Chapter 4
The UNEP/SETAC Life Cycle Initiative

Guido Sonnemann and Sonia Valdivia

Abstract The activities of the UNEP/SETAC Life Cycle Initiative have been crucial for the dissemination of LCA worldwide and the creation of a global life cycle community, since 2002, after the ISO 14040 series had been established. The Life Cycle Initiative not only contributed to capability development and the set up of national and regional life cycle networks in different parts of the world but also to enhancing and building global consensus on life cycle methodologies in areas such as life cycle inventory (LCI), life cycle impact assessment (LCIA), social life cycle assessment as well as carbon and water footprinting. Moreover, the Life Cycle Initiative has successfully promoted the way leading companies are doing life cycle management (LCM) and the integration of the three dimensions of sustainable development in life cycle sustainability assessment (LCSA).

The chapter opens with an introduction on how the UNEP/SETAC Life Cycle Initiative came to life and developed over the years. Then the special relationship of the Life Cycle Initiative to The International Journal of Life Cycle Assessment is highlighted. This section is followed by a description of the main contributions of the Life Cycle Initiative to the international community. In the subsequent section the key messages based on the work conducted during the last 10 years are described. The chapter finishes with some thoughts on the future of life cycle thinking and an introduction to the Phase 3 of the Life Cycle Initiative.

The chapter includes the list of key achievements of the Life Cycle Initiative's Phase 1 and 2 activities that are the creation of a global life cycle community, the LCI Registry, the LCIA Midpoint-damage Framework, the USEtox model, the LCM guide and capability maturity framework, the social LCA guidelines, the LCSA framework and the global guidance principles for LCA databases.

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Keywords Global capability development · LCA databases · LCI registry · LCIA midpoint-damage framework · Life cycle assessment (LCA) · Life cycle impact assessment (LCIA) methodologies · Life cycle inventory analysis (LCI) · Life cycle management (LCM) · Life cycle sustainability assessment (LCSA) · Life cycle thinking · Product sustainability information · Society of Environmental Toxicology and Chemistry (SETAC) · Sustainable consumption and production · United Nations Environment Programme (UNEP) · USEtox model

1   Introduction

In 2002 the United Nations Environment Programme (UNEP), the Society of Environmental Toxicology and Chemistry (SETAC) and partners from governments, academia, civil society, business and industry joined forces to promote life cycle approaches worldwide as a way to increase resource-efficiency and to accelerate a transition towards more sustainable consumption and production patterns. Sustainable development objectives and a company's bottom line come together in the important topic of assessing and managing the life cycle of processes, materials, products and services. After the publication of the ISO 14040 standard dealing with LCA (ISO 14040 1997), UNEP and SETAC, aware of the need for dissemination and implementation, jointly began to engage more partners to work on the articulation of science-based existing efforts around life cycle thinking and established the UNEP/SETAC Life Cycle Initiative (Life Cycle Initiative).

We would like to acknowledge here the crucial role of Helias Udo de Haes, founder and former scientific director of CML, Leiden University, The Netherlands. As chairman of the LCA Steering Committee of SETAC, he took the initiative for the establishment of the UNEP/SETAC Life Cycle Initiative, of which he has been the first and only director until 2006. Olivier Joillet, who at that time was at EPFL in Switzerland, assisted him (Udo de Haes et al. 2002).

UNEP's former Assistant Executive Director Jacqueline Aloisi de Larderel welcomed their efforts and asked them to also engage experts from Asia, North America and Latin America. In this way, Atsushi Inaba from Japan, Jim Fava from SETAC North America and Ana Quiros from Costa Rica were invited to join the organizing committee. Jacqueline Aloisi de Larderel facilitated, jointly with the former UNEP staff Bas de Leeuw and Anne Solgaard, the launch of the initiative in Prague in 2002 and the arrival of Guido Sonnemann to serve the Secretariat of the Initiative. The latter was further strengthened by the recruitment of Sonia Valdivia in 2005.

The life cycle partnership for a more sustainable world between UNEP, SETAC and public/private sector partners has the overall objective of promoting, assisting and supporting the application of life cycle thinking and life cycle approaches, including life cycle management, life cycle assessment, carbon footprinting and water footprinting, by governments as well as companies and their suppliers, customers and other value-chain partners worldwide. The final purpose is furthering sustainable innovation and global use of more sustainable products.

The Life Cycle Initiative is a response to the call from governments for a life cycle economy in the Malmö Ministerial Declaration (2000). It contributes to the 10-Year Framework of Programmes (10YFP) on Sustainable Consumption and Production (SCP), which is a process setup to promote sustainable consumption and production patterns. The 10YFP was adopted during the so-called Rio+20 World Summit on Sustainable Development in June 2012. The Initiative facilitates the exchange of knowledge of currently over 2000 experts worldwide and four regional networks from different continents.

The Life Cycle Initiative's activities to date have been carried out in two phases, in which around 200 members of the global life cycle community have been actively involved.

The first phase (2002–2007) focused on establishing the Life Cycle Initiative as a global focal point of life cycle-related knowledge and activities and on building an expert community of practitioners. Activities to move the Life Cycle agenda forward concentrated on three important fields of work:

1. Life Cycle Management (LCM),
2. Life Cycle Inventory (LCI), and
3. Life Cycle Impact Assessment (LCIA) as well as the crosscutting area of social impacts along the life cycle.

The Life Cycle Management field was added to the LCA areas of LCI and LCIA after the successful first LCM conference and related workshop organized by Allan Astrup Jensen in Copenhagen in 2001. It was considered important by UNEP to focus not only on assessment but also on the use of the life cycle approach and related knowledge in business practice (Sonnemann et al. 2001).

At the end of the first phase a process was started to help the creation of regional and national life cycle networks, in particular in developing countries, to support capability development. In particular due to the important personal engagement of Greg Norris, Harvard School of Public Health, it was possible to get life cycle networks in Africa and Latin America off the ground (Sonnemann 2004b).

Phase 2 activities (2007–2012) saw the Life Cycle Initiative evolve to be more participative with regard to stakeholders, encouraging more involvement from key actors at the global level in order to achieve common understanding and agreement on tools and strategies being developed. The main outcomes of Phase 2 were accomplished through close collaboration with crucial stakeholders in the field.

In both phases, the Life Cycle Initiative was able to provide support in the application of sustainability-driven life cycle approaches based on lessons learned from leading organizations by its capacity of engaging with world class experts and practitioners working in product policy, management and development.

