulness of the European Platform in the EU and international context, towards the agreement on common strategies and harmonisation.

Although a lot of work has been already done, there are still several bottlenecks preventing the Platform to effectively and efficiently meet the growing needs of policy makers and other stakeholders. Seeking for synergies among tools, improving transparency and consistency of data, and populating the ELCD and ILCD DN with new relevant data are just a few examples of further development necessities.

This Roadmap provides an overview of what would be required to further improve and best position the European Platform on LCA in relation to a selection of key on-going EC policy support activities required to facilitate environmental sustainability. The Roadmap specifies a number of action proposals. These actions are differentiated in the Roadmap in terms of time frame (i.e. short-mid-term describing circa 3 years starting from 2014, while the longer-term perspective represents a vision for the future evolution). Based on the availability of resources, three scenarios have been delineated to undertake to various extents these actions.

In short, the **first scenario** assumes **minor changes to the current resource availability**. This scenario would address only the most important needs, detected as transversal across the different EU projects and policies involved, including only the strictly necessary improvements.

According to the **second scenario**, slightly increased investments will be needed. Given the current situation, this scenario seems to be the **minimum-effort scenario to improve the Platform in a timely manner. This scenario entails, among others,** the expansion of the data and information support tools needed **to e.g. ensure the smooth implementation of the Environmental Footprint method; amongst other policy and business support needs of the community.**

With major additional investment into the Platform, very important goals could be achieved in a fast-track manner. Through this third scenario, **the Platform could become the most important reference point for all the life cycle based activities in the EU, facilitating interactions among stakeholders, policy makers and practitioners, and creating synergies for data exchange between the European Commission, other EU institutions, member-states and other non-governmental organizations.**

1. Introduction: objectives of this report and adopted method

Life Cycle Thinking (LCT) and LCA are the scientific approaches behind an increasing number of modern environmental policies and business decision support related to Sustainable Consumption and Production.

Life Cycle Thinking seeks to identify possible improvements to goods / services / systems in the form of lower environmental impacts and reduced use of the resources across all life cycle stages. Life-cycle assessment (LCA) is a process of compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle (i.e. the consecutive and interlinked stages of a product system, from raw material extraction, through production of materials and intermediates, parts to products, through product use or service operation to recycling and/or final disposal).

After its debut in the European Commission's Integrated Product Policy (COM 2003-302), as "*best framework for assessing the potential environmental impacts of products",* Life Cycle Assessment (LCA) has been increasingly used in support of EU policies. Since then, in fact, the use of LCA and other Life Cycle approaches has been increasingly advocated and/or adopted in a wide range of European Commission's policies. It was therefore announced that the Commission was to provide a platform both to facilitate communication on and exchange of life-cycle data, and to co-ordinate on-going initiatives on data collection and method harmonisation. To address this commitment, the Joint Research Centre, together with the DG Environment, launched the European Platform on Life Cycle Assessment (EPLCA). The Platform started in mid-2005. Later, the Sustainable Consumption and Production, and Sustainable Industrial Policy (SCP/SIP) action plan (COM 2008-397), raised a series of proposals on sustainable consumption and production that will contribute to improving the environmental performance of products and increase the demand for more sustainable goods and production technologies. It also seeks to encourage EU industry to take advantage of opportunities to innovate; again it was clearly stated that the life cycle approach is the best framework to pursue the expected objectives.

After the IPP Communication and the SCP/SIP action plan, several further policy documents have re-iterated these key messages including the recent Roadmap to a Resource Efficient Europe (COM 2011- 571) and the Resource Efficiency Flagship (COM 2011-21) as well as in the "Single Market for Green Products Communication" (COM 2013-0196) that led to the Product Environmental Footprint (PEF) and the Organisation Environmental Footprint (OEF) Guides (EC 2013). These methods are aimed to increase the coherence and quality in the assessment of environmental performance of products and organisations, facilitating governments and business stakeholders in that sense. The importance of the Life Cycle Thinking and Assessment has been also highlighted in the Waste Framework Directive (Directive 2008/98/EC), the Ecodesign Directive (2009/125/EC), the Raw Materials Initiative (COM 2008-699), and the Bio economy Strategy (COM 2012-60), to name a few. LCA is also aimed at providing a more advanced basis for indicators and targets accounting for the burdens of EU imports and exports to help focus policies and research funding.

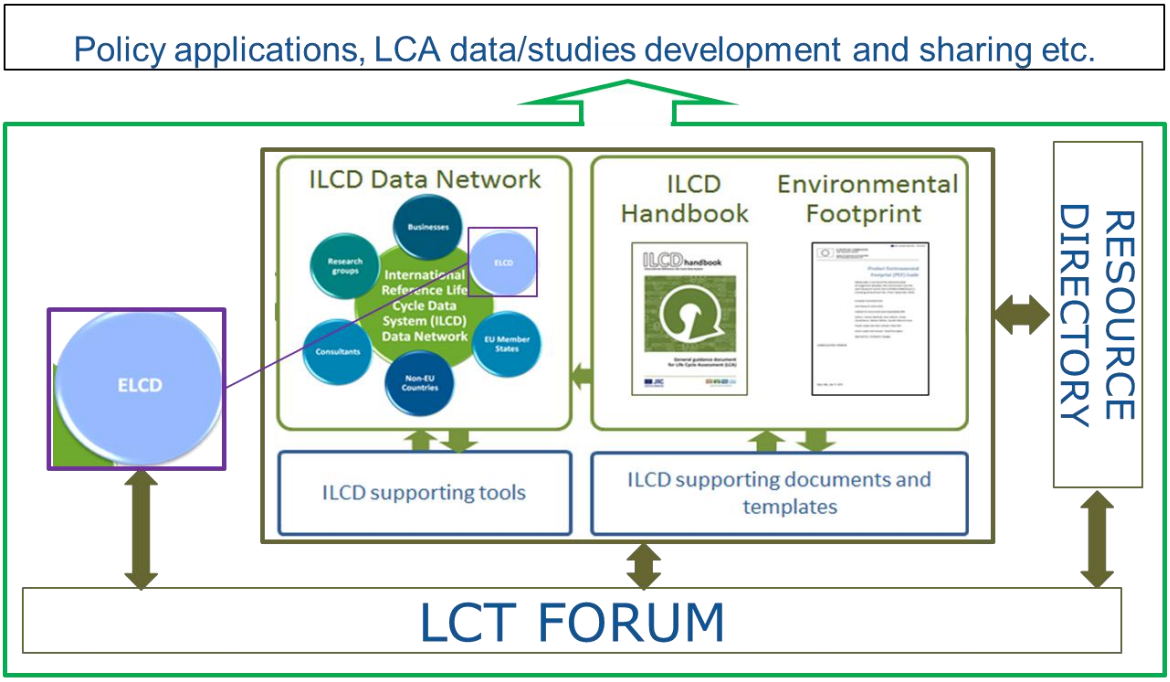
Such European activities are mirrored in many other 3rd countries, where EC services have often established related MoUs. Equally, a collaboration agreement was established with the United

Nations Environment program. Again, In the recent so called Rio+20 (UN, 2012) developments, it was clearly stated that is recognized "*the importance of adopting a life cycle approach and of further development and implementation of policies for resource efficiency and environmentally sound waste management*" and "*the importance of science-based assessments of the risks posed by chemicals to human beings and the environment …"* , furthermore, is encouraged *"life cycle assessment, public information, extended producer responsibility, research and development, sustainable design and knowledge-sharing, as appropriate"*. Interactions have similarly been ongoing with e.g. the UNEP/SETAC Life Cycle Initiative, providing a network and potential forum for leverage of national/European activities.

The common objective is to promote Life Cycle Thinking in business and in policy making in the European Union by focusing on underlying data and methodological needs. The EPLCA is to promote the availability of quality assured, life cycle based information on core products and services as well as reference methodologies. By doing this, the EPLCA raises awareness on Life Cycle Thinking and allows well-informed decision making.

This report provides an overview of what is needed to improve and further expand the EPLCA in relationship with the several on-going policy support activities on Life Cycle Thinking and Life Cycle Assessment . In particular it discusses the current and future links of the EPLCA with the Environmental Footprint, sectorial activities on "food and drinks", energy and raw materials, Resource Efficiency Assessment of product for product policies and Life Cycle Indicators,. In figure 1.1. the current status of the EPLCA is reported, including the available tools.

Figure 1.1. *Current structure of the European Platform on Life Cycle Assessment, see chapter 3 for further details. ILCD=International reference Life Cycle Data system; ELCD=European Reference Life Cycle Database, LCT= Life Cycle Thinking*



At present, amongst others, the following elements are supported via the European Platform on LCA: the International Reference Life Cycle Data System Data Network (ILCD DN) and the European Reference Life Cycle Database (ELCD), both aiming to ensure the availability/accessibility of consistent and reliable data. The Resource Directory (RD) is a structured repository for any type of LCA(e.g. Product Environmental Footprint studies, Environmental Product Declarations (EPD), LCAs according to ISO 14044, carbon footprint

studies, etc.), as well as a detailed world-wide list of Life Cycle based software packages and databases from suppliers/developers and service providers.

Under this framework, several actions and projects, both at the EU and international level, can be usefully linked to the EPLCA in a bidirectional way (i.e. both providing inputs such as datasets or studies, and taking information from the platform).

As a basis for this report and recommendations, the improvement options for the tools in the EPLCA were identified through a stepwise procedure: (a) Two workshops were held at the JRC in 2013 aiming at identifying the needs for improvement of the EPLCA. (b) A detailed analysis of **current and future needs** prioritized based on the relevance to key policy support projects, the current and forthcoming JRC work programme, the objectives of the 2020 EU Strategy, (c) a resource estimation which focused on how to effectively and efficiently address the needs identified in terms of method, human resources, and time.

Next Chapter will summarise the main findings of the analysis. Chapter 3 will present an overview of the current EPLCA. Chapter 4 will deeply analyses the current and future links of the EPLCA with several major European life-cycle based initiatives, while Chapter 5 exam nes the potential links with several other European and global initiatives. Chapter 6 finally discuss the current technical challenges (and associated solutions) linked to the interoperability of the EPLCA databases and LCA Software.

References

COM 2003-302 Integrated Product Policy - Building on Environmental Life-Cycle Thinking – Brussels 18-6-2003.

COM 2008-397 on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan – Brussels 16-7-2008

COM 2008-699 The raw materials initiative — meeting our critical needs for growth and jobs in Europe. Brussels 4-11-2008

COM 2011-21 A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy – Brussels 26-1-2011

COM 2011-571 Roadmap to a Resource Efficient Europe – Brussels 20-9-2011.

COM 2012-60 Innovating for Sustainable Growth: A Bioeconomy for Europe. Brussels 13-2-2102

COM 2013-0196 Building the Single Market for Green Products Facilitating better information on the environmental performance of products and organisations. Brussels 9-4-2013.

Directive 2008/98/EC of the European Parliament and of the Council on Waste and Repealing Certain Directives. 2008.

Directive 2009/125/EC establishing a framework for the setting of Ecodesign requirements for energy-related products. 2009.

Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Official Journal of the EU. 5-6-2009

Regulation (EC/66/2010) of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel. 2010.

EC 2013. European Commission Recommendation 2013/179/EU - on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. Official Journal of the European Union L124 Vol. 56. May 2013.

UN 2012. A/CONF.216/16 Report of the United Nations Conference on Sustainable Development. Rio de Janeiro, 22-6-2012.

UNEP - SETAC Life Cycle Initiative (2011). "'Shonan Guidance Principles' - Global Guidance Principles for LCA Databases."

2. Main findings and future needs

Based on the key policy support projects and activities described in the following chapters, several needs as well as possible links between the tools of the EPLCA and other topics were identified. The possible Platform development options are briefly described below in this subchapter, and the time horizon for the possible updates is outlined in chapter 2.2. As the time perspective is not the only factor limiting the action to be taken, even being a variable, the future improvements are related to the future availability of resources in section 2.3. Some scenarios with different allocation of resources are hypothesised.

2.1. Key Issues and frameworks for possible improvements

This section presents the key recommendations for each of the Platform tools. After the overall presentation of the EPLCA, the current 10 components of the EPLCA are presented grouped in five groups.

OVERALL ROLE OF THE EPLCA: The EPLCA is a commitment of the European Commission established in the IPP COM in 2003. This Platform plays an increasingly visible and vital role in support of many policy needs, particularly in the context of life cycle data without which many recommendations would fail or be of questionable coherence and quality. The above mentioned improvements are aimed to enforce the role of the tools in the EPLCA, in terms of visibility and acceptance by scientific community, policy makers and stakeholders. The long term perspective is to make the platform the official (and most important) reference frame for LC-based activities in the European context.

GUIDANCES

ILCD GUIDANCE/HANDBOOK: The ILCD Handbook was a commitment of the 2003 IPP COM, providing a key step towards coherence and quality assurance for many life cycle applications; including for the specific Environmental Footprint applications, but also for e.g. policy analysis. The ILCD Handbook now needs to be updated, with some sections to be aligned with other more recent EC policy documents. In the mid to long term new ILCD guidance may be defined, some new information may be integrated into the format such as the product classifications with the PRODCOM system, the ILUC effects accounted in the flow list, an updated guidance for data collection, etc.

IMPACT ASSESSMENT: Having collected emission and resource consumption data, this must be interpreted in the context of burdens (generally environmental, health, and resource related). The resultant indicators for a product can then be communicated and cross-compared in terms of e.g. person-equivalents through normalisation and decision support schemes such as weighting. An adequate number of geo-referenced datasets is also required, to support the development of consistent impact assessment methods. This is particularly the case to facilitate better consideration of inventory related to resources, as well as to ensure data are available for a more comprehensive list of impact categories and substances. The ILCD DN could be used in this context, but also considering carefully the need for data in a GIS format, etc.

DATA

EUROPEAN REFERENCE LIFE CYCLE DATABASE (ELCD): A reference database is essential for coherence and quality assurance. This is particularly the case for data used in a wide range of life cycle studies, such as for energy, and where these data are likely to have a significant influence on the outcomes of many assessments. Similarly, such a reference data source can be required in a policy support context, including in e.g. sector and product specific rules/applications. The need of new high quality datasets, especially for the so-called "secondary data", was hence pointed out several times. Thus new datasets on e.g. end of life scenarios, energy/transport, primary production, and raw materials may need to be developed and/or provided. This objective could be achieved through:

- The launch of so called "Calls for data"[5]
- Capacity building involving new members of e.g. an enhanced Advisory group

INTERNATIONAL REFERENCE LIFE CYCLE DATA SYSTEM DATA NETWORK (ILCD D N): A data network is essential for linking users to multiple sources of data, as well as promoting quality and coherence (through the so-called ILCD Data Network entry-level requirements). In order to increase the amount of data available through the ILCD DN new partners must be involved and invited to set up ILCD DN nodes (i.e. databases linked to the network). Considering current encountered hurdles, key actions to be taken are:

- Capacity building
- Supporting partners on acquiring related services
- Further development of dedicated software applications (e.g. Soda4LCA)

Nevertheless the possibility to set up new Data Networks enforcing other quality requirements (e.g. EF quality requirements) than the more general ILCD Entry-Level could be considered.

GOVERNANCE

ADVISORY GROUPS: Formal agreements have been established with 3rd countries, with key data providers from business, tool and database providers such as consultants, as well as with developers of impact assessment methods needed to provide indicators of burdens in life cycle tools. The relations between EC and advisory groups may be further enhanced, by planning at least one meeting per year with all the AGs, discussing the state of the art and upcoming development opportunities of the EPLCA, plus additional specific meeting where needed. Some new advisory groups with e.g. member states or EC-DGs may be created. A new Advisory Group on the Format might also be useful. It would be also useful to create a transversal AG for the general discussion on e.g. the future data provision on the ELCD.

KNOWLEDGE SHARING

RESOURCE DIRECTORY: A common repository of meta information on e.g. existing studies, tool and database, and other life cycle service providers remains vital. This includes identifying and promoting those that support compatibility with EC policy requirements. Some actions must be taken over a short-mid-term, to populate the resource directory to support policy needs for study results and for storage of EC financed studies. On this perspective should be enforced

[5] European Commission, Joint Research Centre, Institute for Environment and Sustainability (2012), ILCD Data Network and ELCD Database: current use and further needs for supporting Environmental Footprint and Life Cycle Indicator Projects.

the interaction with the AGs, and the interconnection between the RD and the other tools (e.g. cross links within the forum), the reviewer registry (e.g. the companies and the reference studies can refer to the content shown in the RD), and the ILCD DN. The interactions with other DGs on that sense may be explored.

EPLCA FORUM: A forum for announcements, making requests for e.g. specific data and studies to support various needs (for policy, business), as well as to exchange point of views in relation to scientific/technical requirements is essential. Almost all the activities related to the EPLCA may require, in the short-mid-term, the development of specific sections in the upcoming online forum. The tool could be also used as a permanent virtual meeting room (or different "rooms") for advisory groups (restricted areas), and to interlink the activities of the users within the other tools (e.g. some links to the publications in the RD or to the reviewer registry profile, directly accessible from the user's profile in the forum)

REVIEWER REGISTRY: Review of studies and data sets in relation to authoritative requirements is essential for quality assurance, as well as potential policy-specific verification needs. Based on the upcoming and future development on LC-based methods, the reviewer registry may be further developed, allowing the possibility to add different nodes of reviewers (e.g. one node for reviewers quality required by the ILCD, by the EF, etc.)

IT TOOLS

FORMAT AND NOMENCLATURE HARMONIZATION: To use life cycle data from different sources, as well as to promote availability and quality assurance, a common format and nomenclature are essential. In a potential agreement with the Platform advisory groups, a common strategy may be adopted to solve the problems related to the remaining differences among ILCD requirements and other existing schemes adopted by database developers. Common nomenclature should be developed and adopted, slightly updating the ILCD data format. This goal should be achieved by:

- Establishing working group involving at least UNEP (as a probable lead), Advisory Groups and main data providers defining a common Nomenclature
- Developing consistency checking tools
- Establishing a permanent steering committee for nomenclature maintenance, as well as further interacting with key stakeholders to promote/maintain a common format.

FORMAT: A converting tool allowing the conversion from ILCD to other formats and vice versa is needed, over the mid-term, to ease the transfer of data between tools and databases that remain incompatible with the ILCD format, towards the long-term perspective to adopt a unique format at least at the EU level.

2.2. Summary tables

The following table summarizes the possible updates for the EPLCA, based on the needs that emerged from the analysis of several key policy support activities. The recommendations and the time horizons are indicative, with the effective possibility to achieve the targets being dependent on resources from different EC sources. The time horizon table has been kept separated from the resource availability, in order to point out what can be achieved in the short-mid-term, and what can ONLY be achieved over a longer term perspective, irrespective of the level of resources involved.

EPLCA tools	Current status	Short-mid-term potential updates	Longer term potential updates
ILCD Data Network ILCD method/ handbook	- ILCD entry level compliance - limited number of nodes (databases) - ELCD included as a node	- Increase the number of nodes in the ILCD DN by: - Increasing project visibility - Increasing relations with stakeholders - Capacity building - Supporting partners on acquiring IT related services - Support member states to set up specific nodes for national DBs - Set up sectorial nodes/datasets for e.g. PEF, PEFCR, FRT, Indicators, and other DG interests - Conduct a series of case studies to revisit guidance for policy making (see ILCD Handbook Situation B) - Review entry level requirements - Update of ILCD recommendations on LCIA - Analysis on how to store of LC-indicators and normalization factors with the ILCD format - support the LC-data storage for EC-related activities with the ILCD DN (E.G. specific nodes for other DGs) - Investigate optimal level of details of average LCIs data for (agri-food sector, raw materials, recycling processes) - Update the characterization factors according to the new methods. - explore the possibility to create a steering committee for the update of the ILCD handbook	- Review of the compliance rules Establishment of new DN enforcing other quality requirements (e.g. EF quality requirements) than the ILCD Entry-Level - Support the improvement of LCIA methods, creating a network for characterization factors and geo-referenced inventory/impact data - storage of LC-indicators and normalization factors - Set up a Life Cycle Indicator DN allowing the upload and use of country-specific datasets - Integration of spatially resolved characterisation factors for LCIA - Set up a steering committee for the regular update of the ILCD handbook
ELCD	- 350 datasets, most of them ILCD-Entry-Level compliant - dataset derived both from software and database developers and Business stakeholders	- maintenance of the ELCD - increase the number of datasets prioritizing the secondary data supporting projects included in this document (Energy, transport, raw material extraction/production, EoL treatments). - Launching “calls for data” for the development of selected datasets - increase the share of data in the ELCD being provided via the ILCD-DN by: - reviewing more datasets against the ILCD Entry-Level requirements - increasing reliance of ELCD reference data on data quality criteria supporting current partners - set up a virtual ELCD (separate DN) supporting and stimulating current partners on setting up nodes - Further develop hierarchies within the ILCD DN to promote e.g. ISO compliant and PEF compliant data, etc. - reviewing some ELCD datasets against the PEF requirements	- Completely discontinue non ILCD-EL compliant Data - integrate the JRC activities with other environmental databases, with different level of compliance and approaches. - eventually adopt EF compliance, and/or set up a specific EF ELCD virtual database

EPLCA tools	Current status	Short-mid-term potential updates	Longer term potential updates
Resource Directory	- New provider's section (tools/DBs developers and suppliers, and service providers) available (self-managed by users) - new study section upcoming in 2013 (new templates for EF, EPD, Eco design and Category Rules) - advanced search tool upcoming in 2013	- Populate the RD including publications related to EC projects (both internally and externally funded), starting with few pilot cases collaborating with specific EC institutions - Keep the templates up to date, according with the evolution of methods/services/tools, insert a repository for studies on characterization factors. - explore possible inter-links among RD and other tools (e.g. direct link to the DN, shortcuts with the forum, etc.) - Create a section of reviewed studies, supplying data where the databases are lacking (e.g. for innovative technologies, data not stored in the other templates like e.g. ILUC values) - Further develop hierarchies to promote information and support in relation to PEF needs, ISO, etc. -support knowledge sharing among LCA practitioners of UN countries by storing reports/publications.	- maintenance and improvement of the templates according to the new needs e.g. specific templates developed together with different EC institutions, for specific frameworks/activities. - explore the possibility to store ALL the publications related to EC projects, concerning LC aspects.
Forum	- Mailing list managed by JRC H08 unit, mainly related to the news (projects, publications etc.)	- set up a real online forum, including different sections/topics, related to EC and external activities - Moderation of each section based on the know-hows within (and outside?) JRC sustainability assessment unit - Dedicate a section of the forum to LCIA, development and characterization factors implementation	- Maintenance and improvement according to the new needs. - interlink with RD and ILCDDN/ new DNs - LCT Forum established as the main EC source for supporting product policies and LC related research
Reviewer Registry	-Prototype, not disclosed, including the ranking of reviewers based on the requirements of the ILCD handbook	- Release the tool online, without ranking, but including the relevant info - encourage the setup of new nodes (e.g. national, sectorial, etc.) managed by third parties - further test and develop screening information for identifying relevant reviewers based on their experience. - check multi-language capacity	- Set up new registries based on the different requirements (e.g. EF-compliant reviewers) - interlink the registry with the other tools (e.g. the profiles of reviewers may be linked with his reviewed datasets in the DN, his forum profile, published studies in the RD, etc.)
Advisory Groups	- Selected AGs (software, LCIA, business, UNEP, MSs.) - Meetings regarding the status and needs of the EPLCA	- Review the MoUs (current versions have expired) and establish new streamlined basis for groups - set up new rules/groups, for a wider and easier participation particularly from business associations - set up a restricted area in the forum, accessible only by the authorized members of AGs	- Set up an enlarged (transversal) AG for providers of datasets focused only on ELCD or virtual ELCD. - Regularly update the MoUs and access rules, basing on the future needs.
Data format and nomencla ture	- ILCD format available (free) in XML format - the technical specification (document) for the development of a converting tool is ongoing	- Advance further key stakeholder discussions and international interactions to solve other format and data related issues for coherence and quality assurance as well as data accessibility. -Establishment of a working group on adopting common a nomenclature through interactions with key stakeholders and via e.g. international groups involving UNEP- Establishment of an open source project to improve/update the ILCD format - launch a contract (IT development) for the creation of a converter (other formats to ILCD and vice-versa)	- Regularly update the converter according to the needs. - Try to make the ILCD format, nomenclature, and other common requirements the official (unique?) format, at least at the EU level; perhaps through e.g. a CEN mandate or stronger links to e.g. PEF or other technical specifications/ recommendations from the EC.

2.3 EPLCA improvement depending on resource availability

Based on the needs from different projects, some possible scenarios have been identified as regards the potential short-mid-term development (i.e.~ 3 year time horizon). The possibility to deliver the actions mentioned in each scenario substantially depends on the available resources.

The resources needed over a longer term perspective cannot be evaluated so far, as they are strictly dependent on the advances made over the short-mid-term.

- Realistic scenario RS: based on minor changes on the resources (human and budget) availability for the EPLCA developments (some variants could be considered between internal staff and external support).

- Increased Resources 1 (IR1) scenario: based on a realistic-optimistic scenario e.g. including additional (i.e. almost doubling the current availability) resources from either institutional or competitive projects (e.g. a dedicated administrative arrangement or other competitive resources).

- Increased Resources 2 (IR2) scenario: based on an optimistic scenario including major additional resources (i.e. almost tripling the current availability) from either institutional or competitive projects (e.g. a dedicated administrative arrangement + other competitive resources).

In the following tables are listed the possible achievements based on the different availability of resources; see the paragraph above for abbreviations and explanations on resources availability.

Scenario	Possible actions/updates
RS (minor changes to current resources)	- **ILCD Data Network:** gradually (e.g. 2-3 per year) increase the number of nodes by third parties (i.e. members of the advisory groups). - **ILCD Handbook:** review the entry level requirements. - **ELCD:** keep the dataset up to date, slightly increase (e.g. by 20% compared to the current situation) the availability of datasets not available in the ILCD Data Network including raw material production processes and EoL-related unit processes. - **Resource Directory:** keep the templates up to date according to the evolution of methods/service/tools, explore the possible interlinks with other tools (e.g. direct links from the forum and the reviewer registry) and try to activate at least one of it. - **Forum:** set up a new online forum including only sections related to the JRC-H08 unit projects/activities/topics, moderation of the forum led by JRC-H08 unit only. - **Reviewer Registry:** release the tool with the ILCD entry level registry at least, including the relevant info (e.g. years of experience, sector, reference publications, personal info etc.) - **Advisory Groups:** Review the current Memorandum of Understanding, organise at least one biannual meeting with all the AGs + dedicated additional meeting where necessary. - **Data Compatibility:** IT contract for the creation of a format converter (with current resources only between ILCD and ONE other format), harmonization of the nomenclature within the datasets (defining operational framework and rules). update the format with the basic needs (e.g. product codes)
IR1 (additional resources)	- **ILCD Data Network:** significantly (e.g. 4-5 per year) increase the number of nodes by third parties (i.e. members of the advisory groups, and other stakeholders), Review the Entry Level DQR (converging with EF), update the format with the basic needs (e.g. product codes), support the EC-related activities with specific nodes (i.e. managed by other DGs), storage of normalization factors within the DN. - **ILCD Handbook:** Review the Entry Level Requirements, update the recommendation on LCIA. Conduct a series of case studies to revisit guidance for policy making (see ILCD Handbook Situation B) - **ELCD:** keep the dataset up to date; significantly increase the availability of datasets not available in the ILCD Data Network for Raw Materials, EoL scenarios, Energy, Transports. The aim is to increase (at least) by 50% the current number of datasets available. - **Resource Directory:** keep the templates up to date according to the evolution of methods/service/tools, set up the interlinks with other tools (e.g. direct links from the forum, the reviewer registry, ILCD DN), Open dedicated sections (at least 2) for the upload of documents related to EC Projects/activities. - **Forum:** set up a new online forum including sections related to the key EC projects/activities/ topics, moderation by JRC H08 unit + people from other EC institutions, for their specific sections. Set up a virtual meeting room for the advisory groups' discussions/activities, not disclosed to the public. - **Reviewer Registry:** release the tool including the relevant info (e.g. years of experience, sector, reference publications, personal info etc.), set up different registries with specific requirements (e.g. ILCD Entry Level, EF), the aim is to set up at least 2 different registries (e.g. for ILCD and EF), each with different nodes. - **Advisory Groups:** Review the current Memorandum of Understanding, organise at least one annual meeting with all the AGs + dedicated additional meeting where necessary, set up new rules (e.g. avoiding in some case the signature of MoU), and build new groups (e.g. EU member states, EC-DGs), basing on the needs of the other tools in the platform (e.g. specific sectorial data providers, etc.). - **Data System:** IT contract for the creation of a format converter (between ILCD and 2 other formats) also for LCIA methods, harmonization of the nomenclature within the datasets (defining operational framework and rules, developing guidance tools for the development of new tools, adopting a multi-mapping tool dependent on nomenclature), update of the ILCD format including to account for emerging requirements such as LCIA and geo-referencing.

Scenario	Possible actions/updates
IR2 (major additional resources)	- **ILCD Data Network:** quickly (e.g. 6-7 per year) increase the number of nodes by third parties (e.g. members of the advisory groups, member states, DGs, and other stakeholders), Review the Entry Level DQR (converging with EF), update the format with the basic needs (e.g. product codes), support the EC-related activities with specific nodes (i.e. managed by other DGs), set up sectorial nodes enlarging the participation of new associations to the AGs (e.g. farming practices, processed food, renewable energy, production of raw and refined materials, emerging products, hazardous substances etc.), storage of LC-indicators and LCIA + normalization factors within the DN - **ILCD Handbook:** Review the Entry Level Requirements; update the recommendation on LCIA and new rules for the update of characterization factors, set up a permanent steering committee for the continuous update of the handbook. - **ELCD:** keep the dataset up to date, significantly increase (almost doubling) the availability of datasets not available in the ILCD Data Network for Raw Materials, EoL scenarios, Energy, Transports; shift to EF compliance or set up a specific EF ELCD, go towards a virtual ELCD with free data provided and self-managed by third parties. - **Resource Directory:** keep the templates up to date according to the evolution of methods/service/tools, set up the interlinks with other tools (e.g. direct links from the forum and the reviewer registry), Open a dedicated section for the upload of documents related to EC Projects/activities, create a section of reviewed studies, prioritizing those related to data not available in the Data Network (e.g. innovative technologies). Set up a section for the storage of LCIA methods. - **Forum:** set up a new online forum including sections related to the key EC projects/activities/ topics, + other EU and non EU related. Moderation by JRC H08 unit + other EC institutions + external companies/institution, set up of virtual meeting rooms for the advisory groups and other online discussion activities, not disclosed to the public (could be used by e.g. other DGs for related projects). , interlinks with all the tools available on the platform, create dedicated sections for the continuous discussion on LCIA methods and Characterization Factors. - **Reviewer Registry:** release the tool including the relevant info (e.g. years of experience, sector, reference publications, personal info etc.), set up different nodes with specific requirements (e.g. ILCD Entry Level, ILCD-Full, EF), within the nodes set up sub-groups by nationality/geographic area, managed at national/regional level (interaction with Member States), interlink the info in the RR with other tools (e.g. publications on the RD, specific topics on the forum, etc.). - **Advisory Groups:** Review the current Memorandum of Understanding, organize at least one annual meeting with all the AGs + dedicated additional meeting where necessary, set up new rules (e.g. avoiding in some case the signature of MoU, and build new groups basing on the needs of the other tools in the platform (e.g. specific sectorial data providers, etc.), restricted discussion areas online (see the "forum" paragraph above), set up an enlarged AG of ELCD Data providers. - **Data Compatibility:** IT contract for the creation of a format converter (among ILCD and the major formats used at EU and international level) also for LCIA methods, harmonization of the nomenclature within the datasets (defining operational framework and rules, developing guidance tools for the development of new tools, adopting a multi-mapping tool dependent on nomenclature), update of the ILCD format, creation of a steering committee for the maintenance and update of the flow list and nomenclature rules.

3. Overview of the EPLCA

3.1. European reference Life Cycle Database (ELCD)

Since its first release in 2006, the ELCD (European reference Life Cycle Database[6]) has been including Life Cycle Inventory (LCI) data from front-running EU-level business associations and other sources for key materials, energy carriers, transport, and waste management. Most of the respective datasets are officially provided and approved by the named industry associations. Some datasets (i.e. those concerning the energy and transport sectors) come from a commercial database. After the first update, the ELCD II provided LCI data for more than 300 processes, and in the last version (ELCD III) the number of processes raised to over 400. Furthermore, many datasets have been revised, and some others are under review against the ILCD Entry Level requirements, enabling to set up an ELCD node as part of the ILCD Data Network, to be launched in 2013. This review against the ILCD Data Network Entry-Level requirements has been run to provide users with useful information on data quality, including minimum documentation and methodological consistency across datasets. The release of the ELCD datasets compliant with the ILCD Entry-Level requirements should enhance dataset quality.

Possible options for the future:

- Keep the ELCD as it is (managed by JRC) trying to regularly update/increase the datasets, giving the priority to secondary data;
- Set up a virtual ELCD with nodes that are self-managed by data providers, with support of the JRC on the methodological framework, with quality requirements to be defined
- Exclude all ELCD datasets that are not compliant with the ILCD entry level requirements.

3.2. International reference Life Cycle Data system (ILCD) Handbook

The ILCD Handbook was developed by the Institute for Environment and Sustainability of the European Commission Joint Research Centre (JRC), in co-operation with the DG Environment, and released between 2010 and 2013 (EC-JRC 2010-2013). The ILCD Handbook consists of a set of documents, based on the international standards on LCA (ISO 14040/44), providing a detailed guidance on several aspects related to the LCA activities, supporting policy and business.

Released in 2010, the "ILCD Handbook - General guide for LCA" is the ILCD Handbook document providing detailed guidance on how to conduct internally-consistent LCA studies. More specifically, technical guidelines are distinguished in such document according to the specific application context concerned. Application contexts as well as guidelines are grouped in the following four situations (i.e. A, B, C1 and C2): Situation A refers to product or process-related decision support studies; Situation B to strategic ("policy") decision support studies; Situation C1 and C2 both refer to monitoring studies. However, while Situation C1 adopts the same approach to solving process multi-functionality as in Situation A, (so allocation is largely avoided), Situation C2 always relies on the allocation technique.

[6] http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm

This general guide is complemented by a few other ILCD Handbook documents covering specific aspects of LCA e.g. generation of datasets, impact assessment, characterization factors and qualification of reviewers, as well as instructions for nomenclature and other conventions, and Entry Level Requirements (i.e. the minimum level of compliance requested for entering data in the ILCD DN).

Guidance for Situation A in the "ILCD Handbook – General guide for LCA" is essentially replaced now by the Product and Organisation Environmental Footprint Guides (see chapter 4.1).

Similarly, Guidance for Situation C1 has been further developed when life cycle based indicators were derived (see chapter 4.6).

How to best assess future-oriented scenarios with LCA has been recently discussed in a dedicated workshop (De Camillis et al. 2013). A wide range of LCA data modelling approaches, including some newly-developed ones, have been reviewed to highlight their features and figure out where they best fit in policy making processes. Building on the outcomes of this workshop, Guidance for Situation B in the "ILCD Handbook – General guide for LCA" may change in the near future.

Possible options for the future:

- Keep the ILCD handbook as it is, keeping separate the ILCD compliance from other methods ;
- Try to expand/modify some parts of the Handbook, based on the upcoming needs.
  - The upcoming needs related to the development of new methods (e.g. the Environmental Footprint - see chapter 4.1), may require some minor modifications of the ILCD Handbook, especially those related to the Entry Level Requirements, in order to ensure an adequate level of compliance of data.
  - To best screen the potential of the LCA data modelling approaches presented in the expert workshop (De Camillis et al., 2013), a series of case studies may be conducted. Building on the learning from these case studies, Guidance for Situation B in the "ILCD Handbook – General guide for LCA" may be updated.
- Set up a permanent steering committee, involving e.g. the advisory groups, in order to constantly update and review the ILCD Handbook;

3.3. Life cycle impact assessment

In the context of the ILCD Handbook, guidance document on Life cycle impact assessment has been released (EC-JRC 2010-2013)The document list recommended impact assessment methods for several impact categories at midpoint and endpoint, namely: climate change, ozone depletion, photochemical ozone formation, respiratory inorganics, ionizing radiation, acidification, eutrophication, human toxicity, ecotoxicity, land use and resource depletion. Current methods are reported with three levels of recommendations, reflecting the robustness of methods and associated characterization factors.