The International Life Cycle Panel (ILCP) became the International Life Cycle Initiative Board (ILCB) in Phase 2 and oversaw the activities of the Life Cycle Initiative in all these years. The name change from ILCP to ICLB was done to emphasise on its actual role as governing body of the Initiative, bringing together all key partners convened by UNEP and SETAC, and to differentiate it from the UNEP International Resource Panel (IRP) launched in 2007. The ILCB plays a key

role in the decision making process and provides strategic direction to the overall work of the Life Cycle Initiative. The Secretariat is hosted at UNEP and helps in implementing the tasks as recommended by the ILCB. The director and the team of programme managers in Phase 1 and the Coordination Committee headed by Jim Fava and consisting of work area chairs in Phase 2 supported the Secretariat.

In 2011 Guido Sonnemann was asked by the ILCB to lead, jointly with Bruce Vigon from SETAC, the strategy development for the next phase of the Life Cycle Initiative that was launched at the global level in Yokohama in November 2012.

In **Phase 3**, a Project Management Group co-chaired by Jim Fava and Guido Sonnemann assists the Secretariat. The vision, mission and activities foreseen in this new phase of the Life Cycle Initiative are explained in Sect. 5.

Before addressing the future of life cycle thinking in Sect. 5 as well as conclusions and perspectives in Sect. 6, the special relationship between the UNEP/SETAC Life Cycle Initiative and The International Journal of Life Cycle Assessment will be described in Sect. 2. Main contributions of the Life Cycle Initiative to the international community in Phases 1 and 2 from 2002 to 2012 will be defined in Sect. 3, and key messages based on the work conducted during the last 10 years will be highlighted in Sect. 4.

2   The UNEP/SETAC Life Cycle Initiative and The International Journal of Life Cycle Assessment

The International Journal of Life Cycle Assessment is the first journal devoted entirely to Life Cycle Assessment. It is a forum for

- scientists developing Life Cycle Assessment and Life Cycle Management,
- LCA and LCM practitioners, consultants and managers concerned about the environmental aspects of products,
- governmental environmental agencies responsible for product quality,
- scientific and industrial societies involved in LCA development, and
- environmental institutions and bodies.

That means that the target audience is similar to the one of the Life Cycle Initiative.

Due to the complementary of the journal and the Initiative, the board of the UNEP/SETAC Life Cycle Initiative decided in 2003 to establish an official collaboration with The International Journal of Life Cycle Assessment, which became the Associated Journal of the UNEP/SETAC Life Cycle Initiative. The co-chairs of the ILCP, Jacqueline Aloisi de Larderel and Jim Fava, appreciated the efforts undertaken by the journal to globalize the use of LCA by being at that time also the official organ of the LCA Society of Japan, the Indian Society for LCA, the Korean Society for LCA, and the Australian LCA Society (Aloisi de Larderel and Fava 2003).

As part of the collaboration, the journal agreed to regularly inform about recent developments and activities of the Life Cycle Initiative and to provide active members of the Initiative from developing countries the journal for a reduced fee.

Already before this agreement, the journal reported with a special issue about the launch of the UNEP/SETAC Life Cycle Initiative. The launch took place on 28 April 2002 during UNEP's 7th High-level Seminar on Cleaner Production, and in presence of the former SETAC President Lorraine Maltby and UNEP's Executive Director Klaus Töpfer. The latter prepared an editorial for the journal and thanked its editor-in-chief, Walter Klöpffer, not only for his valuable work in promoting Life Cycle Assessment and Life Cycle Management on an international level but also for his support of the Life Cycle Initiative by this special issue (Töpfer 2002).

Since 2003 The International Journal of Life Cycle Assessment has been reporting on the Initiative's activities in the so-called Corner of the UNEP/SETAC Life Cycle Initiative in a continuous way: for example in 2005 about progresses in Life Cycle Impact Assessment within the UNEP/SETAC Life Cycle Initiative (Jolliet et al. 2005), in 2007 about the first Phase 2 activities of the Initiative (Sonnemann and Valdivia (2007) and in 2011 about the process on global guidance for LCA databases (Sonnemann et al. 2011).

Furthermore, it has published relevant deliverables such as the LCIA Midpoint-damage Framework of the UNEP/SETAC Life Cycle Initiative in 2004 (Jolliet et al. 2004), the activity of Task Force 1 on global life cycle inventory data resource (Curran 2006) and a special issue on USEtox in 2011 (Hauschild et al. 2011). The secretariat has been negotiating with the journal an open access to a number of those deliverables.

The journal has also been helpful in announcing conferences such as CILCA (International Conference on Life Cycle Assessment) in Costa Rica in 2005 (Sonnemann et al. 2005)[1] and the recent Indian life cycle assessment and management conference in 2012 (Datta et al. 2012) as well as in reporting on events such as in the form of key observations arising from papers on sustainable production, use and recycling of natural resources from the symposium in Portland in 2006 (Fava et al. 2006).

We expect this fruitful cooperation for enhancing the state of worldwide LCA development to continue in the future. As a first step updates on recent developments in Life Cycle Impact Assessment and the finalization and current dissemination activities of the publication on global guidance principles on LCA databases are foreseen. Moreover, special issues on Life Cycle Sustainability Assessment and global land use impacts on biodiversity and ecosystem services in LCA are under preparation.

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[1] The conference series provides an international forum to share experiences on Life Cycle Thinking and related tools. CILCA is a bi-annual event which is held in different countries of Latin America convoking experts and interested audiences from across the globe. The first CILCA was held in 2005 in San José Costa Rica, and from there has followed a successful journey which included locations spread all along the region: Sao Paulo (Brazil) in 2007, Pucón (Chile) in 2009, and Coatzacoalcos (Mexico) in 2011.

3   Main Contributions from 2002 to 2012 of the Life Cycle Initiative to the International Community and Best Examples Worldwide

In this section we will highlight the main contributions from 2002 through 2012 of the Life Cycle Initiative to the international community. This includes relevant deliverables as best examples worldwide. Those deliverables that have been published in official UNEP and SETAC documents, have got an ISBN number and are parts of scientific journals, in particular The International Journal of Life Cycle Assessment, are referenced throughout the text. Other reports, training material and tools mentioned are available at the website of the Life Cycle Initiative at http://www.lifecycleinitiative.org.

3.1   Phase 1—Creating a Global Community

In Phase 1 from 2002 to 2007, programmes to move the life cycle agenda forward concentrated on three important fields of work:

1. Life cycle management,
2. Life cycle inventory, and
3. Life cycle impact assessment including the crosscutting area of social impacts along the life cycle.

3.1.1   The Life Cycle Management Programme

The Life Cycle Management programme was oriented to the application of life cycle approaches aiming to bring LCA and life cycle thinking into the **practice of business** and into policy decision-making. The specific aims were to:

• create awareness and improve skills of decision makers by establishing forums for best practice and carrying out training programmes all over the world;
• document experiences on practical applications of Life Cycle Thinking and to highlight enablers and barriers for development and implementation of a LCM approach;
• develop a LCM framework for different tools and concepts, including e.g. Integrated Product Policy or Extended Product Responsibility;
• take into account economic, social and ethical aspects, and occupational health and safety, risk management, community outreach and other related programs;
• identify needs and availability of training modules and dissemination;
• make recommendations on how to approach the needs of developed, emerging and developing economies as well as SMEs.

Deliverables from this programme that partially continued beyond 2007 include:

- LCM definition study;
- LCM background document;
- Life Cycle Management—A business guide to sustainability (UNEP/SETAC 2007);
- Communication of life cycle information in the building and energy sectors (UNEP/SETAC 2008);
- LCM training kit material in English, French, Spanish and Portuguese.

The following Task Forces (TFs) had been established under the Life Cycle Management (LCM) Programme to help achieving this deliverables:

- LCM Handbook (LCM TF 1)
  - In absence of an agreed upon definition for LCM, the handbook was aimed to introduce the LCM framework, discuss drivers and needs, describe the major underlying approaches and provides selected illustrative examples and successes while introducing and using LCM in practice. As part of the deliverables of this Task Force, a Training Kit on LCM for Trainers and Delegates had been developed.

- Life cycle based product development (LCM TF 2)
  - The integration of environmental considerations along the products life cycle in the product development process, rather than as an isolated function, was subject of this task force. Results of its discussions served the development of the LCM Handbook by the LCM TF2.

- Communication of life cycle information (LCM TF 3)
  - The task force had the aim to position the existing tools for the communication of life cycle information and identify the best options to initiate changes of consumption and production patterns. In particular the task force examined the mutual reinforcement amongst the tools and within the larger LCM framework, specifically within management systems.

- Management and Stakeholder engagement along the life cycle (LCM TF4)
  - Management along the life cycle is to approach and apply life cycle thinking from the management system point of view by using the ISO14001 and 14004 but also other standards such as ISO14031 on indicators together with GRI indicators (for environmental reporting!). Management along the life cycle can be seen as check lists of potential environmental and other sustainability aspects to be included in a life cycle oriented management system (sometimes referred as Product-Oriented Environmental Management System).

3.1.2   The Life Cycle Inventory Programme

The Life Cycle Inventory programme refers to the second phase of LCA and aimed at increasing the access to and quality of LCI databases. The specific aims of the programme were to:

- Identify user needs for data, and needed/desired data characteristics;
- Identify user needs for further LCI methodological guidance and consistency;
- Increase the capacity for making, and judging/validating, LCIs globally;
- Provide users of LCI data the broadest possible view of available LCI data options and the consequences of data selection for results quality and validity;
- Develop and put into place mechanisms or processes that stimulate continuous improvement in data availability, quality, and transparency.

Deliverables stemming from the Life Cycle Inventory programme include:

- LCI definition study,
- Report on Activity of Task Force 1: Data Registry—Global Life Cycle Inventory Data Resources (Curran 2006),
- LCI Database Registry,
- LCI Format Converter,
- Report for Task Force 3: Inventory methods in LCA—towards improved methodological consistency (Lundie et al. 2007),
- Initiation of national and regional life cycle networks (Sonnemann 2004b).

The following Task Forces were established under the Life Cycle Inventory (LCI) Programme:

- LCI Database Registry (LCI TF 1) and LCI Database Characteristics and Quality (LCI TF 2)
    - Task Forces were responsible for developing the UNEP/SETAC Database Registry: a comprehensive, web-based listing of available LCI databases for the world LCA community.
    - The LCI TF 1–2 pursued consistency on four core characteristics of databases:
    Data quality,
    Documentation format,
    Data exchange format,
    Nomenclature.

- LCI Methodological Consistency (LCI TF 3)
    - The aim of this task force was to initiate and stimulate processes, studies, and forums that facilitate voluntary and practice-oriented movement towards transparency, ultimately contributing to improved consistency and commonality of LCI methodological practice.
- LCI Databases and Capacity Building (LCI TF 5)
    - Task Force 5 was a practical one involving many regions (teams from novice and experts) and aiming at
    Practical involvement,
    Job training (training the trainers),
    Capacity building,
    Operational 'field tests' for TF 2 and 3 and I/0 or hybrid LCI,
    Assisting in finding funding.

The first three Task Forces were orientated towards experience sharing and guidance, while the last Task Force was training-orientated supporting the capacity building efforts of the Life Cycle Initiative.

3.1.3   The Life Cycle Impact Assessment Programme

The Life Cycle Impact Assessment programme refers to the third phase of LCA and dealt with the evaluation of environmental impacts, (e.g. climate change and toxicity) of products and services over their whole life cycle. The aim of the LCIA programme was to increase the quality and global reach of the life cycle indicators by promoting the exchange of views among experts. Its specific aims were to:

- Identify user needs for Life Cycle Impact Assessment;
- Provide a clear picture of the impact categories, including different impacts than the one typically applied in "OECD country lcas", like e.g. Erosion or biodiversity;
- Provide guidelines for the starting points, the decision-making framework and guidelines for the identification of recommended practice
- Identify case studies, and industrial partners, to test and improve the method feasibility;
- Identify the links with the LCI and LCM programmes, including the relation of LCIA to indicators, which also include the economical and social dimensions of sustainability.