Within this context, the methods development is advancing fast, thus a list of recommended Life Cycle Impact Assessment methods, suggested by the European Commission, can ensure a coherent background for life cycle based activities for business and in policy.

The ILCD recommended methods are mainly at midpoint and additional effort is needed for updating current midpoint recommendations and overcome the limitation of endpoint methods. Besides, many new methods, in some case spatially resolved, are currently developed in the scientific community and may represent a crucial contribution to future updates (Sala et al. 2012).

Possible options for the future:

- Update of current recommendation for reflecting scientific advancement and international consensus on methods, with regards of midpoint and endpoint.
- Set up of a procedure for updating of characterization factors in specific cases, such as the release of new factors by the method's developers or the inclusion of new flows/substances.
- Implementation and expansion of spatially resolved characterization factors
- Creation of a section of the forum dedicated to discussion on the impact assessment methods
- Integration of source of the impact assessment methods in the resource directory

3.4. International reference Life Cycle Data system (ILCD) Data Network

The ILCD Data Network (ILCD DN) intended to be launched in early 2014, aims at providing a globally usable infrastructure for consistent and quality assured LCA data (i.e. Life Cycle Inventory (LCI) and Life Cycle Impact Assessment (LCIA) datasets) from different organisations. It is a web-based infrastructure to ensure LCA data are easy to access via searches, filtering, and sorting, and, thus, it helps reducing assessment cost overall.

The provision of authoritative requirements by the European Commission, may lead to the availability of coherent, quality-assured life cycle data and studies is aimed to harmonize the LCA and the environmental footprint methods in business and in policy.

Currently, the network is working and any data provider from any country can join. The datasets in the web-based, non-centralized network may come from any data developer/owner/provider, e.g. industry, single organizations, national and international LCA projects, research groups, and consultants. The data will be published by the developer/owner/provider under its own conditions (e.g. free-of-charge, for fee, via registration).

Metadata on datasets are to be left accessible by anyone. Yet, data on input and output flows can be offered free-of-charge, for fee, for members only, etc. Businesses, governments, academia, and consultancies can hence provide their data to this decentralized network, based on their own licensing and financial conditions. The ILCD Data Network is hence designed as "yellow pages" for life cycle data.

Dataset quality within the ILCD DN is ensured through the ILCD Entry-Level requirements (European Commission, 2010). The compliance with these requirements is a pre-requisite for the registration to the ILCD DN.

The ILCD DN, currently in beta-testing phase, is expected to be launched in the next months. The ILCD DN will be then further expanded, with more nodes and more quality-assured datasets to be registered into the Data Network.

Possible options for the future:

- Keep the ILCD DN as it is, and make efforts to expand the number of datasets;
- Make efforts to set up new DNs with different DQRs, in order to capture more datasets;
- Revise the review process of datasets, allowing to quickly review large sections of databases, and hence increase the data availability in the ILCD DN;
- Set up specific nodes for LC-related activities of other EC institutions, with JRC support.

3.5. Resource Directory

The Resources Directory (RD) (Sanfelix et al. 2011) which has been online since 2006, contains structured and comprehensive pieces of information on: the services provided e.g. by consultants or research organisations on LCA and LCA-related tools; software packages (e.g. LCA and ecodesign tools); databases (e.g. Life Cycle Inventory (LCI) databases); and links to the corresponding developers/providers worldwide. The scope of the RD has been expanded in 2012 in order to include a section on LCA studies where users are allowed to upload their own studies. All studies in this section are characterised according to e.g. goal and scope, inventory modelling, results, review, and compliance.

The RD is currently under improvement. Both the LCA studies and contributors' section are being updated with new functionalities. In particular, for the contributors' section, the users (i.e. developers and suppliers of Life-Cycle based tools and databases, and providers of LCA services) will be able to register and directly manage their own info (e.g. contacts, tools and database releases and functionalities, descriptions, etc.). The LCA studies' section will be expanded (currently, it is under development) with some additional new templates for uploading documents (i.e. for Ecodesign, Environmental Footprint, and a dedicated section for the category rules, or product criteria under the different methodologies). Also, the embedded search tool will be enhanced in order to let the user search through the characterizing parameters of the studies.

Possible options for the future:

- Keep the structure as it is, trying to expand the number of studies / providers available in the RD
- Set up new templates for studies, adapted to different methods (prioritizing those related to EC-EU activities).
- Revise the structure of the contributors' section, based on the needs of stakeholders (e.g. introduce a distinction between general or sector-specific tools/databases, add new kinds of services, etc.)

3.6. EPLCA Forum

The EPLCA forum is now structured as a periodical newsletter, facilitating interactions among the users registered to the specific service. However, a new overall structure of the forum is currently under development. The new structure will be organised as an out-and-out online discussion site where people can hold conversations in the form of posted messages. It will be hierarchically ordered and will contain a number of sub sections on different LC-related issues, each of which may have several topics. Some additional functionalities will also be implemented (e.g. the automatic RSS feed that will alert the users via e-mail, once a specific thread is updated or replied). The forum is expected to act as reference point for scholars and

practitioners to discuss and share experiences on methods, data, events, etc., but also as a virtual meeting room for LC-related topics for business stakeholders and policy makers (including areas with restricted access only for specific users), .

Possible options for the future:

- Set up the forum and leave it just open to external contributions;
- Create and manage a community of users of EPLCA tools, animating the discussions with specific topics, updating it regularly, and allowing external contributors to expand it.

3.7. Reviewer Registry

Until now a Reviewer Registry was unavailable, but a prototype is currently under discussion among JRC staff and the EPLCA advisory groups. This Reviewer Registry is designed to provide information about reviewers (e.g. their expertise, knowledge and other relevant info). Based on the entries, a score is assigned to each reviewer. This helps users identify the potential appropriate reviewer(s) for their LCA Studies. The current prototype of the Reviewer Registry builds on ILCD requirements, and the nodes (i.e. the subsets of the Registry) are only based on the nationality of reviewers.

Possible options for the future:

- Set up a single central Reviewer Registry (based on the current prototype) allowing to set up national nodes each of which containing a ranking of reviewers based on their experience;
- Set up a more structured Reviewer Registry, allowing advanced search among nodes by nationality, sector, methodology, etc. including only the “compliant” reviewers within the nodes, without ranking;
- Set up a specific node within the Reviewer Registry indexing the reviewers qualified for reviews of Environmental Footprint (EF) studies.

3.8. Advisory Groups

The EPLCA is in contact with some advisory groups (i.e. software developers and database providers, business associations, developers of LCIA methods and standards, and extra-EU stakeholders/institutions). The interaction between the JRC and advisory groups plays a relevant role for the further development of the EPLCA. The consultation of the advisory groups is indeed deemed necessary in order to enhance the usefulness of the EPLCA in the EU and international context. Under this framework the future role, governance and planning of the activities of the advisory groups need to be planned according to the needs pointed out in this report. The future perspective of the aspects related to the Advisory Groups will be discussed directly in the following chapters.

References

De Camillis, C., Brandão, M., Zamagni, A., Pennington, D. (2013) Sustainability assessment of future-oriented scenarios: a review of data modelling approaches in Life Cycle Assessment. Towards recommendations for policy making and business strategies. European Commission, Joint Research Centre, Institute for Environment and Sustainability, Publications Office of the European Union, Luxemburg.

European Commission, J. R. C., Institute for Environment and Sustainability (2010). International Reference Life Cycle Data System (ILCD) Data Network, Compliance rules, Entry-Level requirements.

European Commission, J.R.C., Institute for Environment and Sustainability (2010-2013): International Reference Life Cycle Data System (ILCD) Handbook General guide for Life Cycle Assessment (several handbooks, including those on Life cycle impact assessment) available at http://lct.jrc.ec.europa.eu/assessment/publications

Javier Sanfélix, F. M., Cristina de la Rúa, Marc-Andree Wolf, Kirana Chomkhamsri (2012). "The enhanced LCA Resources Directory: a tool aimed at improving Life Cycle Thinking practices." International Journal of LCA 18: 273-27

Sala S.; Pant, R.; Hauschild, M.; Pennington, D. (2012) Research Needs and Challenges from Science to Decision Support. Lesson Learnt from the Development of the International Reference Life Cycle Data System (ILCD) Recommendations for Life Cycle Impact Assessment. Sustainability, 4:1412-1425 doi:10.3390/su4071412 http://www.mdpi.com/2071-1050/4/7/1412

4. Analysis of key EC activities in relation to life cycle support needs from the EPLCA

4.1. Environmental Footprint

The European Commission has developed a set of methods to calculate the Environmental Footprint of Products (PEF) and Organizations (OEF)[7].

General introduction

The "Roadmap to a Resource Efficient Europe" (EC 2011) proposes ways to increase resource productivity and to decouple economic growth from both resource use and environmental impacts, taking a life-cycle perspective. One of its objectives is to: "*Establish a common methodological approach to enable Member States and the private sector to assess, display and benchmark the environmental performance of products, services and companies based on a comprehensive assessment of environmental impacts over the life-cycle ('environmental footprint')*".

In April 2013, the European Commission published its Communication "Building the Single Market for Green Products" (EC 2013b), and related Recommendation on "the use of common methods to measure and communicate the life cycle environmental performance of products and organisations" (EC 2013a). Annex II of this Recommendation is the PEF Guide and annex III is the OEF Guide. These are translated into more than 20 European languages and are due to be of increasing relevance in the coming years.

The aim of the EF is to provide more comparable and reliable environmental information in order to build confidence for consumers, business partners, investors and other stakeholders. It should provide the basis for addressing the current confusion of environmental sustainability claims. The EF Guides give precise technical guidance on amongst others the choice of impact categories, type of data to be used and data quality requirements. To further increase the reproducibility, quality, consistency, and relevance of EF studies, PEF category rules (PEFCR) and OEF sector rules (OEFSR) will be developed from autumn 2013 onwards. PEFCRs and OEFSRs are a necessary extension of and complement to the more general EF Guides and are required for business-to-business (B2B) and business-to-consumer (B2C) communication intended to be used for comparisons/comparative assertions.

Possible links to EPLCA

The EPLCA can play an important role in supporting PEF/OEF studies and vice versa regarding the following issues:

- as a repository of PEF/OEF studies, PEFCRs and OEFSRs in its enhanced RD,
- by providing high quality generic data (ILCD DN and ELCD) in support of modelling background systems.

[7] http://ec.europa.eu/environment/eussd/smgp/index.htm

These links will become even more relevant with the upcoming development of product group specific (Product Environmental Footprint Category Rules – PEFCRs) and sector specific (Organisation Environmental Footprint Sector Rules – OEFSRs) rules.
PEFCRs and OEFSR will specify data needs for foreground and background processed together with related specific data quality requirements. PEFCR and OEFSRs will also define benchmarks based on a representative product, which will require the provision of data for creating a model of a representative product.

Data quality requirements

There are nine data quality criteria for PEF and OEF studies. These can be divided into two types: qualitative and semi-quantitative data quality requirements. The following qualitative data quality requirements need to be fulfilled (i.e. "shall" requirement): (1) documentation (ILCD Format); (2) ILCD nomenclature; (3) review. The ILCD format and ILCD nomenclature are specified in the ILCD Handbook (EC 2010).The semi-quantitative data quality requirements comprise the following: (4) technological representativeness (TR); (5) geographical representativeness (GR); (6) time-related representativeness (TRR); (7) completeness; (8) parameter uncertainty; and (9) methodological appropriateness and consistency (see EF guidelines for further details: EC, 2013a) .
LCI datasets in the ELCD are due to gain higher quality and consistency with general rules in the PEF Guide when PEFCRs are developed and become available. PEFCRs are, in fact, due to prescribe specific methodological approaches which will have to be reflected in the LCI datasets.

Environmental Impact assessment

The PEF and OEF Guides require the use of 14 environmental impact categories and the impact assessment methods (with corresponding indicators and characterization factors). It will be important for the EPLCA to ensure compliance. For instance, this implies that datasets in the ELCD and ILCD DN include the necessary flows to calculate the indicators of the 14 PEF/OEF impact categories.

The two impact categories "*land use"* and "*resource depletion, water"* are currently recommended by the ILCD, but they are to be applied with caution (level III) (ILCD 2011). Both land use and water-related impacts are, in fact, highly dependent on where the impact occurs (opposite to e.g. global warming). This also applies to other impact categories such as acidification and terrestrial eutrophication. Therefore, geographic differentiation can be important for further increasing relevance and robustness of assessments. If this differentiation will be made in future updated environmental impact assessment models (with regional or local characterization factors), then regional or local emissions and resource consumption data may be necessary. As result, this might require additional data and information on the inventory side, and hence all datasets in the ELCD and ILCD DN would need to be updated accordingly.

The PEF and OEF Guides also allow to add additional environmental impact categories and/or to use additional impact assessment models for the 14 default impact categories when relevant. It is hence recommended to include all known emissions, resource use, and other environmental impact for the processes.

End-of-life (EoL) modelling

EoL treatment options considered in the PEF/OEF method include options like e.g. (partial) re-use, material recycling, energy recovery and disposal. The EF method provides a single EoL formula applicable for both open-loop and closed-loop recycling; and can accommodate both the recycled content on the input side (R_1) and recyclability rate at the output side (R_2).

The single EoL formula uses a 50/50 approach for distributing the impacts of the processes linked to EoL co-products. This 50/50 approach has consequences on the LCI data. In order to apply the 50/50 modelling approach, specific LCI data are needed relative to virgin materials, recovery and recycling. This means that, in order to use the abovementioned formula, from-cradle/gate-to-gate LCI data are needed for: the production of 100% virgin material and the production of 100% recycled material. Equally, from-gate-to-gate LCI data are needed for each possible EoL process such as e.g. different energy recovery operations, different biological and chemical treatment facilities and different types of landfills. It is hence important that such datasets are made available in the ELCD and ILCD DN. Currently, the available LCI data of material production and EoL processes do not fit for the purpose of the PEF/OEF because these are often representative of specific market mixes (e.g. an LCI dataset of on steel production using as inputs 90% of recycled material and 10% virgin steel).

Product Codes

Product classification systems which group products in a hierarchical system may be a help to group products and may be useful in a search for a specific product, thus can be usefully added to the ILCD format. The unit of analysis in the PEF studies should be defined among others with the use of the NACE[8] code. Also, when developing PEFCRs and OEFSRs, NACE/CPA codes shall be used for coding and defining the information modules used to represent the product life cycle (EC 2013a). PRODCOM[9] is a classification system based eight digits (including NACE code in the first four digits). As the reporting level in the EU for manufactured products is on the PRODCOM level (with eight digit including NACE), there would not be much more effort needed for PEF studies to also report the PRODCOM code.

Problems/Hurdles to overcome and priorities

As explained above, PEF/OEF studies require high quality reviewed data in ILCD format. PEF/OEF studies are expected to collect own data for the unit processes of foreground systems, but for the rest of the life cycle background data may be used. Here, the EPLCA can play an important role:

- as a repository of PEF/OEF studies, PEFCRs and OEFSRs in its enhanced RD,
- by providing high quality generic data (ILCD DN and ELCD) in support of modelling background systems.

[8] The full English name is Statistical Classification of Economic Activities in the European Community. And is also in English abbreviated NACE after the French full name: Nomenclature statistique des Activités économiques dans la Communauté Européenne.

[9] PRODCOM provides statistics on the production of manufactured goods. The term comes from the French "PRODuction COMmunautaire" (Community Production) for mining, quarrying and manufacturing: sections B and C of the Statistical Classification of Economy Activity in the European Union (NACE 2) http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/introduction

Possible support function of the EPLCA: A support function of the EPLCA can be seen in several areas like data provision, data storage and repository, repository of conducted PEF/OEF studies, repository of developed PEFCRs and OEFSRs and dissemination of information via the LCT Forum.

Data provision: As the Environmental Footprint method is the recommended method of the EC for environmental assessments of products and organisations, the use of the PEF and OEF Guides are expected to increase over time. Also globally, as the European Union is of the largest economies in the world, the Environmental Footprint is expected to become more and more popular within and out of the EU. Therefore, a variety of high quality (generic) life cycle inventory (LCI) data will be required to fulfil the increasing demand for data that comply with the PEF/OEF requirements. The following analysis tries to provide an overview of quality level of ELCD ILCD DN Entry-Level compliant datasets. Up to 185 datasets of the ELCD III have been judge to be compliant to the ILCD Entry level requirements by 8 external reviewers. During the revision a pre-evaluation of quality indicators have been performed on 185 ELCD datasets. Being Completeness (C), Precision (P) and Methodological Appropriateness and Consistency (M) are context-independent indicators, this pre-evaluation applies to any possible datasets use. Figure 4.1.1 shows how these evaluations have been reported in the review reports (JRC 2013).

Figure 4.1.1. *extract from one ILCD DN Entry-Level review report showing completeness (C) and Methodological Appropriateness and Consistency (M)*

ITEMs	Comments
	check for data outliers.
Completeness: "percentage of flow that is measured or estimated"; assessed on level of process	Assessed as good using expert judgment. Declared cut off as follows: 99.9% of mass inputs and all non-mass inputs reported as included. Wastes of less than 1% by mass for a process not recorded unless treated outside the system. All upstream energy inputs included except compressed air which has a negligible contribution. 98% of upstream mass inputs included. 99% of emissions included on basis of environmental relevance.
Consistency: "qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis"	Assessed as good using expert judgment. Study methodology appears to be applied consistently, for example, with respect to allocation procedures. Worldsteel uses secondary data including other trade association and GaBi data for some processes, for which it is more difficult to assess the extent of compliance with the worldsteel methodology.
Uncertainty of the information (e.g. data, models and assumptions).	Assessed as good [illegible]. Having reviewed the methodology (as part of an independent review panel), model, assumptions and data, the level of uncertainty is judged to be low.