Key deliverables prepared in this programme are the following:

- LCIA definition study;
- UNEP publication: Evaluation of Environmental Impacts in Life Cycle Assessment (UNEP 2003);
- A paper on the LCIA Midpoint-damage Framework of the UNEP/SETAC Life Cycle Initiative (Jolliet et al. 2004);
- A paper on the progresses in Life Cycle Impact Assessment made within the UNEP/SETAC Life Cycle Initiative (Jolliet et al. 2005);
- SETAC publication: Life-cycle assessment of metals—issues and research directions (SETAC 2005);
- A scientific paper on the key elements in a framework for land use impact assessment within LCA (Mila i Canals et al. 2007);
- Declaration of Apeldoorn on Life Cycle Assessment of Non-Ferrous Metals and related scientific articles such as on the Clearwater consensus for the estimation of metal hazard in fresh water (Diamond et al. 2010);
- USEtox model as an environmental model for characterization of human and ecotoxic impacts in LCIA and for comparative assessment and ranking of chemicals according to their inherent hazard characteristics (Rosenbaum et al. 2008);

- A report on guidance on how to move from current practice to recommended practice in Life Cycle Impact Assessment, in particular for transboundary impacts.

The Life Cycle Impact Assessment programme was established with the following four task forces:

- LCIA information system (LCIA TF 1)
  - Towards the enhancement of the availability of sound LCIA data and methods, this Task Force aimed to develop an LCIA information system and to finalize and extend the general framework.

- Natural resources and land use (LCIA TF 2)
  - This task force aimed at establishing recommended practice and guidance for natural resources and land use categories, i.e.: water resources, minerals resources, energy carriers, soil resources and erosion, land use, salinisation and desiccation and biotic resources. It addressed both midpoint categories and their relation to damage categories such as the biotic and abiotic natural environment.

- Toxicity impacts (LCIA TF 3)
  - Identification and quantification of impacts on human health and on ecosystems linked to the use and emissions of toxic substances were of central importance to the development of sustainable technology. On the one hand, the UNEP/SETAC Life Cycle Initiative made use of significant recent progress in LCIA of toxics. On the other hand, several crucial shortages of present methodologies were addressed to enable a proper interpretation of LCI results.

- Transboundary impacts (LCIA TF 4)
  - This task force aimed at establishing recommended practice and guidance for use in transboundary categories, i.e.: climate change, ozone depletion, aquatic and terrestrial eutrophication and acidification, photooxidant formation and respiratory inorganics.

3.1.4 Crosscutting Activities

The aim of the crosscutting activities was to address questions in relation to life cycle approaches that were identified as relevant in the overall user needs assessment, but that have not been further developed as part of the Definition Studies since they included topics that concern more than one programme.

   Main outcomes of the crosscutting activities were the following deliverables:

- Report 'Life Cycle Approaches—The road from analysis to practice',
- Brochure 'Why Take a Life Cycle Approach?' (UNEP/SETAC 2004, translated into French, Spanish, Chinese and Japanese),
- Feasibility Study on the integration of social aspects into LCA,

- Life Cycle Management navigator for SMEs (prepared jointly with the LCM programme).

The life cycle based topics embraced under the heading of crosscutting activities were (Sonnemann 2004a):

- Simple life cycle based tools,
- Integrated resource and waste management,
- Integration of social aspects into LCA,
- Function-Based Approach.

While TFs 1, 2, 3 were experience-sharing- and guidance-orientated, the focus of TF 4 was practice and training-orientated and closely linked to the task force on LCI Databases and Capacity Building. The work on integrated resource and waste management was taken over by the International expert group on Life Cycle assessment for integrated waste management (Coleman et al. 2003) and the International Resource Panel (IRP).

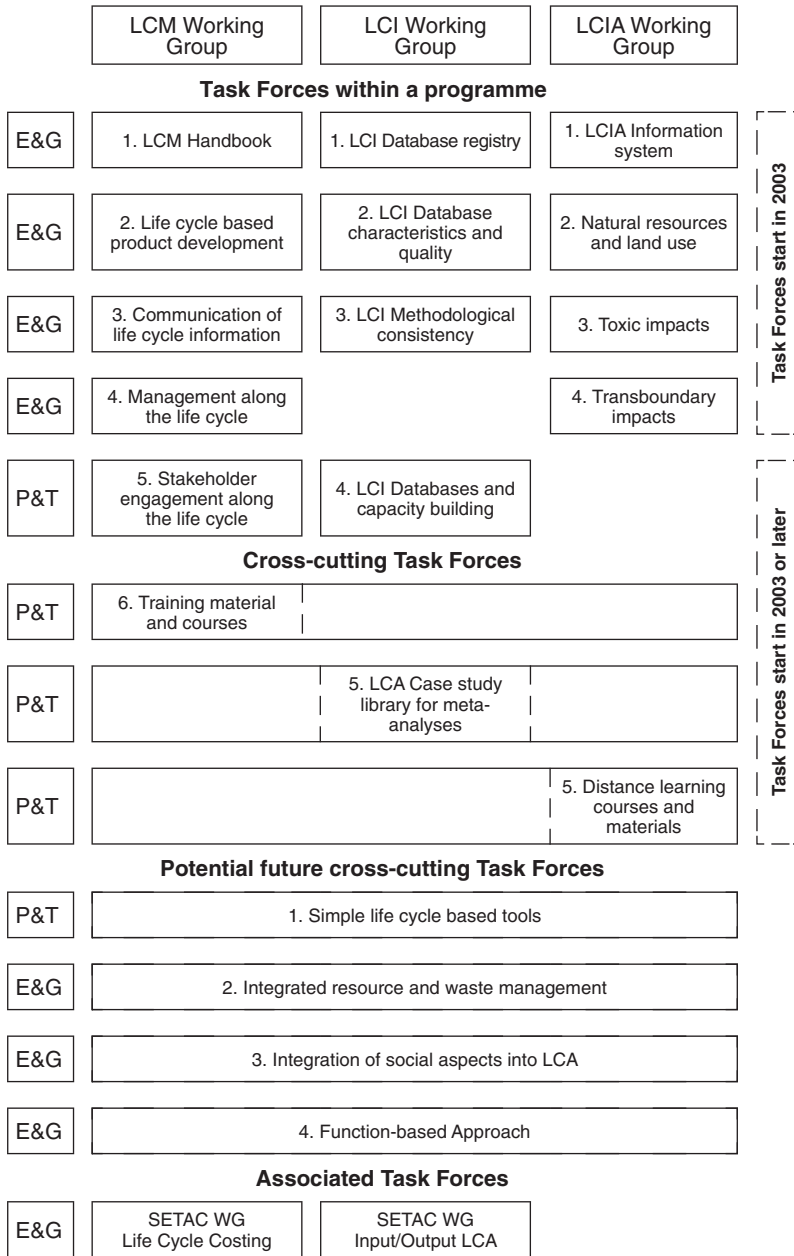An overview of Phase 1 structure is given in Fig. 4.1.

3.2   Phase 2—Becoming a Stakeholder

3.2.1   Overall Structure

In 2006, the strategy for a new phase was developed to give a new focus and ensure that on-going activities were finalized as far as possible in a given period. Key activities like the promotion of Life Cycle Management, the development of an LCI registry and the USEtox model continued in Phase 2. The achievements with regard to the national and regional networks and the establishment of a truly global life cycle community were used to foster capability development on life cycle approaches worldwide among other activities through the launch of an LCA award for developing country projects and the support of the organization of conferences in emerging economies such as Brazil, China, India, Mexico and South Africa.

The identified objectives for Phase 2 were met through projects in five Work Area Interest Groups (WAIG), as indicated in Fig. 4.2:

A. Life Cycle Approaches for Methodologies and Data (including data, methods, case studies, etc.);
B. Life Cycle Approaches for Resources and Impacts (including natural resources, chemicals, water, energy, etc.);
C. Life Cycle Approaches for Consumption Clusters (structured in housing, mobility, food and consumer products);
D. Life Cycle Approaches for Capability Development (including institutional empowerment, training, curricular development, etc.;
E. Life Cycle Management in Businesses and Industries.

	LCM Working Group	LCI Working Group	LCIA Working Group	

Task Forces within a programme

	LCM Working Group	LCI Working Group	LCIA Working Group	Task Forces start in 2003
E&G	1. LCM Handbook	1. LCI Database registry	1. LCIA Information system	
E&G	2. Life cycle based product development	2. LCI Database characteristics and quality	2. Natural resources and land use	
E&G	3. Communication of life cycle information	3. LCI Methodological consistency	3. Toxic impacts	
E&G	4. Management along the life cycle		4. Transboundary impacts	
P&T	5. Stakeholder engagement along the life cycle	4. LCI Databases and capacity building		

Cross-cutting Task Forces

				Task Forces start in 2003 or later
P&T	6. Training material and courses			
P&T		5. LCA Case study library for meta-analyses		
P&T			5. Distance learning courses and materials	

Potential future cross-cutting Task Forces

P&T	1. Simple life cycle based tools
E&G	2. Integrated resource and waste management
E&G	3. Integration of social aspects into LCA
E&G	4. Function-based Approach

Associated Task Forces

E&G	SETAC WG Life Cycle Costing	SETAC WG Input/Output LCA

Types of Task Forces:
E&G   Experience-sharing and guidance-oriented Task Forces (or 'guidance' TF)
P&T   Practice and training-oriented Task Forces (or 'practice' TF)

Fig. 4.1 Overview of working groups and task forces in phase 1. (Sonnemann 2003)

Fig. 4.2 Relationship among the five work area interest groups chosen for the practical application approach in phase 2. (UNEP/SETAC 2012b)
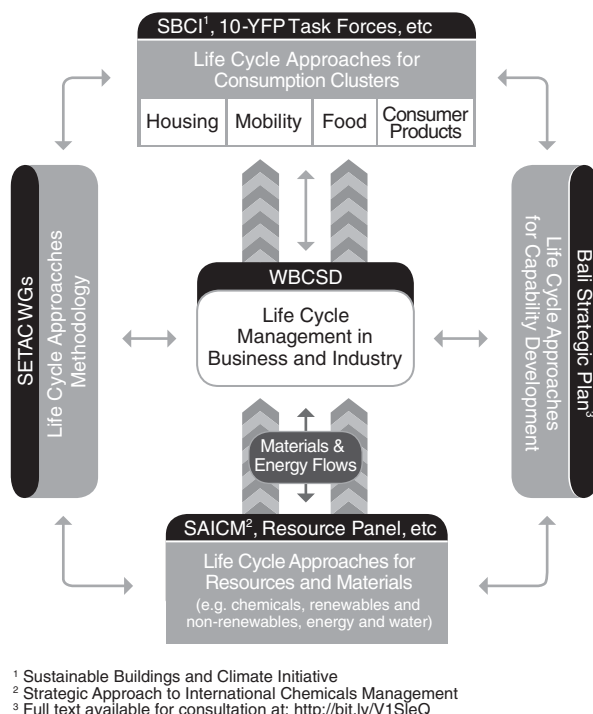

SBCI[1], 10-YFP Task Forces, etc

Life Cycle Approaches for Consumption Clusters

| Housing | Mobility | Food | Consumer Products |

SETAC WGs — Life Cycle Approaches Methodology

WBCSD
Life Cycle Management in Business and Industry

Bali Strategic Plan[3] — Life Cycle Approaches for Capability Development

Materials & Energy Flows

SAICM[2], Resource Panel, etc
Life Cycle Approaches for Resources and Materials
(e.g. chemicals, renewables and non-renewables, energy and water)

[1] Sustainable Buildings and Climate Initiative
[2] Strategic Approach to International Chemicals Management
[3] Full text available for consultation at: http://bit.ly/V1SIeQ

Figure 4.2 indicates the relationship among the WAIGs. In this way it was expected that the impact of the Life Cycle Initiative goes, beyond the work on methodologies and capacity building, to practical applications that make a difference in the real world and thus contribute more effectively to the on-going international efforts to change unsustainable patterns of consumption and production. The expectations for each of the objectives were met by having the Secretariat conducting the work and the experts carrying out projects in the five Work Area Interest Groups.

3.2.2   Deliverables

Relevant UNEP publications as products of the Phase 2 activities are:

- Greening the Economy through Life Cycle Thinking—10 Years of the UNEP/SETAC Life Cycle Initiative (UNEP/SETAC 2012a),
- Global Guidance Principles for Life Cycle Assessment Databases—A Basis for Greener Processes and Products (UNEP/SETAC 2011a),
- Towards a Life Cycle Sustainability Assessment—Making informed choices on products (UNEP/SETAC 2011b),
- Guidelines for Social Life Cycle Assessment of Products (UNEP/SETAC 2009a, translated into French and Dutch),

- Life Cycle Management—How business uses it to decrease footprint, create opportunities and make value chains more sustainable (UNEP/SETAC 2009b).