Assessed quality indicators have been used to calculate the datasets DQR against PEF guide quality requirements with the following results.

C quality indicators have always been evaluated between 1 and 2. P indicators have been generally evaluated with a 2 and with a 5 only when unknown. Assessment of M quality indicators according to ILCD Entry-Level requirements cannot be considered valid while assessing the datasets against PEF requirements. M quality indicator has been evaluated with a 4 in the worst case as all the ELCD datasets use an attributional process-based approach and implement at least the "system boundary" method requirements of the PEF Guide.

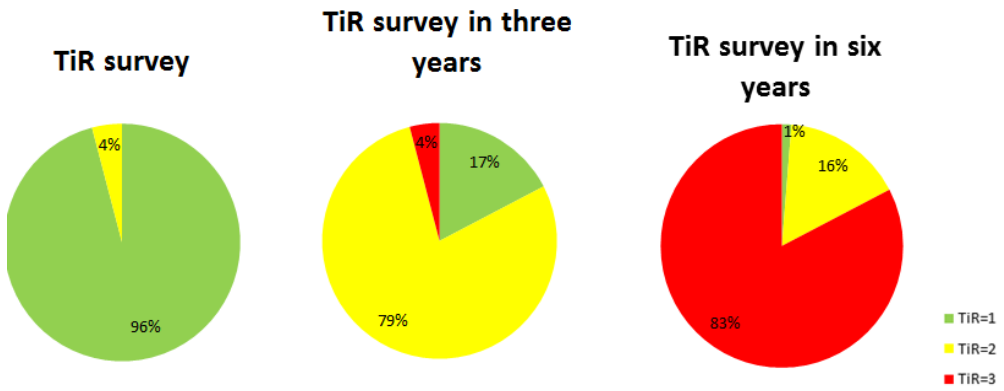
Context dependent quality indicators have been evaluated taking into account table 5 of the PEF guide and considering a PEF study with reference year 2012, European based.

DQR have been evaluated with the PEF guide formula with the following results: 25 datasets with a DQR < 3; 154 datasets with a DQR < 2.5; 6 datasets with a DQR < 2

Given all the limitation of this preliminary study, a large majority of the ELCD ILCD DN Entry-Level compliant datasets can be considered compliant to the current PEF quality requirements.

In addition time related representativeness have been evaluated taking into account ELCD datasets validity in order to investigate the needed maintenance cycle in order to guarantee the datasets to be up to date.

Figure 4.1.2. survey of ELCD Datasets current time representativeness, in three years and in six years.



The surveys show that the ELCD time representativeness will strongly decrease in the next 3 to 6 years. This will decrease datasets usability within EF study. Geographical / technological / time representativeness needs to be updated regularly.

The EPLCA is the umbrella to support this need by providing different tools.

In the short-mid-term, the development and provision of a converter for existing data-formats or databases to the ILCD format and nomenclature will probably be the most feasible option to facilitate the development of ILCD format high quality data. Nevertheless, in the mid-long them a process to ensure the harmonization of other nomenclature systems to the ILCD one will be established. In the longer term, the EPLCA could act as a"yellow pages" to seek for relevant data in support of e.g. PEF/OEF studies and policy making.

User friendly search options are needed to seek for high quality data that comply with all (or a subset of) the Data Quality Requirements of the PEF/OEF methods, and that hence include information on a) format and nomenclature requirements b) review and documentation requirements, c) completeness, consistency and uncertainty requirements and d) geographical, technological and time representativeness requirements.

ELCD:

- It should be systematically maintained as easy and user friendly to search for and identify the datasets in the ELCD which are compliant with the data quality requirements (DQR) of the PEF/OEF Guides
- At present, numerous LCI datasets fulfilling ILCD entry-level requirements already populate the ELCD. The large majority of these LCI datasets in the ELCD are of sufficient high quality to comply with the DQR of the PEF/OEF Guides and, hence, can be used in PEF/OEF studies.

In the longer term, all ELCD data should be possible to use in PEF/OEF studies. In addition, the quality of datasets is due to continually increase, assumed the use of the PEF/OEF Guides increases over time (including the associated development of PEFCRs/OEFCRs)

- The ELCD should contain the European average datasets needed for PEF/OEF studies

ILCD DN:

- It should be easy and user friendly to search for and identify the datasets in the ILCD DN which are compliant with the data quality requirements (DQR) of the PEF/OEF Guides;
- The share of the data in the ILCD DN that is of sufficient high quality to comply with the DQR of the PEF/OEF Guides (and hence can be used in PEF/OEF studies) should increase over time;
- The ILCD DN should develop to a very significant source of data for datasets needed for PEF/OEF studies.
- ILCD Format datasets to store and publish PEF studies could be developed, the datasets and consequently the PEF studies could be then distributed through the ILCD DN

Data repository: On the other hand, PEF/OEF studies will generate new good quality data. These data could be of interest for the EPLCA to store and or disseminate via the ILCD DN. Also PEF/OEF product models (sort of template, stored as a data file and easy to reuse) could be of long term interest for the EPLCA. This would simplify the creation of PEF/OEF studies, especially for small and medium sized enterprises, that today use costly external consultants for LCA studies of their own products. A comprehensive repository could also be a very efficient support in the development of product related policies like Eco-label, Green Public Procurement (GPP), Eco-design and other SCP related instruments. In the longer term, the EPLCA could function as a "one-stop-shop" for the dissemination of PEF/OEF related results (i.e. studies and method guides, PEFCRs, OEFSRs).

Table 4.1.3. summarizes the visions how the EPLCA can support the PEF/OEF development. In the short term with normal resources, a format converter and nomenclature checker and a storage for PEF/OEF reports can be in place. In the short term with increased resources also an increased share of the ELCD datasets will be suitable for PEF/OEF studies. Also an overview of projects with LCA elements funded by the EU would be possible in the short term with increased resources.

In the longer term, the ELCD databases should contain only datasets suitable for PEF/OEF studies. However, with no increased resources, this will mean that the ELCD will not contain all the background data needed for PEF/OEF studies. With increased resources, the ELCD can become the "one-stop-shop" for European average datasets needed for PEF/OEF studies. And together, the ELCD and ILCD DN can be the most relevant source of data for PEF/OEF studies.

Table 4.1.3. Summary table for EPLCA as support to PEF/OEF needs

Time horizon	INPUT TO PEF/OEF and other projects	OUTPUT FROM PEF/OEF and other projects	Information dissemination	feasibility/ resource needs
short-mid term	Format converter and nomenclature checker; Increased share of ELCD datasets which are PEF/OEF compliant	Storage for PEF/OEF reports from the pilot phase; Overview of projects funded with EU money that include life cycle based assessments	LCT forum increasingly used as source for supporting product policies and LC related research, both EC internally and externally Development of ILCD format datasets specific for PEF Studies	Feasible assuming continued support mainly from institutional (and limited additional competitive) resources Improvements in the ILCD format can only be made with major additional resources
Longer term	- All ELCD datasets are PEF/OEF compliant, ELCD becomes the "one-stop-shop" for European average datasets needed for PEF/OEF studies - ILCD DN, incl. the ELCD, is the most relevant source of PEF/OEF compliant data (BUT NOT THE SINGLE SOURCE!)	- PEF/OEF product models (in addition to the data) are stored and made available for easy reuse in LCA -Storage for LCA reports from research projects that have been funded with EU money (FP7, HORIZON 2020), EF related work, and EU-Funded LC-related activities (e.g. Eco-Label, Eco-Design, GPP, etc.)	- LCT forum used and recognized (official EC tool?) as one of the most important sources for supporting product policies and LC related research, both EC internally and externally; regularly updated. -Development of ILCD DN to distribute PEF Studies specific datasets	Feasible assuming significantly increased support from institutional needed especially if ELCD should become "one-stop-shop" for EU average data (and limited additional competitive) resources

References

Council of the European Union. (2010). Council conclusions on sustainable materials management and sustainable production and consumption: key contribution to a resource-efficient Europe 3061st ENVIRONMENT Council meeting, Brussels, 20 December 2010. Brussels. Retrieved from http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/envir/118642.pdf

European Commission. (2011). Roadmap to a Resource Efficient Europe COM (2011) 571 final - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:DKEY=615217:EN:NOT

European Commission. (2013a). Recommendation on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations 2013/179/EU, Annex II: Product Environmental Footprint (PEF) Guide (pp. 140). Brussels, European Commission.

European Commission. (2013b). Communication Building the Single Market for Green Products, COM (2013) 196 final, 9 April 2013, Brussels, European Commission

JRC (2013) - ILCD Data Network and ELCD Database: current use and further needs for supporting Environmental Footprint and Life Cycle Indicator Projects. Luxembourg: Publications Office of the European Union

4.2. Sector Specific Activities: Food/Agri/Bio Products

General Introduction

"Food and drink" products are the basis of life. However, it is recognised that their supply also significantly contributes to the environmental impacts associated with production and consumption (Peacock, De Camillis et al. 2011; De Camillis, Bligny et al. 2012).

Environmental assessments of food and drink products, and more in general of bio-based products (e.g. food, feed, biofuels, fibers, and other bio-materials) require data for all relevant emissions, resources consumed, and associated pressures at all stages of their life cycle. These environmental assessments will be as good as the data that they are based on. Costs of conducting an assessment are equally driven by the availability of appropriate-quality data and calculation tools.

Developing a reference database and calculation tools requires consideration to ensure all actors along the food (or bio-based) chain, regardless of size (including SMEs), have equal opportunity to assess their products and to communicate environmental information. Reproducibility across similar assessments is similarly dictated primarily by the usage of the same secondary data (i.e. basically those data relating to processes on which the organization under concern has no or limited control, or data relating to those processes on which tools and literature may ensure higher quality – e.g. methane emissions from enteric fermentation) by different organisations. Such data must, hence, be available and of sufficiently high quality.

In the context of the Environmental Footprint (see previous section), the European Food Sustainable Consumption and Production Roundtable[10] is on the way to launch the EnviFood Protocol, a sector-specific guide for conducting environmental life cycle assessments of food and drink products. The results of these assessments (i.e. the environmental footprint of products) will constitute the basis of the environmental communication both from-business-to-business and from-business-to-consumer. The Protocol is complementary to general requirements established for good practice on life cycle assessment, for example, by ISO 14044. In relation to the EC's Integrated Product Policy (IPP) Communication, the Protocol is complementary to the Product Environmental Footprint methodology, contained in one the annexes of the EC's Single Market for Green Products Communication. The Protocol, hence, tries not to duplicate these general methodologies. It aims to provide added value through further guidance in the context of food and drink products.

Both the Product Environmental Footprint (PEF) Guide and the Protocol provide guidance, inter alia, on how to deal with inventory data quality and data gaps.

[10] The European Food Sustainable Consumption and Production (SCP) Round Table is an initiative that is co-chaired by the European Commission and food supply chain partners and supported by the UN Environment Programme (UNEP) and European Environment Agency. There are 24 member organisations representing the European food supply chain. Participation in the European Food SCP Round Table is also open to consumer representative organisations and environmental/nature conservation NGOs.

Besides communication purposes, environmental footprint data can support decision making processes in the context of policy and business strategies.

To move towards low-carbon farming practices, life cycle inventory data are largely used in carbon footprint calculators (Tuomisto et al., 2012).

Life cycle inventory data of the products from the agri-food industry, and agro-industry in general, may be used by the energy industry and to establish specific policies on climate chance. Currently, the European Commission has been using life cycle inventory data to calculate GHG default values for biofuels and bioliquids[11].

Possible links to EPLCA

The environmental assessment of food and drink products requires consideration of all key stages and environmental burdens that are associated with a product's life cycle. Emissions and resource consumption data need to be compiled for each stage. These are combined in an inventory which is then assessed in the impact assessment phase. Data are, hence, required at both the inventory and the impact phases. The European Platform on LCA (EPLCA) can facilitate access to data.

At the inventory level, so-called foreground data are normally directly available for a given facility and to a given organisation. In others, data are related to activities of other organisations and need to be provided as background data. Background data include, for example, energy, transport, and other inputs necessary in a product's life cycle.

To make environmental footprinting more and more accessible, especially to SMEs, the EPLCA can help provide high quality data in support of modelling both foreground and background system. More detail on how EPLCA can facilitate such modelling is provided ahead in this section.

In addition, data used for the impact assessment phase (i.e. LCIA data) are usually generic and already provided by the EPLCA through the International Reference Life Cycle Data System (ILCD). The same data are also publicly available in the European Reference Life Cycle Database (ELCD).

Finally, the EPLCA could make more transparent certain policy making processes by rendering publicly available all datasets used (e.g. LCI data for biofuels and bioliquids in the context of Directive 2009/28/EC, background data of the Carbon Calculator developed in the context of the "Low Carbon Farming practices" project).

Problems/Hurdles to overcome and priorities

Inventory:

Without changing much the current situation, the ELCD could be maintained over time and be used as reference database, even if for a limited number of LCI datasets only.

Alternatively, the scope of the ELCD could be expanded to better support environmental assessment of foods, drinks, bio-fuels and other bio-based products. This may require the identification of key datasets normally used in a wide range of assessments in this sector.

[11] Annex V of the Directive 2009/28/EC and Annex IV of Directive 98/70/EC.

This could be done either in isolation by the Commission or in cooperation with the European Food SCP Roundtable.

As another option, the relevant databases for conducting food LCAs are made compliant for the ILCD Data Network, and PEF/OEF studies and a node to the Network is created for each database.

Please find below a list of some datasets (the list is not comprehensive) where data collection could focus on.

Average LCI datasets for farming practices

- Fertilizers, pesticides, herbicides,
- Capital goods and services such as tractors and other devices used for e.g. sowing, planting, watering, harvesting, pruning, etc. Note: use of devices is to be parameterised

Average LCI datasets for processed food products

- Base ingredients (e.g. sugar, salt, spices, cereals, fruits, horticultural products, etc.)
- Food additives (i.e. acids, acidity regulators, anticaking agents, antifoaming agents, antioxidants, bulking agents, food colouring, colour retention agents, emulsifiers, flavours, flavour enhancers, flour treatment agents, glazing agents, humectants, tracer gases, preservatives, stabilizers, sweeteners, surfactants, thickeners)
- Supplements (e.g. vitamins, proteins, etc.)
- Dry, fresh, refrigerated or frozen freight transport services
- Cleaning services, working equipment, capital goods
- Unit processes for use phase modelling (e.g. cooking in the oven, frying, warming up, etc.)
- On the top of the end-of-life unit processes mentioned in the section on environmental footprint that are mostly relevant for modelling the end-of-life of packaging, process-specific data for modelling the end-of-life of foods and drinks are needed (e.g. aerobic composting, anaerobic digestion, mechanical-biological treatment, energy recovery, incineration of animal products, waste water treatment of e.g. slaughterhouses, sewage sludge treatment, landfilling).

In addition, the GHG emission default values for indirect land use change could be integrated into the ELCD, or at least the ILCD, as additional information to complement e.g. emission profiles of e.g. biofuel production. A large set of default values has been recently calculated by the JRC and published in COM (2012) 595 final, which proposes amendments to the Directives 2009/28/EC and 98/70/EC.

Besides the development of databases in support of modelling background systems, the ELCD, or at least the ILCD data network, should facilitate the modelling of foreground systems by providing those high quality data from the literature whose collection would be otherwise expensive (e.g. methane emissions from enteric fermentation). This is deeply necessary to make environmental footprinting more and more accessible for SMEs.

The development of secondary data is always a trade-off between having representative data reflecting actual product life-cycle and managing the system complexity by adopting average solutions. Average LCI datasets might be rather not representative of specific processes

depending on peculiar parameters; this is even more evident in the agri-food sector. An analysis aimed on identifying optimal level of details of average agri-food sector LCIs data is desirable.

Finally, the EPLCA could provide ad hoc tools facilitating environmental accounting at the foreground system level (e.g. assigning pesticide emissions from field application to the different environmental compartments).

Impact assessment: The European Commission's JRC could facilitate environmental assessments in the agri-food sector by elaborating and providing systematically-updated characterization factors for calculating indicators such as e.g. water footprint and biodiversity loss (e.g. fish stock depletion.

Further collaboration could be pursued to set up and maintain spatially- and temporally-resolved databases on:

- Water scarcity indices, characterization factors of the blue water footprint indicator.
- Volume of precipitations per month to facilitate calculation of the green water footprint indicator.

Similarly, the spatially- and temporally-resolved databases held by DG Mare on various fish stocks may also be incorporated in the ELCD to facilitate calculation of fish stock depletion indicators, this part will be developed in accordance to the needs of relevant stakeholders, when developing the category rules for the PEF, and to the LCIA-related projects. Synergies with DG Mare should be explored. Alternatively, this can also be achieved in the context of fish PEFCRs development by the relevant stakeholders, to complement the broader, mandatory LCIA indicators.

Coming up with scientifically-sound fish stock depletion indicators and linking them to publicly-available databases like the ones from DG Mare represents a priority to correctly inform citizens on the actual environmental footprint of wild fish.

Some of these indicators have mostly a socio-economic nature. The green water indicator is, for example, able to inform on the efficiency in managing green water availability. For this reason, more discussion is needed to figure out if these indicators fit in the environmental life cycle impact assessment framework or if they should better be placed in the scope of the broader life cycle sustainability assessment.

Table 42.1. *Summary table for EPLCA as support Food/Agri/Bio needs*

Time horizon	INPUT TO Food/Agri/ Bio Sectors	OUTPUT FROM Food/ Agri/Bio Sectors	Information dissemination	Feasibility / resource needs
Short-mid term	Increase the availability of datasets which are compliant with the PEF/ OEF and the EnviFood Protocol; Increase the availability of high quality data in support of foreground system modeling; Develop ad hoc methods and tools to assign emissions (e.g. from pesticide, herbicide, etc.) from field application to the different environ-mental compartments (air, water, etc.) The EPLCA is the interface where new LCIA datasets developed in-house by the JRC and concerning e.g. water use, fish depletion and other types of biodiversity loss are made available. (partly longer term) Investigate optimal level of details of average LCIs data.	The Resource Directory is used to store PEFCRs/OEFCs and LCA reports The Resource Directory also includes the studies on which basis the recommended direct and indirect land use change default values for biofuels are derived. The carbon calculator for fostering low carbon farming practices is developed according to the OEF/PEF guides and the EnviFood Protocol All LCI datasets used in policies (e.g. those on biofuels and bioliquids) are made available via the ELCD or ILCD	LCT forum and Resource directory increasingly used as source for supporting product policies and LC related research, both EC internally and externally	Feasible assuming continued support mainly from institutional (and additional competitive) resources
Longer term	- ILCD DN, incl. the ELCD, is the most relevant source of secondary data compliant with PEF/OEF and EnviFood Protocol	Ad hoc PEF/OEF calculators available for download	Same as PEF and OEF	Feasible assuming significantly increased support from institutional needed resources

References

De Camillis, C., J.-C. Bligny, et al. (2012). "Outcomes of the second workshop of the Food Sustainable Consumption and Production Round Table Working Group 1: deriving scientifically sound rules for a sector-specific environmental assessment methodology." The International Journal of Life Cycle Assessment **17**(4): 511-515.

Peacock, N., C. De Camillis, et al. (2011). "Towards a harmonised framework methodology for the environmental assessment of food and drink products." The International Journal of Life Cycle Assessment **16**(3): 189-197.

Tuomisto, H.L., Angileri, V., De Camillis, C., Leip, A., Pelletier, N., Ramos, F., and P. Haastrup, (2012). Establishing a reference carbon calculator and policy options to promote low carbon farming practices in the EU. In: *8th International Conference on Life Cycle Assessment in the agri-food sector*. Book of abstracts. p. 921, PARIS: INRA, Saint-Malo, France, 1-4 October 2012.

4.3. Sector Specific Activities: Energy

General introduction

It is widely known that the use of primary energy for power generation and fuels production, is significantly contributing to the environmental impacts related to production and consumption, and more in general to almost all the human activities, particularly if the primary sources used are non-renewable. For instance recent statistics [12] shown that in the EU the industry and transport sector (i.e. the sectors that are basically linked to the environmental burdens of products), impacts for more than 55% on the total primary energy consumption of the member countries.

The use of energy can be therefore considered as a significant entry, also as regards the environmental burdens, related to all the production chains. Furthermore, the LCI data related to the use of power and fuels are often taken into account as secondary data, derived from third party sources, and not directly measured/derived within the LCA study.

Nevertheless, the energy market is extremely variable, at least on a mid-term perspective, due to economic and geopolitical reasons, and in the last decade, due to the rising global awareness towards environmental issues, some renewable energy system are increasing their importance in the national and EU energy mix.

For these reasons a good availability of data on those topics are very relevant for LCA practitioners, in order to make sure to use consistent and quality assured secondary data on energy and transport.

Possible links to EPLCA

The ELCD III is already containing some datasets related to energy systems, matching the ILCD entry level requirements. More precise and site specific dataset may be required in the future, thus the ILCD Data Network, and a further expansion of the ELCD may be useful in this perspective.

Under the LCA practitioners' point of view, the energy-related data (i.e. mainly those regarding power generation and fuels for transport) are often considered as secondary or background data; in this context the ILCD DN can represent a useful way to harmonize the energy data to be used in LCA; hence contributing significantly to coherence of assessments.

As regards the raising of renewable energy systems, the platform can give a significant contribution as well, allowing to include both the datasets, where they are compliant with the ILCD entry level; those not compliant can be stored in the single nodes of the DN. Normally the energy-related datasets refer to medium- or large-scale systems, or to average data at regional-, national- or EU-level, but since there are several new technologies related to renewable energy, or to increase the efficiency of the energy systems, that are currently under development, the datasets for such patterns will not be available during the experimental and start-up phase. In this framework the Resource Directory can supply some information until the new technologies are released in a large scale; scientific studies and technical reports related

[12] http://www.eea.europa.eu/data-and-maps/indicators/final-energy-consumption-by-sector-5/assessment

to LCA of the technologies under development can indeed be stored in the RD, and may supply information where the DN or ELCD are lacking. Furthermore the upcoming new version of the forum may include a specific section on energy and transport topics, and could be useful for practitioners to discuss about the new environmental issues related to future developments in the energy sector.

Problems/Hurdles to overcome and priorities

One of the most relevant weaknesses of the ELCD, and more in general to LCI data related to power generation, is the lack of datasets that model electricity (and to some extent also fuels) produced by each technology in each European country. Currently, the ELCD includes electricity mix datasets for each country, modelled considering an established share of sources that might be different to current situation.

Although the optimal solution to this limitation would be to model new datasets (where lacking) for electricity production by technology and for each country, this might not be feasible for the short term. An alternative solution would be to model datasets for each technology under a European context, and to introduce parameters in the electricity mix datasets to vary the shares of each technology.

In order to give response to any change or advance in technologies, and to be able to model new datasets and/or to modify the current ones if necessary, it is highly recommended to constantly review the evolution of advanced technologies and their share in the European market (e.g. Carbon Capture and Storage, Small hydropower, Small and medium scale wind, and wind re-powering, Concentrated Solar Power, Shale gas, etc.).

As mentioned before, future versions of the ELCD should include new datasets for electricity production by technology and by country. Also, future electricity scenarios can be developed using to that end the output from energy models such as PRIMES[13] or TIMES[14]. PRIMES is a modelling system that simulates a market equilibrium solution for energy supply and demand in the EU-27 and its Member States and it is used by the European Commission for its official electricity production scenarios. The model determines the equilibrium by finding the prices of each energy form such that the quantity producers find best to supply matches the quantity consumers wish to use. The market equilibrium is for each time period and the simulation is dynamic over time. Since electricity is a major input in many processes. TIMES (The Integrated MARKAL-EFOM System) is an economic model generator for local, national or multi-regional energy systems which provides a technology rich basis for estimating the development of the energy system over a longer-term time horizon. It has been developed in the framework of the Energy Technology Systems Analysis Programme (ETSAP) implementing agreement of the International Energy Agency (IEA). The use of those models to improve the database, including the most important technologies that are foreseen to assume a relevant role in the energy market in the future, could be very useful for prospective and consequential LCA studies.

Modelling the end of life of the systems appears to be a difficult task due to the novelty of some technologies and the lack of data from other technologies (solar PV, final repository for spent nuclear fuel and natural gas plant dismantling). Efforts on this challenge should be kept in the future.

[13] http://ec.europa.eu/environment/air/pollutants/models/primes.htm
[14] http://ipts.jrc.ec.europa.eu/activities/energy-and-transport/TIMES.cfm

Since its first release, the ELCD database has been updated 3 times. The needs of reviewing and updating the ELCD database depend on the different sectors and the technologies. It would be useful to define periods to revise the energy-related datasets, but the revising period need to be defined case by case, according to the rate of obsolescence of the different technologies.

For this purpose, a deep analysis of the learning curves would identify the level of maturity for each technology. Then, special periods for reviewing could be identified by technology.

Some recent analysis (JRC 2013, unpublished. JRC 2013a) of the energy datasets contained in the ELCD, against the ILCD DQRs, pointed out some weakness related to data completeness, particularly Halon 1211, CFC-10, CFC-11, CFC-12, cadmium, indium, iridium, cypermethrin and decane, that are precluding the full compliance of the dataset, thus in the future those flows shall be considered in the databases.

Business associations and authoritative sources are relevant sources to update the status of these technologies, those sources can be contacted from the dataset developers to define new datasets, or directly invited to set up their own node in the ILCD DN. Some relevant sources have been identified (Table 4.3.2).

Table 4.3.1. *Summary table for EPLCA as support Energy sector needs*

Time horizon	INPUT TO Energy policies/sector	OUTPUT FROM Energy sector to EPLCA	Information dissemination	feasibility, resource needs
Short-mid term	Modeling long term scenarios basing on the data available in EPLCA, and existing models (e.g. PRIMES and TIMES) Keep the energy datasets regularly updated, depending on the rate of obsolescence of different technologies (involving the member states energy authorities?)	Increase the availability of datasets related to the energy systems including all the existing technologies and the emerging ones. Improve the existing datasets with the lacking flows (increase the data completeness)	LCT forum and Resource directory increasingly used as source for supporting energy policy. Resource directory used as repository for studies related to new technologies in the energy sector.	Feasible assuming continued support from institutional and additional competitive resources
Longer term	Increase the relevance of ILCD DN, as a source of secondary data for LC-based approaches Modeling the EoL datasets for power generation systems	Create specific nodes, managed at national or EU level, including the energy datasets by country at least for EU countries.	Increase the relevance of the RD on energy sector, including a section for reviewed studies.	Feasible assuming continued support from institutional and additional competitive resources

Table 4.3.2. List of relevant Authoritative Sources and Business Associations for the energy sector (JRC 2013-unpublished).

Name	Web page	Sector /Technology	Type of information
British Wind Energy Association (BWEA)	http://www.renewableuk.com/	Wind energy industry in UK	Technical and statistical data
European Association of Coal and Lignite (EURACOAL)	http://www.euracoal.be/	Lignite and coal	Precise inventories
European Association of Gas Wholesale, Retail and Distribution Sector (EUROGAS)	http://www.eurogas.org/	Gas	Sector statistics
EurObserv'ER Barometer	http://www.eurobserv-er.org/	Renewable Energy	Technical fact sheets, statistics, sectorial reports
European Photovoltaic Industry Association	http://www.epia.org/home/	European PV stakeholders	Technical and statistical data, market development and position papers
European Photovoltaic Technology Platform	http://www.eupvplatform.org/	Photovoltaic	Technical, statistical, market and legislative data
European Pollutant Release and Transfer Register (E-PRTR)	http://prtr.ec.europa.eu/	Industrial facilities (including power plants)	Key environmental data
European Small Hydropower Association (ESHA)	http://www.esha.be/	European Hydropower stakeholders	Technical, statistical, market and legislative data
European Wind Energy Association (EWEA)	http://www.ewea.org/	Wind	Technical, statistical, market and legislative data
Gas Infrastructure Europe (GIE)	http://www.gie.eu.com/	Gas	Market data related to LNG infrastructure
International Hydropower Association (IHA)	http://www.hydropower.org/	International Hydropower stakeholders	Studies related to sustainability
International Energy Agency (IEA)	http://www.iea.org/	Energy security, economic development, environmental awareness, and engagement worldwide	Technical, statistical, market and legislative data Researching activities
Statistical Office of the European Communities (Eurostat)	http://ec.europa.eu/eurostat	European statistics	Databases, statistics
Technical Association of the European Natural Gas Industry (MARCOGAZ)	http://www.marcogaz.org/	Gas	Technical, statistical and legislative data
Union of Electricity Industry (EURELECTRIC)	http://www.eurelectric.org/	Electricity Generation	EU data fact sheets
Wind Power Net	http://www.thewindpower.net/	Wind Power	Wind turbines and wind farms database
UNSCEAR (**United Nations Scientific Committee on the Effects of Atomic Radiation**)	http://www.unscear.org/	Nuclear power	Radioactive emissions
IAEA (International Atomic Energy Agency) DIRATA database.	http://dirata.iaea.org	Nuclear power	Radioactive emissions

References

JRC 2013 – in press - Background analysis of energy data to be considered for the European Reference Life Cycle Database (ELCD) - final report from CIEMAT, Madrid (ES).

JRC 2013a – Recchioni M., Garrain D., Fazio S., De La Rua C., Mathieux F., Lechon Y. Methodology applied to the background analysis of energy data to be considered for the European Reference Life Cycle Database (ELCD). 23rd Annual Meeting of the Society of Environmental Toxicology and Chemistry (SETAC Europe). Glasgow.

4.4. Sector Specific Activities: Raw Materials

General introduction

The material consumption of economies and the use of materials in supply chains are relevant aspects for shaping sustainable systems and reducing environmental impacts of products (both goods and services) and economies. Monitoring the use of material resources in relation to economy performance is a consolidated method for promoting sustainable production and consumption.

A further aspect that is gaining more and more attention is the access to resources. European economy relies to a large extend on import of raw materials, which have been subject to an increasing application of export restrictions from producing countries. The growing and volatile trend of raw materials' prices has been showing that the competition for resources intensified during the last years.

Export restrictions are sometimes implemented because of the growing internal demand for these resources, e.g. in countries with emerging economies; the high environmental impacts linked to the extractions can also induce governments to restrain the mining activity and reduce exports; in other cases the protectionist measures are strategically applied for political reasons.

At policy level the EU has started addressing the security of supply issue in the Raw Materials Initiative (EC - European Commission, 2008), that has been updated in 2011(EC - European Commission, 2011). This policy initiative included the identification of the so called Critical Raw Materials (CRM), i.e. the materials having a relatively higher economic importance and risk of supply (EC - European Commission, 2010). In this methodology the supply risk is measured considering the governance and the environmental performance in the producing countries (using the World Governance Indicator and the Environmental Performance Index). Poor governance is supposed to increase the risk of supply, as well as low environmental standards are expected to increase the risk that environmental measures could be implemented in the future, restraining the mining activity. The resultant level of risk is then adjusted on the base of recycling rate and substitution potential of each material under evaluation. While the recycling rate is based on data, substitution potential has been evaluated through expert judgments.

The assessment performed in 2010 produced a list of 14 materials that is going to be updated by the end of 2013. It includes the following materials considered as critical: antimony, beryllium, cobalt, fluorspar, gallium, germanium, graphite, indium, magnesium, niobium, PGM (Platinum Group Metals: platinum, palladium, iridium, rhodium, ruthenium and osmium); rare earths (yttrium, scandium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium), tantalum, tungsten.

Supply chain analysis and critical raw materials: Supply chain stakeholders can be negatively affected by limited material availability. Even though at business level price fluctuations of raw materials and availability of technological options normally drive decision makers (e.g. encouraging substitution when a material price is increasing and other materials can be used for the same function), information on materials' criticality can reduce the supply chain vulnerability with respect to materials' provision and potential supply disruptions.

Life Cycle Assessment (LCA) could have a relevant role in detecting the risk associated with resource supply, since the methodology has built upon a supply chain analysis and the accounting of input flows along the life cycle of products is the first step for performing LCA. In general, the risk related to resources could be properly encompassed in the sustainability assessment practice, since this risk closely relates with economic, environmental and social impacts.

The Joint Research Centre is currently developing research activity aimed at exploring and testing the potential of LCA in managing the risk connected to resources in supply chain. A workshop has been organized in November 2012 to explore this topic and provide recommendation for considering security of supply in sustainability assessment practice (Mancini, De Camillis, & Pennington, 2013).

Possible links to EPLCA

Improving the availability of LC data on CRM is of utmost importance for managing the risk related to resources in the context of a supply chain sustainability assessment. Two different kinds of information could be useful for this purpose:

1. LC data on the production processes of raw materials
2. LC data of products containing/using CRM

In the first case should be noticed that raw materials are merely production inputs (or intermediate products), entering in other production processes. Therefore, a cradle-to-grave assessment cannot be conducted for CRMs. Nevertheless, the environmental profile of CRMs can be calculated performing a "from cradle -to-gate" LCA (i.e. from the extraction of natural resources to the supply of CRMs). So far, only few LC inventory (LCI) datasets are available on these processes in the commonly-used LCA databases (Ardente and Mathieux, 2012). Although LCI datasets are increasingly needed, developing ad hoc LCI databases on CRMs is often restrained by the limited number of mines for these materials (often located, by definition, in countries with poor governance) and the high market concentration.

Table 4.4.1 provides a list of the main end-use markets for CRMs and the current availability of datasets in the ECLD. It also displays the main data gaps for CRM and, therefore, where future efforts for data acquirements should be addressed in order to develop the potential of LCA for analysing the risk connected with the access to resources.

The second typology of data can be very relevant for monitoring flows of CRMs and apply resource efficiency strategies specific for these materials. There is a large variety of products and sectors where CRMs are used, but many of them have particular properties (and therefore low substitutable) which make them particularly suitable for electronic and ICT products, mechanical and electrical equipment, production of alloys. Some CRMs, e.g. rare earths, indium and gallium, are used in low-carbon energy technologies and the deployment of these technologies is expected to significantly increase the demand of these materials in the next 20 years (Moss, Tzimas, Kara H., Willis, & Kooroshy, 2011). However CRMs are often used in very small amounts and can be easily dismissed in the inventories when cut-off criteria based on mass are applied. In ILCD compliant datasets the application of cut-off rules, when occurring, is documented.

At macro-economic level, life cycle resource efficiency indicators can be used to inform decision makers on the flows of CRMs within the EU economy as well as on the resource depletion caused by the consumption of these materials. The data underlying life cycle

indicators are suitable for estimating direct and indirect flows of CRMs in the EU economy, as both EU domestic extraction and the consumption of CRMs driven by EU imports are accounted for. In particular, this data allow accounting for:

- The amounts of CRMs domestically extracted in the European Union.
- The amounts of CRMs extracted and used for producing imported and exported intermediate products.
- The resource depletion related to the consumption of CRMs.
- The efficiency of the CRM use, indicating the amount used in relation to the economic performance and the resource efficiency of economic growth.

The data on CRM which are currently available within the life cycle indicators for the years 2004, 2005 and 2006 are reported in Table 4.4.2.

A further issue to take into account when analysing the use of critical resources in supply chains regards the nature of criticality indicators, also in relation with the current nature of resource impact indicators. In the study performed for the European economy the "supply risk" aggregated indicator includes country dependent indexes, i.e. Herfindahl-Hirschman Index and Worldwide Governance Indicator. The "environmental country risk" is also measured through the Environmental Performance Index, which ranks countries on the base of their "closeness" to environmental policy goals. The impact assessment indicators recommended at EU level by the ILCD have a general validity, since they are built on world reserve data and extraction rates. The development of site-dependent indicators/data, possibly at a national level, would allow including security of supply considerations.

Biotic materials are scarcely represented in the ELCD. While few datasets are currently available for wood and carton materials like, e.g. natural rubber and paper, are missing. Resource security policies are instead starting focusing on biotic materials, since for some of them Europe relies on imports to a large extent.