A particular achievement in the area of LCM is the Life Cycle Management capability maturity framework. The latter shifts the focus from driving performance on prescriptive sustainability metrics to building the capacity of organizations in a supply chain to identify and manage social and environmental issues in a manner that is tailored to their business strategy. It helps the supplier to identify where and how to start and continue their journey towards sustainability (Swarr 2011).

A related product was produced by a SETAC working group: the Environmental Life Cycle Costing: A Code of Practice (SETAC 2011). Thanks to this SETAC publication it was possible to present a common framework for Life Cycle Sustainability Assessment (LCSA), covering environmental LCA (E-LCA), Life Cycle Costing (LCC) and social LCA (S-LCA) (UNEP/SETAC 2011b).

Moreover, training kits and courses on the following topics were developed:

- Water Footprinting—2012,
- Life Cycle Management Capability Maturity Model: helping SMEs apply
    - LCA in business decision-making—2012,
    - Global Guidance Principles for LCA Databases—2012,
- Social Life Cycle Assessment and Life Cycle Sustainability Assessment—2011,
- LCA (Life Cycle Assessment) Training Kit Material—2008.

Finally, project groups have organised an important number of workshops and published relevant supporting documentation and scientific papers in international journals:

- WULCA, the project group on the Assessment of Use and Depletion of Water Resources within LCA, has provided relevant input through the SETAC liaison role, to the ISO standardisation process on water footprintng (ISO 2012) and has published articles such as a framework for assessing off-stream freshwater use in LCA. (Bayart et al. 2010);
- The project group on Carbon Footprinting has managed to provide technical input to the WBCSD/WRI Greenhouse Gas Protocol WBCSD/WRI (2011) and the ISO standardisation process on carbon footprinting (ISO 2013), ensuring that both standards are based on ISO 14040 and close to each other (Finkbeiner 2009);
- The project group on Integrating Human Indoor Air Pollutant Exposure within Life Cycle Impact Assessment has proposed a new methodological framework for a general procedure to include human-health effects from indoor exposure in LCA (Hellweg et al. 2009);
- The project group on Global Land Use Impacts on Biodiversity and Ecosystem Services in LCA is working towards widely accepted characterisation factors. (Koellner et al. 2013);
- Methodological sheets for social LCA have been developed by the project group working on social and socio-economic LCA (Benoît-Norris et al. 2011).

3.2.3   Running a Multi-Stakeholder Process: Global Guidance for LCA Databases

A particular challenge in the second phase was to run the process on 'global guidance for LCA databases' towards overall consensus since a number of stakeholders had controversial views in this field of LCA. The process was launched at the first Stakeholder Engagement Meeting, 'Towards Global Guidance for LCA Databases', in Boston in September 2009, where the high attendance confirmed the international interest in the UNEP/SETAC proposal. Many participants felt that the process was very timely and a majority of the participants agreed with the vision, which was to help provide global guidance on the establishment and maintenance of LCA databases, as an input for improved interlinkages of databases worldwide. The vision was expected to contribute to increasing the credibility of existing LCA data, to further foster the generation of more data (also for applications such as carbon and water footprint) and to enhance their overall accessibility.

The process was overseen by a Steering Committee consisting of stakeholders from governments, industry and academia/NGOs (Sonnemann et al. 2011). In seven stakeholder meetings following the launch the interested audience was informed about the plan for the development of a global guidance. The central activity was a 5-day Pellston-type Workshop in Shonan Village in January/February 2011 organized by the Secretariat of the Life Cycle Initiative on behalf of UNEP and SETAC, in close co-operation with the Japanese hosts.

The workshop participants included selected experts from on-going regional and national as well as industry database initiatives in OECD countries, emerging economies and developing countries. Moreover, a few key consultants developing databases as well as experienced SETAC and regional life cycle network experts were also attending together with UNEP staff and relevant users of LCA databases. The workshop participants were able to put together the basis for a publication on the Global Guidance Principles for LCA Databases, called Shonan Principles, which was launched in Berlin in August 2012. These principles give guidance for proper gathering and management of data, which enable better, more reliable life cycle assessment results and improve their use for decision-making. (UNEP/SETAC 2011a)

4   Key Messages Based on Work Conducted During the Last 10 Years[2]

The UNEP/SETAC Life Cycle Initiative members and its network of stakeholders and professionals in the field believe that the transition to a green economy can only be successfully accomplished if the decisions made toward this goal are based

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upon solid, science-backed information. Life cycle thinking, through its many approaches and tools, helps to identify both the negative and positive consequences of decision-making to the sustainability triple-bottom line, thus enabling an appropriate weighing of options.

In support of this position, the Life Cycle Initiative has developed the following seven key messages. The messages describe the current state of use of life cycle approaches and tools, their beneficial qualities that support the transition to a green economy, and a glimpse into the future of life cycle approaches and tools.

4.1   Life Cycle Thinking in the Private Sector—Ahead of the Curve

Many companies, both large and small have realized that introducing sustainability into operations management makes business sense. Management trends today are now moving towards a true triple-bottom line approach, supported by a mature, broad spectrum of life cycle approaches and tools that can be selected and tailored to examine specific issues or impact areas, and are supported by knowledgeable networks of stakeholders and professionals, reliable data and standardized methodologies. Using this approach, the ultimate goal of addressing the environmental impact of a product over its life cycle has changed. Before, the goal was to make it less damaging, whereas now, a potential goal is that it leads to an improvement of the environment. In addition, the application of life cycle tools has been extended to simultaneously consider social and economic aspects, thus providing an approach to measure changes to societal well-being and wealth.

Life cycle thinking that influences product design, strategic planning, procurement, and sales helps businesses:

- Enhance their image and the value of their brands—businesses can avoid criticism since responsibilities are better defined along the supply chain. Suppliers are made responsible for their own share of impacts as well as for corrective and preventive actions;
- Find new ways for marketing and sales departments to communicate and interact with customers—a company can promote its products and services supported by positive social and environmental claims derived from an impartial and science-based approach;
- Share life cycle information with suppliers, customers, and waste handlers to identify risks and opportunities for improvement—the risks might relate to the environment, human health, safety, or finance. Opportunities here include increasing market share, improved brand image, more effective use of materials, and innovation, amongst others.