Table 4.4.1. List of CRM, main end-use markets and datasets availability in ELCD

CRM	MAIN END-USE MARKETS	MEGASECTORS	available ELCD datasets
Antimony	Flame retardants, Glass	Rubber, plastic & glass	Continuous filament glass fibre
Beryllium	Electronic equipment, domestic appliances	Electronic equipment and domestic appliances	
	Mechanical equipment	Mechanical equipment	
Cobalt	Batteries, Pigments	Chemicals	
	Super alloys and magnets, Hard metals	Metals and minerals	Steel
Fluorspar	Hydrofluoric acid	Chemicals	
	Steel, Aluminium	Metals and minerals	Aluminium, steel, lead
	Others		crushed stone, gypsum, Portland cement, sand, nylon, other plastics
Gallium	Integrated circuits, laser diodes and LED	Electronics % ICT	
	Alloys	Research & development	
Germanium	Fiber optic, Electrical and solar equipment	Electronics % ICT	
Graphite	Steel industry, Crucible production	Metals	
	Electrical applications	Electronics % ICT	
Indium	Flat display panels	Electronics % ICT	
	Low melting point alloys	Metals and minerals	
	Architectural glass, windscreen	Rubber, plastic & glass	
Magnesium	Casting alloys (car parts)	Road transport	Aluminium, lead, zinc, steel, calcium carbonate, crushed stone, gravel, gypsum plaster, gypsum stone, kaolin coarse filler, Portland cement, sand, silica sand
	Al-alloys (packaging)	beverage	
	Al-alloys (transport)	Metals and minerals	
Niobium	Ferroniobium for steel, alloy	Metals and minerals	
	Ferroniobium for construction	construction material	
Platinum Group Metal	autocatalysis	road transport	Aluminium, lead, zinc, crushed stone, gravel, gypsum, Portland cement, sand, polyacrylonitrile, polyamide, acrylonitrile-butadiene-styrene, polystyrene, nylon, polyacrylonitrile fibres, other plastics
	jewellery	consumer goods	
	electronics and electrics	electronics & ICT	
	Others	metals, minerals and plastics	
Rare earths	catalysts, batteries	Chemicals	
	magnets	Electrical equipment, domestic appliances	
	Glass	rubber, plastic & glass	Filament glass fibre
	Iron and steel	Metals and minerals	Steel
Tantalum	capacitors	electronics & ICT	
	cemented carbides	Mechanical equipment	
	aerospace and automobile	Road transport	
Tungsten	cemented carbides, alloy steels	Mechanical equipment	
	fabricated products	Electrical equipment, domestic appliances	

Table 4.4.2 CRM data availability in the LC indicators database

	Basket of products	Resource efficiency			Life Cycle Impact Assessment
	EU citizen average consumption[1]	Domestic[2]	Import[3]	Export[4]	Resource depletion[5] (person reserve)
Antimony	x	0 n.m.	x	x	x
Beryllium	n.q.	0 n.m.	n.q.	n.q.	n.e.
Cobalt	x	0 n.m.	x	n.q.	x
Fluorspar	x	x	x	x	n.e.
Gallium	x	0 n.m.	n.q.	n.q.	n.e.
Germanium	n.q.	0 n.m.	n.q.	n.q.	n.e.
Graphite	n.q.	x	n.q.	n.q.	n.e.
Indium	x	0 n.m.	n.q.	n.q.	n.e.
Magnesium	n.q.	x	x	x	n.e.
Niobium	n.q.	0 n.m.	n.q.	n.q.	n.e.
PGMs**	x(1)	0 n.m.	x(1)	x(1)	x(3)
Rare earths***	x(2)	0 n.m.	x(2)	x(2)	n.e.
Tantalum	x	0 n.m.	n.q.	n.q.	x
Tungsten	x	x	x	x	x

[1]Amount of materials consumed by an average EU citizen in 1 year (disaggregated by life cycle phase); [2]Extracted within EU-27 (or member state) territory; [3]Import of intermediate products (representative sub-set); [4]Export of intermediate products (representative sub-set); [5]Resource depletion of materials (EDIP2003 methodology - Hauschild and Wenzel, 1998 – updated in 2004)

n.q.: not quantified because of the limitations in the methodology; n.e.: not existing – missing characterization factors; n.m.: not mined in European Union, 0 values represent actual 0 extractions.

** PGM, Platinum Group Metals: platinum, palladium, iridium, rhodium, ruthenium and osmium; *** Rare Earths: yttrium, scandium, lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium.

(1) Only palladium, platinum, rhodium; (2) only lanthanum and neodymium; (3) only palladium and platinum.

Problems/Hurdles to overcome and priorities

The potential of LCA for managing CRMs along the supply chain and improving resource security could be enhanced through the expansion of data availability and the impact assessment methods' development.

A relevant contribution could be produced by the development of spatial differentiated LCI. The concept of spatial differentiated resources inventory has been already introduced (Gao, Nie, Wang, Gong, & Zuo, 2009; Strauss, Brent, & Hietkamp, 2006), although only few examples can be found in literature. A country level resolution of the resource inventory would drastically improve the capability of LCA of managing CRMs, since the geographic origin of raw materials is fundamental information for assessing criticality.

Concerning the data gaps on raw materials, opportunities for enlarging the actual availability can be envisaged on the light of the Transatlantic Economic Council (TEC). This policy initiative aims at advancing economic integration between European Union and United States and includes a work plan on raw materials.

A US-EU workshop has been organized in October 2012 on Raw Material Flows & Data. It has started exploring steps to create a joint raw materials data inventory and other means to share raw materials data. This initiative could improve the access to U.S. Geological Survey (www.usgs.gov) data, which is the main scientific agency for the collection, analysis, and dissemination of data and information on domestic and international minerals production, consumption, and materials flow. This full spectrum of mineral resource science allows for a comprehensive understanding of the complete life cycle of mineral resources and materials – resource formation, discovery, production, consumption, use, recycling, and reuse.

While a closer collaboration with USGS will be beneficial for future data provision, other stakeholders could be involved in the shorter terms for developing the data availability of the ELCD. These include industry associations and companies, both from the mining sector, minerals and metals industries, and recyclers. Industries dealing with biotic raw materials (e.g. rubber and tyres manufactures) are also relevant.

Industry associations are usually allowed neither to distribute nor to manage members' confidential data. This implies that collected LCI are necessarily average ones. An analysis aimed on identifying optimal level of aggregation of average LCIs data to allow fulfilling the confidentiality issue but providing enough details to capture processes peculiarity is desirable.

Table 4.4.3. *List of relevant organizations and companies which could be relevant sources of data.*

Name	Web page	Sector/Technology	Type of information
Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe BGR)	http://www.bgr.bund.de/EN/Home/homepage_node_en.html	German geoscientific authority	mainly geological data and maps on mineral availability and supply
British Geological Survey	http://www.bgs.ac.uk/home.html?src=topNav	United Kingdom's national geological survey	mainly geological data and maps on mineral availability and supply
European Association of Mining Industries, Metal Ores & Industrial Minerals (Euromines)	http://www.euromines.org/what-we-do	representative of the European metals and minerals mining industry	technical data
Eurometeaux	http://www.eurometaux.eu/	European association of metals	technical data
IntierraRMG	http://www.intierra.com/Homepage.aspx	research company and consultant for the resource sector	economic data, sector data on mining and exploration; finance; manufacturers, suppliers and service providers
Umicore	http://www.umicore.com/en/	global materials technology and recycling group	technical data
International Council on Mining & Metal	http://www.icmm.com/	membership organization of mining and metals companies and associations	technical data
European Tyre & Rubber manufacturers association	http://www.etrma.org/	representative of tyre and rubber goods producers	technical data

Table 4.4.4. Summary table for EPLCA as support raw materials needs

Time horizon	INPUT TO Raw Materials project	OUTPUT FROM RM project	Information dissemination	feasibility/ resource needs
short-mid term	- Inventory data for CRMs - Inventory data of intermediate products (e.g. metallurgical components) and key products containing critical elements (see table 4.4.1) - Expansion of the dataset availability for biotic raw materials - Investigate optimal level of details of average LCIs data.	- Updated methods for assessing resource risks in LCIA - Case studies assessing the capability of LC analysis of managing supply risk - Inclusion of social hotspots databases	Technical reports and scientific publications	- Additional resources needed to develop databases on social hotspots; - Expansion of datasets on biotic materials can be partially covered by internal resources and will rely on present and future collaborations with organizations and companies
Longer term	- Comprehensive life cycle inventory database of production of some critical raw materials - the development of spatial differentiated LC inventories could enhance the capability of managing supply risk within the LCA	- Development of a dedicated session providing information on supply risk of raw materials; as well as economic data on raw materials supply	Technical reports and scientific publications	Limited number of mining sites and concentration of supply of these materials will constrain the data availability, but the data could be collected from few sites. Feasible with Institutional resources assuming that the short-mid-term goals will be achieved.

References

Ardente F, Mathieux F. "Application of the project's methods to three product groups". European Commission. Joint Research Centre. Institute for Environment and Sustainability. Report n. 2 of the project "Integration of resource efficiency and waste management criteria in European product policies – Second phase". November (2012).

EC - European Commission The raw materials initiative - meeting our critical needs for growth and jobs in Europe (2008).

EC - European Commission. (2010). Critical Raw Materials for the EU. Report of the Ad-Hoc Working Group on Defining Critical Raw Materials. (EC, Ed.). Brussels.

EC - European Commission Tackling the challenges in commodity markets and on raw materials (2011).

Gao, F., Nie, Z., Wang, Z., Gong, X., & Zuo, T. (2009). Characterization and normalization factors of abiotic resource depletion for life cycle impact assessment in China. Science in China Series E: Technological Sciences, 52(1), 215–222. doi:10.1007/s11431-009-0028-1

Mancini, L., De Camillis, C., & Pennington, D. W. (2013). Security of supply and scarcity of raw materials. Towards a methodological framework for sustainability assessment. Luxemburg: European Commission, Joint Research Centre, Institute for Environment and Sustainability, Publications Office of the European Union. doi:10.2788/94926

Moss, R. L., Tzimas, E., Kara H., Willis, P., & Kooroshy, J. (2011). Critical metals in strategic energy technologies. (J. R. C. S. and T. Reports, Ed.). Luxembourg: European Commission Joint Research Centre Institute for Energy and Transport.

4.5. Resource Efficiency Assessment of Products (re-usability, recyclability, recoverability, durability, Recycled content) for product policies

Introduction

A resource-conscious design of products can contribute to reduce supply risk and to ease the pressure on natural reserves. For example, the improvement of design for recycling of the product can make available larger amounts of recovered materials at the product's End-of-Life (EoL), both in terms of additional masses of recycled materials and their quality.

The Joint Research Centre (JRC) – Institute for Environment and Sustainability (IES) developed the Resource Efficiency Assessment of Products (REAPro) method for the assessment and improvement of resources efficiency of products. The method has been applied to support the identification of potentially relevant Ecodesign requirements to improve resource efficiency of Energy Related Products. These aspects are also, to some extent, captured in the End of Life (EoL) formula proposed by the PEF methodology.

However, the application of the REAPro method as well as the PEF EoL formula requires some quality-assured and representative data such as: LCI data about primary and secondary materials, LCI data about some emerging materials, LCI data about some potentially hazardous substances, data about quality of recycled materials (including downcycling factors) and data (LCI as well as yields) about End-of-Life treatment processes.

In order to promote further sustainable consumption and production, the European Commission (EC) announced in its "Roadmap to a Resource Efficient Europe" the will to "*address the environmental footprint of products [...] including through setting requirements under the Ecodesign directive, to boost the material resource efficiency of products (e.g. reusability/recoverability/recyclability, recycled content, durability)*" (COM 2011-571).

Also the availability of raw materials and their efficient use are some of the key issues that the EC is currently tackling. In its communication on "tackling the challenges in commodity markets and on raw materials" the Commissions stated that "*as worldwide demand for raw materials increases, greater efforts will have to be made on recycling. Higher recycling rates will reduce the pressure on demand for primary raw materials, help to reuse valuable materials which would otherwise be wasted, and reduce energy consumption and greenhouse gas emissions from extraction and processing*" (COM 2011-25). Therefore the Commission proposes as solution, among the other, "*to analyse the feasibility of developing ecodesign instruments (i) to foster more efficient use of raw materials, (ii) ensure the recyclability and durability of products and (iii) promote the use of secondary raw materials in products, notably in the context of the Ecodesign Directive" Possible measures to tackle challenges in the supply of relevant raw materials include, among the others, the promotion of the "extraction, recycling, research, innovation and substitution inside the EU*"(COM 2011-21).

Possible links to EPLCA

The application of the REAPro method and of the PEF EoL formula requires some specific additional life cycle inventory data that should be used as input for the calculation of a set of multi-criteria indexes related to: reusability/recyclability/recoverability-RRR, use of relevant resources, recycled content, use of hazardous substances, durability, as well as PEF EoL formula.

In particular, it has been identified the need of life cycle inventory data of:

- primary productions of materials (e.g. 100% primary steel, 100% primary aluminium);
- secondary productions of materials (e.g. 100% recycled polymers, 100% recycled precious metals),
- some potentially relevant emerging materials (e.g. several EU critical raw materials (EC-2010).
- some potentially hazardous substances (e.g. flame retardants and plasticizer);
- EoL treatments (including shredding processes, landfill/incineration of different materials, waste water treatments, etc.).

Problems/hurdles to overcome, and identified priorities

Concerning the previously identified need of life cycle inventory data, some problems are to be addressed:

- difficulties to collect/model data about primary production of materials. This is, for example, the case of some metals (e.g. steel) that are currently not produced only primary (e.g. some amounts of scraps are always introduced in the production processes).
- difficulties to collect/model data about the production of recycled materials methodologically consistent with data about primary production (e.g. concerning the system boundaries definition and allocation problems). It has been observed a general lack of information of such data in all the most common life cycle inventory databases (especially concerning recycled plastics). In some cases, data about recycled materials are already 'embodied' into average data mix, including also the crediting of avoided primary productions. On the other hand, it is highlighted that data about 100% recycled materials should be carefully used by LCA practitioners for some specific purposes (e.g. Ecodesign, Product Environmental Footprint). In other cases, average marked data (including a mix of primary and secondary materials) should be used. Information about loss of quality of recycled materials (downcycling) is generally missing among metadata. In particular it is necessary to clarify to what extent recycled materials could substitute primary materials. Downcycling could be assessed via physical properties (e.g. tensile strength of materials) or in lack of technical parameters via economic parameters (e.g. costs of primary/secondary materials) but is a methodological issue still under discussion.

- data about primary/secondary production of some emerging materials are missing. These materials could be the target for some specific Ecodesign requirements (e.g. design for dismantling of components containing them) and, therefore, the detailed assessment of their environmental impacts is important. However, in some case, the production of these materials is controlled by few companies in the worlds and the disclosure of information is very restricted. Furthermore, the recycling of these materials is, in some cases, not developed yet at the industrial level (only some pilot plants are available);
- data about EoL treatments are sometimes missing (e.g. concerning the shredding and sorting processes, losses of materials and quality of recycled materials) or out-of-date (e.g. concerning landfill/incineration of different materials, waste water treatments, etc.). The provision of detailed and up-to-date data on EoL processes is essential for a precise assessment of resource efficiency of products. Data gaps could be solved by organizing new campaigns for data collection at the recycling plants.

Options to solve the problems:

The previously described hurdles affect the uncertainties of LCA studies at different level but, however, it is not possible to set a univocal ranking of priorities.

Missing data about EoL treatments could be collected by establishing a network with relevant stakeholders (e.g. recyclers, association of recyclers, take-back schemes). This strategy could also contribute to the development and the maintenance of a European database on yields of recovery processes applied to EoL products, and associated recyclability/recoverability rates. Initial contacts have been taken with some stakeholders concerning digital technologies.

Data about impacts of primary production of some materials, when not directly measurable, should be extrapolated from data related to real production processes (mix of primary and secondary production). This task should be further explored with business associations, as for example the metal industries (e.g. Worldsteel, Eurocopper, European Aluminium Association).

Data about production of secondary materials can be obtained in cooperation with recyclers. Some potential partners could include Plastic Recyclers Europe (for plastics), Umicore (for some rare, precious and critical metals), Relight (for the recovery rare earths from fluorescent lamps). Initial contacts with Umicore and Relight have been already established.

Some of the previous problems (as for example missing data about primary/secondary production of some emerging materials) are very difficult to be overcome. These data are in fact, intentionally not disclosed by producing companies due to confidentiality reasons. In these cases, when it is observed the impossibility of collecting primary data, indirect estimations should be performed (based on e.g. average geological and mining data and production processes of potentially similar materials).

Observed difficulties related to missing information about EoL in available datasets could be solved by the introduction of specific fields in the metadata formats. These could require the insertion of potentially relevant details on: system boundaries and allocation rules adopted for

EoL; use, origin and treatments of scraps used as input materials; EoL processes considered for the functional unit and produced waste; estimated/calculated recovery/recycling yields; potential credits for recycled/recovered materials. High quality datasets should include detailed and reliable information in these fields, due to their potential relevance for the inventory and impact assessment phases.

An analysis aimed on identifying optimal level of aggregation of average LCIs data to allow fulfilling the confidentiality issue but providing enough details to capture processes peculiarity is desirable.

Finally, the accounting/assessment of the loss of quality of recycled materials (downcycling) still requires some additional research. In this case, in fact, the scientific community has not yet agreed on robust approaches to take it into account.

Time horizon and efforts needed for data collection:

According to the previously described difficulties, it is difficult to establish a time horizon needed for the collection of required data. The expected efforts are largely dependent on the availability of stakeholders providing data.

The data collection process could last various years, especially if the objective is to produce data representative for Europe. In fact, especially concerning data about recycling processes, a large geographical variability of treatments has been observed.

Furthermore recycling processes of some waste, as Waste of Electrical and Electronic Equipment (WEEE), are affected also by a large temporal variability, due to changes in the products' technology and compositions.

Possible links to other topics:

As evidenced in the introduction, the data need evidenced for the resource efficiency analysis of products is transversal to several other purposes. The analysis of EoL is, in fact, an essential part of every LCA.

In particular, the data need for the REAPro method is generally very close to that of the PEF and, in general, of all the supporting studies for products' declaration (e.g. the Environmental Product Declaration) and/or certification (e.g. the EU Ecolabel).