The private sector is incorporating life cycle thinking on many fronts, including:

- Product development (via design for environment, design for disassembly…);

- Production (via environmental and social life cycle assessment, carbon footprint, water footprint, material flow accounting, supplier codes of conduct, supplier audits…);
- Marketing (via use of eco-labels, social and environmental certifications and labels, environmental and/or social product declarations…);
- Use (via demand-side management, integration of monitoring and communication technologies into products to inform users on energy and water use, design for easy maintenance, product service system development, user training on environmentally friendly product use…);
- Disposal (via design for disassembly or compostability, participation in product recycling systems or product take-back programmes…);
- Management (via operational transparency through reporting on environmental, social, and sustainability performance; corporate social and environmental responsibility; commitment to continuous improvement…).

For the most part, companies start with the use of some life cycle approaches and tools on a product-oriented or project-organized basis. For example, in Asia and Latin America the need and use of water and carbon footprints is increasing exponentially.

The next step is to broaden the integration of life cycle thinking on a 'top to bottom' basis, including internal policies, management systems, accountabilities, and incentives—and at the same time, applying these elements wherever possible to yield improvements across the value chain.

There are some companies that are forging ahead by working with suppliers and supply chain issues towards continuous improvement as an important strategic consideration. Realizing that their future relies on "sustained profits", these companies are taking bold steps forward to fully address the triple bottom line of sustainability.

Over the past decade of activities, the Life Cycle Initiative has helped to improve the understanding in the private sector of the benefits that can be derived from implementing life cycle methodologies and using the related tools within an environmental management framework. Workshops, study trips, and seminars brought together experts and stakeholders from many industry sectors (e.g. automotive, forestry, building and construction, electronics…) to share experience, and move the life cycle agenda forward in those sectors.

The Life Cycle Initiative produced several reports, guidance document and training materials and courses touching on most of the elements relevant to Life Cycle Management to support the uptake of life cycle approaches and the use of life cycle tools in the private sector.

4.2   Life Cycle Thinking in the Public Sector—Potential for Improvement

Life cycle approaches are not new to the public sector, particularly in industrialised countries. Life cycle costing was used in the 1960's by the US army to assess the

full life cycle costs of investments in tanks and tractors. Since then, life cycle approaches and tools have been making inroads to address the environmental, and even the social side of government operations.

Public spending normally represents 8–30% of national Gross Domestic Product and every purchase is an opportunity to drive markets towards innovation and sustainability. Purchasing products and services that are "environmentally preferable" reduces the impact government operations have on the environment and supports regional and global markets for environmentally "preferable" products and services. This approach has matured since the 1990's to the extent that green and sustainable public procurement strategies at the national, provincial/state and local level have been implemented in both industrialized and developing countries alike.

Good examples of policies based on life cycle approaches are already in place. On the production side, pollution limits and cleaner production are typically supported by regulations and often by economic instruments, such as green taxes or emissions trading systems operating on a regional or international basis. On the product side, policies (in addition to sustainable public procurement noted above) have been put into place that encourage the development of green products, including ecodesign directives, or material recovery programmes. Extended producer responsibility regulations make producers responsible for their products from production through final disposal, and therefore, provide an incentive to develop products with improved environmental performance in all stages of the product life cycle. Regarding policy measures to support a shift to renewable energy, some countries encourage the installation of renewable energy capacity by offering premium feed-in tariffs for solar generated electricity.

However, these examples could be described as a dartboard approach, addressing individual issues with specific policies and tools. There are some forerunners in the public sector that have seen the benefit to be gained from going beyond the dartboard approach, toward fully integrating a life cycle perspective into all areas of government operations and policy. The bold steps taken by these public authorities will yield dividends for the sustainability of their constituencies and stakeholders, and will be the ones to watch as lessons are learned from their progress.

There are several measures that can be taken by governments at all levels to create an enabling environment for life cycle thinking and approaches to gain a foothold, and help to set the course for the transition to a green economy.

First, governments can support data gathering and information sharing on the state of the environment, ecosystems and biodiversity, as well as for social indicators. Going further, an assessment of the wide range of environmental and social impacts of upcoming policies from a life cycle perspective can help to identify priority impact areas, and provide the knowledge required to avoid decisions that may undercut environmental conservation and social well-being.

Second, when subnational or national governments design policy, negotiate voluntary agreements with industry, or decide where to invest resources, life cycle thinking can apply. Measuring potential life cycle impacts of decisions can help governments to:

- Inform government programmes and help prioritise these programmes, based on life cycle information;
- Make policies more consistent among consumers, producers, material suppliers, retailers, and waste managers and also among different policy instruments (such as harmonising regulations, voluntary agreements, taxes, and subsidies);
- Promote pricing products and services to accurately reflect the costs of environmental degradation, health problems, erosion of social welfare, and impacts at other life cycle stages. Such "price signals" can send messages to consumers and provide incentives for businesses to continuously improve the environmental and social performance of products or services, across each stage of the life cycle;
- Introduce policies that support take-back systems to establish a recycling-based economy according to the hierarchy reduces, reuse and recycle.

In support of the public sector taking on life cycle perspectives, the Life Cycle Initiative organized the Third Chinese Roundtable on Sustainable Consumption and Production with a focus on Life Cycle Assessment and Life Cycle Management in Beijing in 2009. The participants represented international organizations, Chinese national and local government agencies, Chinese companies from different industry sectors including minerals & metals, building & construction and ICT, and research institutes, from China and overseas.

Moreover, joint efforts were initiated with UNEP activities such as the Marrakech Process on Sustainable Consumption and Production, the Sustainable Building and Construction Initiative and the Strategic Approach to International Chemicals Management in order to inform decision-makers about life cycle approaches.

4.3   Life Cycle Methodologies, Impact Assessment and Data— The Foundation for Informed Decision-Making

Methodologies and tools are the working-level of life cycle thinking. They can be put into practice in many ways and towards many ends. For those who are new to life cycle thinking, they may be surprised to learn that many thousands of individuals use life cycle tools daily in their decision-making. Purchasing consumer goods while considering the water or energy use information provided by environmental product declarations is one way. Buying food while considering labels for certified organic produce and meat is another. Shopping for textiles and clothing while considering social and eco-labels is yet another.

Progress in making life cycle tools user-friendly with easy to interpret outputs is a result of years of data gathering and sharing, database development, refining of methodologies, and the development of appropriate means of communication. Accessibility has expanded from its debut in universities and research centres to one that is used daily by people of all ages and around the world via the internet. These on-line tools enable a personal water, energy, or ecological footprint to be derived

and in so doing, allow the user to identify where the environmental (or social) impact of their consumption and lifestyle is the greatest.