The collection of inventory data about primary and secondary production of emerging materials could serve the purpose of identifying, revising and updating the list of critical raw materials. The assessment of the criticality of raw materials could be, in fact, include information about life cycle impacts of the production processes. On the other side, low impacts due to recycling processes and high recovery yields for some materials could contribute to reduce their criticality.

Possible links with other ongoing activities on Ecodesign and recycling/recovery of products are:

- Preparatory studies for Ecodesign implementing measures[15] (according to the Directive 2009/125/EC) and other applications of the MEErP methodology[16];

[15] http://ec.europa.eu/enterprise/policies/sustainable-business/documents/eco-design/
[16] http://www.meerp.eu/

- Networks and activities for the recycling of some precious and critical materials (based e.g. on European programs[17, 18], and on industry research and dissemination programs[19]);
- Activities of standardization bodies on recyclability/recoverability of products[20];
- Research projects for some specific product groups and/or materials promoted by universities[21] and other research bodies[22 23].

Table 4.5.1 *Summary table for EPLCA as support to Ecodesign needs*

Time horizon	INPUT TO Ecodesign projects/studies	OUTPUT FROM Ecodesign projects/studies	Information dissemination	feasibility/ resource needs
short-mid term	- Inventory data of some exemplary EoL treatments for recycling/recovery - Inventory data for the production of some primary/secondary relevant materials	- Inventory data about some EoL treatments (ILCD / ELCD) - Partial database of recyclability/recoverability rates of some case-study products	- Ecodesign preparatory studies and reports (resource directory) - Scientific publications (EPLCA website) - -Dedicated session in the Forum	Feasible, with current resources, for the run on some pilot projects and for a restricted set of relevant products
Longer term	- Inventory data of main EU treatments for recycling/recovery - Comprehensive life cycle inventory database of primary/secondary production of materials (including some rare and critical materials)	- Inventory data about the majority of EoL treatments (ILCD / ELCD) - Robust database for Recyclability/recoverability rates of product's groups	- Ecodesign preparatory studies and reports (resource directory) - Scientific publications (EPLCA website) - Dedicated session in the Forum	Additional resources needed (doubling the current availability) for the production of a representative set of data

References

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Roadmap to a Resource Efficient Europe. COM(2011) 571 final.

Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the committee of the regions tackling the challenges in commodity markets and on raw materials. COM(2011) 25 final

Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the committee of the regions. A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy. COM(2011) 21

European Commission, Enterprise and Industry. "Critical raw materials for the EU. Report of the Ad-hoc Working Group on defining critical raw materials". 30 July 2010

[17] http://ec.europa.eu/enterprise/policies/raw-materials/critical/index_en.htm
[18] http://ec.europa.eu/enterprise/policies/raw-materials/erecon/index_en.htm
[19] http://www.preciousmetals.umicore.com/PMR/Media/sustainability/
[20] http://webstore.iec.ch/preview/info_iec62635%7Bed1.0%7Den.pdf
[21] https://lirias.kuleuven.be/handle/123456789/348773
[22] http://www.oeko.de/publications/dok/1193.php
[23] http://extra.ivf.se/hapla/Default.asp

4.6. Life Cycle Indicators

General introduction

In the context of the increased policy support for the life cycle thinking such as Integrated Product Policy (EC, 2003), Thematic Strategy on the sustainable use of natural resources (EC, 2005a), and Thematic strategy on the prevention and recycling of waste (EC, 2005b), EC-JRC has developed a framework for life cycle based indicators (EC 2012 a, b, c and d)[24]. These indicators are aiming at monitoring of the environmental impacts associated with European production and consumption, as well as waste management. They support different policy areas as outlined in table 4.6.1. Also, they respond to the current policy needs for the environmental impact indicators that capture also impacts from trade as expressed in the Roadmap to a resource efficient Europe (EC, 2011b) developed under A resource-efficient Europe – Flagship initiative of the Europe 2020 Strategy (EC, 2011a).

Among these indicators sets, the 'Resource efficiency indicators' set is designed to provide information on the potential environmental impacts of domestic European consumption and production, including the impacts that happen outside Europe, but are linked to European consumption (import). The environmental impacts are assessed according to the life-cycle assessment methodology, following the ILCD recommendations (EC, 2010b). This means that the environmental impacts are expressed in terms of LCIA impact categories (e.g. climate change, acidification, etc.). The dataset currently covers years from 2004 to 2006 for the whole EU27 and a case study member country (Germany) and the dataset is being currently updated within the EC-JRC-IES, to cover a longer time series from 1990 to 2010 for the totality of the EU countries.

Table 4.6.1 *Scope and policies addressed by life cycle indicators (EC, 2012a, b, c, d)*

INDICATORS	LCI DATA	SCOPE	POLICY
Resource efficiency indicators	LCI data sets of representative products traded in EU – cradle-to-gate boundaries LC-based territorial inventories - macro-level statistics on emissions and resource consumption, mapped into ILCD flows	Assessing the environmental impacts of the EU and of each Member State linked to the resource consumption and related environmental emissions Assessing the efficiency of the use of natural resources Assessing the degree of decoupling environmental impacts and economic growth	Sustainable use of natural resources [EC, 2005a] A resource-efficient Europe 2020 Strategy [EC, 2011a] Roadmap to a resource efficient Europe – [EC, 2011b]
Basket of products indicators	LCI data sets of products consumed in the EU – cradle to grave boundaries (Production, Use and EoL phases)	Assessing the environmental impacts related to the consumption of goods and services by an average EU (and MS) citizen	Integrated Product Policy [EC, 2003]
Waste management indicators	LCI data for management options (collection, transport, treatment, processing) for relevant waste streams LCI data sets of products avoided, to account for the environmental benefits of recovery and recycling	Assessing the environmental impacts related to the management of the waste streams in EU and in each MS.	Thematic strategy on the prevention and recycling of waste [EC, 2005b]

[24] http://lct.jrc.ec.europa.eu/

Possible links to EPLCA:

Arguably, the inputs to and the results from the LC-Indicators are of relevance to EPLCA, both in terms of datasets to be added into the ILCD DN, such as the ones resulting from the LC-Indicators, and in terms of support that EPLCA can provide to the further development of the LC-Indicators. Moreover, the inclusion of the LC-Indicators outcomes within the RD would be useful for dissemination purposes as very few examples of these macro-scale analyses are currently available in LCA literature, mostly related to normalization studies (Sleeswijk et al. 2008). Being different in nature, each of the dataset composing the Life Cycle Indicators has a different relation to the EPLCA. A brief overview of the LCI dataset which were developed within the project is listed below[25] and the potential relevance of such datasets is described in the following sections. The LC-Indicators LCI dataset is composed of several LCI data sets, as reported below:

1. ILCD and PEF compliant LCI of representative traded products (import and exports), with cradle-to-gate boundaries;
2. territorial statistics on emissions and resources consumption mapped into ILCD flows;
3. ILCD compliant LCA studies on representative products and services consumed in the EU – cradle-to-grave boundaries (Production, Use and EoL[26] phases);
4. LCI data for waste management options (collection, transport, treatment, processing) for relevant waste streams;
5. ILCD compliant LCI data sets of products avoided from recycling, to account for the environmental benefits of recovery and recycling, with cradle-to-grave approach.

Potential linkages between the EPLCA and the LC-Indicators:

The possible linkages between the EPLCA and the LC-Indicators are summarized below and discussed in the next paragraphs:

- Data storage and repository of the LC-Indicators database and PEF normalization factors;
- Support to the development of the LC-Indicators data network;
- Data provision for sector-scale analysis and link to traded products through product nomenclature.

Data storage and repository - Life Cycle Indicators database PEF normalization factors:

The LC-Indicators database is currently independent from the EPLCA, however is based on and linked to EPLCA/ILCD/PEF structure for what concerns the nomenclature of flows, the ILCD dataset format, as well as the recommended LCIA characterisation factors. The relations of the whole database of the LC-Indicators with the EPLCA is premised on the close one way connection, i.e. LC-Indicators are sourcing from the EPLCA all the data that are basic (e.g.

[25] Other datasets related to statistics on emissions and resources consumption, traded products (ComExt[25]), household expenditure and consumption by product, statistics on waste generation, collection and properties by waste sub-stream are part of the LCIndicators database, however such statistics are not taken into account, as not consisting of LCI data sets.

[26] End of Life

country codes, elementary flows uuid and names, characterisation factors etc.), in order to produce the environmental impact results based on the ILCD recommendations. In effect, the most important part of the LC-Indicators database which is connected to the ILCD DN is the life cycle inventories for domestic and trade related activities. These might form a node in the ILCD DN, but it is not crucial neither for the EPLCA nor for the usability of the LC-Indicators database. In order to benefit the most from the information stored within the LC-Indicators the ELCD and the ILCD DN should be populated by adding the LCI data sets relative to traded products (cradle-to-gate), most impacting products consumed in the EU, as well as LCI data on waste management options and avoided products due to waste recycling. For each of these LCI data sets, it would be worth to upload the relative studies on the RD. Moreover, as described in table 4.6.2, it could be worth to upload within the ILCD DN/ELCD the dataset related to the territorial inventory, mapped into the ILCD flows dataset; however this will have to be carefully analysed with regards to copyright issues.

Table 4.6.2. *LC-Indicators datasets of relevance for the EPLCA*

LC-Indicators datasets and documentation	EPLCA					
	ELCD	ILCD DN	Resource Directory	Forum	Reviewer Registry	Advisory group
Territorial Inventory – resource and emission flows mapped into ILCD elementary flow format	inclusion within the ELCD as dataset	inclusion within the ILCD DN as dataset	Papers and reports	To be further explored	A new Reviewer category should be added	nr*
ILCD and PEF compliant LCI on representative products of import/export – cradle-to-gate	inclusion of the LCI data sets within the ELCD (copyright issue)	inclusion of the LCI data sets within the ILCD DN (copyright issue)	Inclusion of PEF-compliant LCA studies	To be further explored	To be further explored	To be further explored
ILCD compliant LCI datasets of representative products consumed in the EU – cradle to grave boundaries (Production, Use and EoL phases)	inclusion of the LCI data sets within the ELCD (copyright issue)	inclusion of the LCI data sets within the ILCD DN (copyright issue)	Inclusion of ILCD compliant LCA studies	To be further explored	To be further explored	To be further explored
LCI data for management options (collection, transport, treatment, processing) for relevant waste streams	inclusion of the LCI data sets within the ELCD (copyright issue)	inclusion of the LCI data sets within the ILCD DN (copyright issue)	Inclusion of ILCD compliant LCA studies	To be further explored	To be further explored	To be further explored
LCI data sets of products avoided, to account for the environmental benefits of recovery and recycling	inclusion of the LCI data sets within the ELCD (copyright issue)	inclusion of the LCI data sets within the ILCD DN (copyright issue)	Inclusion of ILCD compliant LCA studies	To be further explored	To be further explored	To be further explored

*nr: not relevant

Support to the development of the LC-Indicators Data Network

Currently there is no existing life cycle indicators data network. However it should ideally built on, and intrinsic to, the EPLCA network so to link national LCA associations, researchers, statistical offices and other data providers from EU Member States. This would facilitate the upload, use and validation of country (Member State) specific datasets, both LC Inventories and statistics. By developing such DN, it is very likely that the quality of the data and estimations will be significantly improved. However this is a long-term project and substantial resources would have to be spent in order to start it up and maintain it over time.

Table 4.6.3. *Existing and expected datasets to be part of the LC-Indicators DN (limited to the Resource Efficiency Indicators)*

LC-Indicators existing and potential datasets and documentation.	LC-Indicators Data Network	
	Data typology	Expected data providers
Territorial Inventory – statistics on resources and emissions mapped into ILCD flows	relevant statistics on territorial emissions and resources consumption to be uploaded by data providers in case the LC-Ind DN becomes a node within the EPLCA	*statistical offices and other data providers from EU Member State, researchers*
Trade statistics on imported/exported products, taken from the ComExt database;	relevant statistics on trade to be uploaded by data providers in case the LC-Ind DN becomes a node within the EPLCA	*statistical offices and other data providers from EU Member State,*
Profiles of emissions and resources consumption from economic sectors	LC Inventories expressing environmental performances at economic sector scale (see the next section)	*national LCA associations, business, researchers, statistical offices and other data providers from EU Member State*

Data provision for sector-scale analysis and link to traded products through product nomenclature Through the implementation of the LC-Indicators Data Network and by making use of the ILCD and ELCD datasets that will be available in the future for more products it would be possible to model part of the EU production system and/or the EU import-related environmental burden. This would represent advancement in modelling sectorial environmental performance, while overcoming the limitations of other approaches which usually account for only a limited set of pollutants and resource consumed, such as the environmentally extended multi-regional input output tables (Wiedmann et al., 2011).

This would be possible provided that a link between the datasets stored in the ILCD DN and a statistical product code will be implemented. In order to do so, the implementation of the product category classification system within the ILCD format is needed. Such statistical structure could be directly taken from the statistics reported within the Eurostat statistical framework[27] or it can be refined accordingly to the specific needs, considering the broadness and representativeness of each statistical category. Such exercise would lead to a straightforward grouping of products within the ELCD and ILCD DN. Currently the ELCD is not

[27] i.e. NACE2, CPA, PRODCOM and CN nomenclature systems - http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Statistical_classification_of_economic_activities_in_the_European_Community_%28NACE%29

including any statistical coding of products. The structure of the database should be revised in order to add this field that is meant to be beneficial as discussed above. The implementation of the statistical classification can be made operational by:

- Modifying the ELCD/ILCD structure by adding a field on product classification to the ELCD database;
- Modifying the ELCD/ILCD manual by including the technical specifications of such modification;
- Modifying the entry level information required from LCI datasets, by asking the providers to report the CN-8 digit code (and/or other codes) associated with the products ;
- Adding a key search feature to the ELCD search page, so that users interested in having information on specific sectors and products can easily get it;
- Reviewer's guidelines/manuals: such modification should be integrated within the reviewer's manuals in order to allow consistency within the reviewing process.

Such new requirement could be potentially seen by data providers as a further effort, especially if the ILCD nomenclature on products/processes and the statistical nomenclature to be adopted are too different. This aspect should be assessed and evaluated through a dedicated analysis before making any change to the ELCD and Platform structures. The development of such classification might be beneficial to the PEF and OEF methodological development and applications to the definition of product groups/categories and then to normalization factors by product group/category. The reviewer registry should be implemented accordingly to the newly information (statistical classification), so that reviewers are asked to be competent in this field as well for checking whether the statistical classification is consistent or not.

The outcomes of such modifications are expected to be potentially beneficial for the LC-Indicators project (or other projects e.g. scenario analysis, assessment of economic sectors environmental performance, integrated sustainability assessment platform ISAP) in the long run, when the ELCD / ILCD DN datasets will be more complete than it is now. The higher the number of datasets stored in the dataset, the higher the potential relevance to the projects mentioned above. For the time being, there is no strict priority of having such modification done in the ELCD / ILCD DN.

Problems/Hurdles to overcome and priorities

In table 4.6.4 the summary of the links between EPLCA and LC-Indicators as foreseen in the nearby future are reported.

The key option to overcome the issues related to the product statistical classification within the ILCD is to carry out an in-depth feasibility analysis aimed at comparing ILCD and PRODCOM or equivalent international nomenclature systems, as well as assessing how such additional requirement can be met by the data providers. This could be done by starting from the ILCD-compliant datasets. The analysis should clearly underline the issues and problems arising from such modification, both in terms of consistency and in terms of needed data provision efforts. A set of industrial associations such as the ones already providing the LCI datasets to the ILCD/ELCD (e.g. Plastics Europe, Worldsteel, etc.) as well as companies (e.g. Pre', PE International, etc.) should be informed and involved in the process to getting their feedback on such proposed modification.

The time horizon for such implementation could be approximately quantified in 1 to 1.5 persons-years. The first task could consist in the assessment of the feasibility of such modification, for which 6 to 9 person-months should suffice. Then the second task would be the development of a statistical classification system building on the existing ones within Eurostat as well as the development of a methodology for matching the existing datasets within the ELCD to the existing statistical classes and the updating of the ILCD guidelines. This could cost from 6 to 9 person-months. However, the time horizon of the results could be much longer, from 3 to 5 years, depending on how the ELCD will develop in the short run.

Table 4.6.4. *Summary table for EPLCA linkages to and from LC-Indicators*

Time horizon	INPUT TO LC-Indicators	OUTPUT FROM LC-Indicators	Information dissemination	Estimate on feasibility/ resource needs
short term	ELCD datasets PEF Guidelines ILCD Handbook ILCD DN	Draft life cycle indicators: domestic and trade life cycle inventories, basket-of-products, both LCI and impact assessment results Analysis of product nomenclature consistency with the ELCD Storage and repository of the LC-Indicators database and normalization factors within the ELCD/ILCD DN	Papers, reports, website, forum	Feasible with current institutional + limited foreseeable additional competitive resources
Long term	Analysis of product nomenclature consistency with the ELCD ELCD data sets PEF Guidelines ILCD Handbook	sector-scale analysis based on LCI of products available within the ELCD/ILCD DN and trade statistics through product nomenclature Improved life cycle indicators: domestic and trade life cycle inventories, impact assessment results	Papers, reports, website, forum	Feasible with current institutional resources + additional competitive resources remains available, or increased institutional resources.

References

European Commission, 2012. Life cycle indicators framework: development of life cycle based macro-level monitoring indicators for resources, products and waste for the EU-27. European Commission, Joint Research Centre, Institute for Environment and Sustainability. ISBN 978-92-79-25937-1

Sleeswijk A.W., van Oers L.F.C.M., Guinee J.B., Struijs J., Huijbregts M. A. J., 2008. Normalization in product life cycle assessment: An LCA of the global and European economic system in the year 2000

Wiedmann T., Wilting H.C., Lenzen M., Lutter S., Palm V., 2011. Quo Vadis MRIO? Methodological, data and institutional requirements for multi-region input–output analysis. Ecological Economics 70 (2011) 1937–1945

5. Potential Links of EPLCA to other EU community and international activities

The EPLCA is a wide and open set of tools, supporting life cycle initiatives also beyond the EC-related activities; the scopes of the platform can be extended at EU level, as regards both institutional and private actions, as well as at the international level. The external activities are therefore deemed very relevant, in terms of data and info exchange, avoiding duplication of efforts, on a bi-directional way. It has to be noted that **the list of mentioned activities is not exhaustive, but exemplary.**

5.1. EU funded research projects including life cycle approaches

DG RTD may play a strategic role Through the FP7 framework program, life cycle thinking has been promoted but a direct link between the programs and the EU platform on LCA is not established, even if DG RTD includes explicit reference to the EPLCA, in the calls including LCA activities. A closer coordination within Horizon 2020 may be beneficial and this may imply boosting the availability of updated data and studies.

Some potential areas of synergies with DG RTD are:

Knowledge mining form FP7 project dealing with LCA (in order to collect data and case studies on already funded projects). A systematic analysis of the extent to which LCA has been used within FP7 could be envisaged. Obviously, the previous projects/case studies will not fulfil the ILCD requirement in most of the cases. However, gathering data and studies could be of interest, especially in relation to emerging materials and technologies.[28]

The potential of better integrating in Horizon 2020 the adoption of LCA for the evaluation of new technologies and materials, requiring to prepare an inventory ILCD compliant and asking for adding the study in the resource directory. Ideally, the costs of the review of both dataset and study have to be considered as an eligible cost in the project.

In the future the possible links between the EPLCA and DG RTD can include the creation of a DG RTD node in the data network, for inventory developed by EU funded project; the coordination with DG RTD in order to populate the resource directory with case studies developed within EU funded project; the participation of DG RTD in the Forum:

5.2. EU-funded developing and international cooperation projects

DG DEVCO in a recent communication to the European Parliament, the Council, and other EU institutions (Brussels, COM-2013-92) stated that *"The EU will continue to pursue the sustainable development, including by implementingRio+20 commitments through a range of overarching policies, in particular through its overarching strategy for smart, inclusive and sustainable growth - Europe 2020. This covers, inter alia, resource efficiency, low carbon economy, research and innovation … …Sustainable development objectives will be made operational through a range of key policies under preparation, including the reform of the*

[28] E.g. in a recent report by DG RTD (Report on Responses to Questionnaire on Environmental Issues in FP7 NMP Projects on Materials, 2012, ISBN 978-92-79-25640-0) 28% of the respondents stated that they conduct a LCA within the funded project. NMP -Nanotechnology, Materials & Production

Common Agricultural and the Common Fisheries Policies, the forthcoming 7th Environmental Action Programme, the Innovation Union, Horizon 2020 and the Social Investment Package… ….Through its external action and notably the implementation of the Agenda for Change, the EU will continue facilitating progress towards the MDGs and sustainable development in developing countries, with a specific focus on the least developed and the ones most in need. At the same time, a number of actions need to be carried out in order to contribute to the implementation of Rio+20 commitments." In this perspective, several EU activities are expected to give a significant contribution to the implementation of the "Rio+20" agreements and related topics. Among them ELCD at the EU level, and the ILCD DN worldwide, are expected to give a significant contribution to the Clean industry and life cycle accounting area.

Some potential areas of synergies with DG DEVCO are:

Under this framework it would be useful to set up a system of data collection and exchange, in line with the ILCD requirements. A specific node financed/managed by DG DEVCO could be deployed in the ILCD DN, including the data coming from developing and cooperation projects, furthermore the platform can support some other activities related to this field, such as a dedicated area in the upcoming forum and a specific node within the reviewer registry. These objectives are linked with the UNEP/SETAC Life Cycled initiative, described below.

5.3. UNEP/SETAC Life Cycle Initiative

The overarching objective of the Life Cycle Initiative[29], in line with the Rio+20 objectives[30], is to: Facilitate the generation and uptake of science-based life cycle approaches and information for products by business, government and civil society practice worldwide as a basis for sustainable consumption and production. The specific objectives of the Life Cycle Initiative are to:

- Enhance the global consensus and relevance of existing and emerging life cycle methodologies and data management;
- Expand capability worldwide to apply and to improve life cycle approaches; making them operational for organisations;
- Communicate current life cycle knowledge and be the global voice of the Life Cycle community to influence and partner with stakeholders.

Some potential areas of synergies with the UNEP/SETAC LC Initiative are:

The UNEP/SETAC Life Cycle Initiative Phase 3 (2012-2017) contains a flagship on Global database management network and training, building in particular on the "Global Guidance Principles for Life Cycle Assessment Databases"[31]. The enounced principles contribute to inspire the ILCD DN. The ILCD DN has been inspired by the above said Global Guidance Principles. Cooperation with the Life Cycle Initiative, with UNEP in particular, should be strengthened. Joint organization of working group and workshop on the Format and Nomenclature topics would be very useful.

[29] www.lifecycleinitiative.org

[30] UN 2012. A/CONF.216/16 Report of the United Nations Conference on Sustainable Development. Rio de Janeiro, 22-6-2012

[31] UNEP - SETAC Life Cycle Initiative (2011). "'Shonan Guidance Principles' - Global Guidance Principles for Life Cycle Assessment Databases."

As capacity building is one of the main goals of the initiative, there could be some common advantages from proposing to UNEP:

- The use of EPLCA RD to support knowledge sharing among LCA practitioners of UN countries
- The use of The ILCD DN as a tool to promote LCI data sharing
- To include courses on EPLCA tools in their capacity building program

Currently, IES is participating to a working group on LCI data quality chaired by UNEP. The work done with the working group will contribute to some of the development proposed within this document.

5.4. European Resource Efficiency Platform

Europe is taking important decisions on strengthening economic and monetary union, the future EU budget and engaging with the international community in the follow up of the Rio+20 Summit. Against this background, the European Resource Efficiency Platform (EREP) is calling on business, labour and civil society leaders to support resource efficiency and the transformation to a circular economy and society now because this offers a path out of the current crisis towards a reindustrialisation of the European economy on the basis of resource-efficient growth that will last[32]. A circular, resource-efficient and resilient economy should be achieved in a socially inclusive and responsible way by creating better market conditions for products and services that have lower impacts across their life-cycles.

Some potential areas of synergies with the EREP activities are:

- Supporting Resource efficiency knowledge sharing through the RD
- By supporting Life Cycle Study providing high quality data (e.g. within the Resource Directory)
- Through enhancing discussion throng the EPLCA forum

[32] MANIFESTO FOR A RESOURCE-EFFICIENT EUROPE - European Commission - MEMO/12/989 - 17/12/2012

6. Interoperability among ELCD/ILCD DN and existing LCA software

A key common need for the success of the ILCD DN and the ELCD projects, and for a fruitful implementation of all projects mentioned above, is to increase the interoperability among ELCD/ILCD DN and existing LCA software packages.

Facilitating the development of ILCD format datasets is crucial to increase the availability of high quality coherent data contributing to the ELCD and to the ILCD DN.

Furthermore, the launch of the ILCD Data Network will increase the number of ILCD format datasets shared among LCA community to be used to perform LCA study. Facilitating the use of ILCD format datasets in existing LCA software packages will become crucial.

Moreover, the compliance with ILCD format, documentation and nomenclature are enforced in EF requirements and are referred to in other EC LC projects.

So far, the most important LCA software, are not releasing an import/export tool for the ILCD format. Currently, only OpenLCA software, released under an open source license by GreenDelta GmbH, allows the interoperability with the ILCD Format.

A better interface between ILCD format datasets, and LCA software may be required in the next future to ensure the diffusion of the ILCD DN.

Conversion between ILCD format and other formats will increase Interoperability between the ELCD and ILCD Format datasets and existing LCA software. Some Aspects to be considered under this framework are described in the following paragraphs.

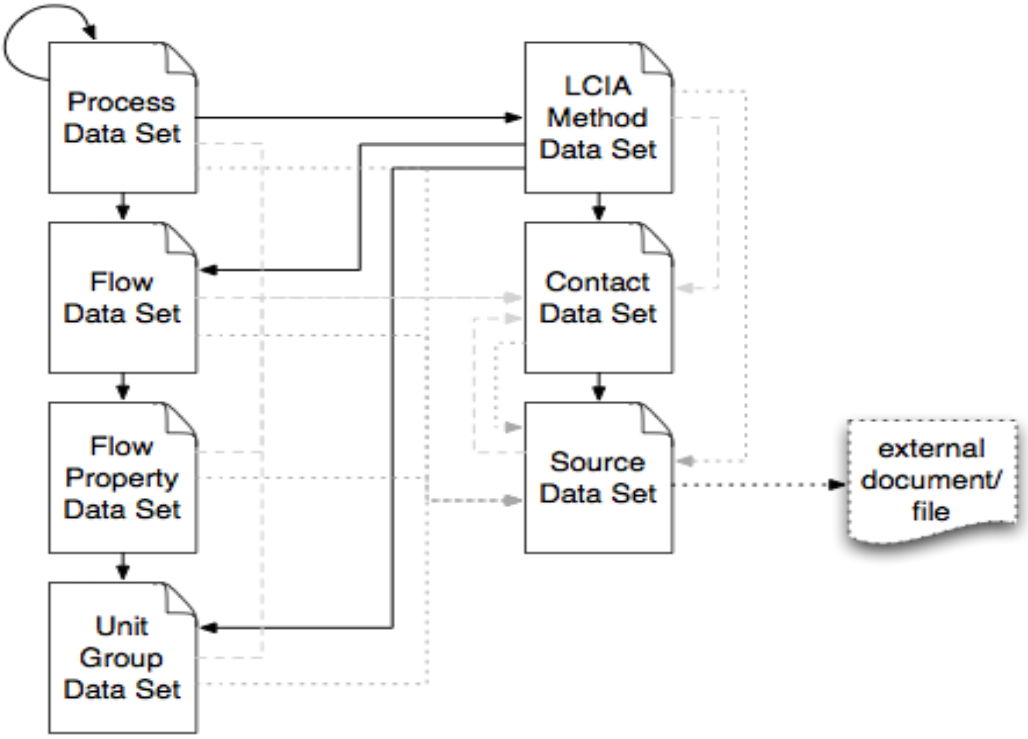
6.1. ILCD Format

The ILCD format is designed to be comprehensive in scope, starting from ISO/TS 14048, taking into account documentation needs of the formats of widespread LCA software and databases. This has been achieved by analysing the most widely used and market-relevant formats, identifying documentation needs, and involving various stakeholders through an extensive consultation.

To improve the data exchange and work-flow also from the IT and web perspectives, the ILCD format implementation in XML (extended Mark-up Language) has been focusing on supporting effective workflow and efficient data management in a web 2.0 context. The ILCD format is open to all software and database developers, not only for the implementation of interfaces allowing the data exchange with the ILCD Data Network, but also to be used as internal working format, in order to self-create datasets directly in the ILCD format. This is free of charge and has been available for software developers from a long time.

In order to increase documentation capabilities offered by the ILCD format, seven dataset types are needed to represent both LCIs and LCIA Methods. Figure 6.1.1 shows the seven data set types and their relationship.

Figure 61.1. ILCD format datasets



Although facilitating LCA practitioner to proper use ILCD format datasets, the use of multiple datasets to document LCI, increases the complexity in the database management and interoperability with LCA software tools.

6.2. ILCD Nomenclature

Different LCA data providers often use considerably different nomenclature and other conventions. As a consequence, LCI datasets are mismatched at different levels, that represents the major limitation to the combined use of LCI datasets from different sources, and electronic data exchange among practitioners and tools. This situation also hampers a clear and unambiguous understanding of LCA study reports and their efficient review.

JRC has developed a guidance document (EC, 2010) in order to overcome the described issues, affecting LCI data collection, documentation and use in LCA studies, by providing a common nomenclature and provisions on related topics. This is meant to support an efficient LCA work and data exchange among different LCA tools and databases.

JRC has also developed a common reference elementary flow list .An updated version of the reference flow list has been recently released. The current version includes around 40.000 elementary flows, supporting both LCI and LCIA methods.

Several attempts have been made to develop reliable mapping solution between other major existing nomenclature systems and the ILCD one, unfortunately none of these attempts has been completely successful covering 100% of existing elementary flows. Although the ILCD

reference flow list covers all substances having a characterization factor considering this might still be enlarged.

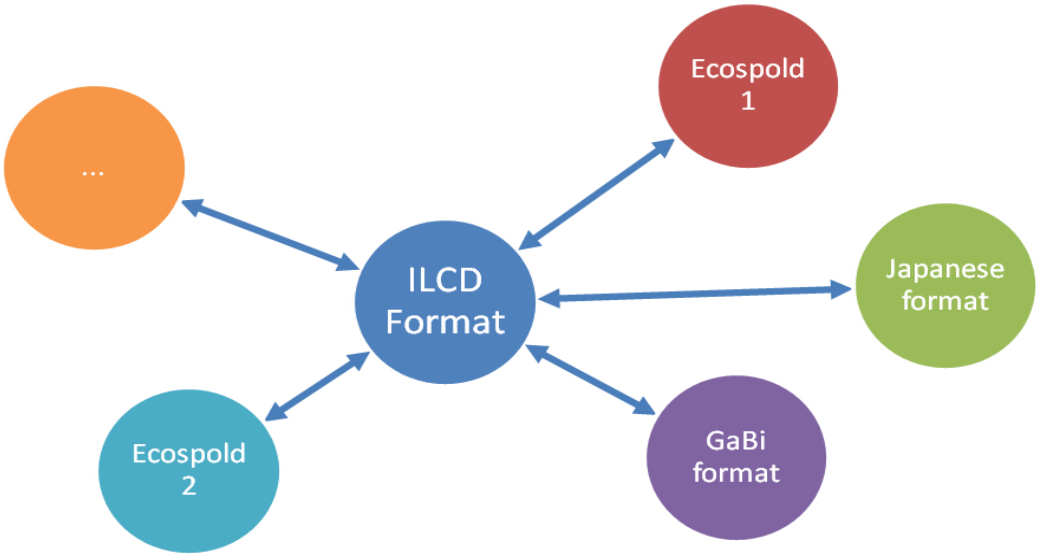
Among the flows that were not properly mapped three categories can be outlined:

- Flows existing in other nomenclatures but not in the ILCD reference flow list not having a characterization factor in the ILCD recommended LCIA methods
- Flows existing in the ILCD reference flow list and not in other nomenclatures
- Flows used differently in different nomenclatures than the ILCD one

6.3. Problems/Hurdles to overcome and priorities:

Solving current interoperability hurdles, the ILCD format would become the "de facto" reference format. Once this goal would be achieved, commonly available LCA software will allow a faster and better editing of ILCD files, facilitating ILCD datasets development. Following sub-paragraphs describe needed actions

Figure 6.3.2. *ILCD format positioning*



Adopting common nomenclature

During a recent meeting with the Advisory Group for tools and database developer, the need to adopt a common nomenclature has been underlined. The following steps are to be made:

- Establishing a working group (e.g. involving UNEP) including all main actors in order to:
  - Defining operational framework to solve issues related to existing nomenclature and the ILCD one
  - Defining rules for enlarging the future common nomenclature
  - Developing guidance tools for the development of new flows
- Instituting a permanent steering committee:
  - Maintaining the elementary flow list
  - Collecting
  - Updating the common nomenclature

It is strongly recommended a direct involvement of JRC, in order to ensure the harmonization of other nomenclature systems to the ILCD one.

Adapting ILCD format current needs

A critical review of the ILCD Format could be needed, depending on the new development related to the ILCD DN, the working group on nomenclature and the future developments of the above described projects. This document could be developed together with the UNEP LC Initiative.

The needed adaptation of the ILCD Format should be realized with the support of KIT. The ILCD Format should be implemented as an open source project.

Format converter

A format converter with the following characteristics may be developed:

- Converting major formats LCI datasets into the ILCD format and vice versa
- Converting LCIA methods datasets into the ILCD format and vice versa
- Connected to the ILCD DN or other existing DN (if any) in order to convert datasets consistently with other existing one
- Allowing the use of multi-mapping files depending on the adopted nomenclature

Possible links to other EPLCA elements:

EPLCA Forum will represent a perfect tool to animate discussion on nomenclature. It is recommended to open such a section.

Table 63.1. Summary table

Time horizon	Objectives	Information dissemination	Estimate on feasibility/ resource needs
short-mid term	Developing a LCI datasets format converter with the following characteristics: Converting major formats LCI datasets into the ILCD format and vice versa; Converting LCIA methods datasets into the ILCD format and vice versa; Connected to the ILCD DN or other existing DN (if any) in order to convert datasets consistently with other existing one; Allowing the use of multiple mapping files depending on the adopted nomenclature. Establishing a working group on nomenclature Critical review of the ILCD Format (e.g. involving UNEP): Defining operational framework to solve issues related to existing nomenclature and the ILCD one; Defining rules for enlarging the future common nomenclature; Developing guidance tools for the development of new flows Using EPLCA Forum for debating on nomenclature	JRC Reports Scientific publications	Feasible with institutional + competitive resources
Longer term	launching a permanent steering committee on LCA nomenclature Implementing ILCD Format needed development	JRC Reports Scientific publications	Feasible with increased institutional resources

References

- European Commission, J. R. C., Institute for Environment and Sustainability (2010). International Reference Life Cycle Data System (ILCD) Handbook, Nomenclature and other conventions.

Acknowledgments

The editing and publication of the present report has been partly funded under the framework of the Administrative Arrangement between DG ENV and DG JRC – Institute for Environment and Sustainability (IES). № 070307/2012/ENV.C.1/635340 - "Environmental Footprint and Material Efficiency Support for Product Policy". Specifically referred to the Task and Deliverable 3 of the AA.

European Commission
EUR 26379– Joint Research Centre – Institute for Environment and Sustainability

Roadmap for the European Platform on Life Cycle Assessment: facilitating data collection and sustainability assessments for policy and business

Authors (in alphabetical order): Karen Allacker, Fulvio Ardente, Lorenzo Benini, Camillo De Camillis, Simone Fazio, Malgorzata Goralczyk, Lucia Mancini, Rana Pant, Marco Recchioni, Serenella Sala, Erwin M. Schau.

Luxembourg: Publications Office of the European Union

2013 – 67 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series

ISSN 1831-9424

ISBN 978-92-79-34880-8

DOI: 10.2788/47216

LB-NA-26379-EN-N

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

Publications Office

ISBN 978-92-79-34880-8

9 789279 348808