The ease with which more involved assessments are undertaken has also benefitted from developments over the past decade. With the right tools, life cycle 'screens' can be completed within several hours. Quick studies can take several days. Larger assessments can take up to several months, depending on the need for new data collection. Once main operations are modelled, studies can be performed quickly.

However, with the large number of methods, labels and calculators now available, there is a risk of confusion of which is best to use for decision-making. It is therefore important that methods are harmonized to generate assessment results that are consistent, comparable, and transparent. Also, one can note certain limitations built into some tools in that the availability of locally relevant data is often limited.

The Life Cycle Initiative, with the tremendous dedication of its task force and project group members, has been able to expand the variety and at the same time increase the robustness of methodologies and tools, and consolidate international consensus around them (e.g. LCM concept, the USEtox model, social LCA guidelines, guidance principles for LCA Databases, etc.). In addition, gaps and limitations of LCA tools and techniques have been explored and addressed, also with international acceptance (e.g., life cycle impact assessment framework including climate change and ozone depletion impacts).

The deliverables have focused on life cycle management, life cycle inventory and impact assessment methodologies, databases, the impact of chemicals, the development of a social life cycle assessment framework, jointly with life cycle costing as a part of the broader life cycle sustainability assessment. All the publications, reports and scientific papers derived from these activities have been mentioned before.

4.4 Life Cycle Sustainability Approaches—Measuring Triple Bottom Line Impacts

In addition to tackling economic questions when developing policies and strategies, or products and services, governments and enterprises are under increasing pressure to consider impacts on the environment and society. The growing societal concern with addressing the three pillars of sustainability (i.e. environment, economic, and social) requires that appropriate tools are available to inform decision-making. Up to now, environmental LCA and life cycle costing have been applied to assess the environmental and economic aspects. The recent addition of social LCA to the life cycle toolbox puts the last piece in place for a life cycle sustainability assessment.

One key objective of the Life Cycle Initiative is to help extend LCA methodologies beyond their original scope of identifying and assessing resource consumption and environmental interventions associated with products or processes. LCA can be extended in many ways, but one major advance has been the elaboration of methods and techniques that can measure sustainability, thus allowing LCA to support decision-making toward more sustainable product and process systems. Synthesiz-

ing these methods with life cycle techniques has enabled the elaboration of a life cycle sustainability assessment (LCSA).

LCSA contributes to the discussions on sustainable development as a methodology with a great deal of potential to provide a combined sustainability indicator of a product or process by combining environmental life cycle assessment (E-LCA), social life cycle assessment (S-LCA) and life cycle costing (LCC) in a coherent. The benefits of a simultaneous assessment of the three sustainability pillars in one tool, as opposed to using three separate tools are numerous:

- Helps clarify the trade-offs between the three sustainability pillars, life cycle stages and impacts, products and possibly;
- Implies the ability to reduce environmental degradation and the use of natural resources in a cost-effective manner, while at the same time contributing to social welfare;
- Promotes awareness on triple bottom line sustainability issues in value chain actors;
- Supports enterprises and value chain actors in identifying weaknesses and enabling further improvements of a product life cycle;
- Supports decision-makers in prioritizing resources and investing them where there are more chances of positive impacts and less risk of negative ones;
- Helps decision-makers choose sustainable products and technologies; consumers will not only know which products are more cost-efficient, eco-efficient or socially responsible, but also more sustainable;
- Provides guiding principles to achieve sustainable consumption and production.

The Life Cycle Initiative led the effort to develop this framework, resulting in the publication 'Towards a Life Cycle Sustainability Assessment: Making Informed Choices on Products'. The aim of the publication is to support stakeholders looking for approaches that will provide holistic assessments of the implications of a product's life cycle for the environment and society. The publication includes eight case studies that illustrate how current and emerging life cycle assessment techniques are being implemented worldwide.

4.5 Trade-Offs and Unexpected Consequences—Avoiding the Pitfalls

It has been proven time and time again that making decisions with a limited vision of a problem can be counter-productive, and in extreme cases, even take society in the wrong direction when unexpected consequences occur.

Trade-offs will always be a part of decision-making, but when a life cycle perspective is considered, it expands the field of vision of the issue at hand. Looking up and down the value chain can help to reveal acceptable and unacceptable trade-offs, and may uncover otherwise unexpected consequences that could occur—in diverse stages of the value chain, to other sustainability pillars, to other societies,

and so on. Because it is holistic, systemic and rigorous, life cycle assessment is an essential tool for generating information and broadening knowledge about potential and real impacts along a product's life cycle, and thereby increases the possibility to improve overall product sustainability.

Potential trade-offs can be characterized in many ways.

4.5.1 Trade-Offs Between Stages of the Product Value Chain

From its humble beginnings as a raw material taken from the Earth, a product and its components can travel thousands of kilometres and be handled and used by hundreds or thousands of people before it reaches its final disposal phase. Similarly, a decision to use one raw material over another can have an impact on each link of the product value chain.

For example, consider a car made with lightweight composite materials as opposed to conventional steel. While the benefits of lighter automobile weight can translate into fuel savings in the use phase, the production and disposal or recycling of composite materials need to be assessed as well and compared to conventional steel production and recycling in order to truly know which will be more beneficial to society and the environment.

4.5.2 Trade-Offs Between Environmental Impact Categories

Land, water and air are intricately involved in the human life cycle, as well as in the life cycle of products. Decisions made in the name of protecting one of these environmental 'media' can result in the detriment of another, and possibly lead to consequences for human health.

A classic example is MTBE (Methyl Tertiary Butyl Ether). MTBE is added to gasoline to increase octane levels and enhance combustion, which in turn reduces polluting emissions. MTBE in gasoline can reduce ozone precursors by 15%, benzene emissions by 50%, and CO emissions by 11%. While MTBE helps mitigate air pollution, the MTBE itself may be toxic if not combusted fully. MTBE is not considered highly toxic, but it has been banned for use in many US states. Of most concern is the MTBE found in lakes, reservoirs, and groundwater for potable water supplies. Levels of MTBE in the environment are now measured when MTBE is suspected to have evaporated from gasoline or leaked from storage tanks, lines and fuelling stations.

4.5.3 Trade-Offs Between Sustainability Pillars: Environmental, Social, Economic

In a green economy based on the principle that products and services should ultimately be to the benefit of the environment and society over their life cycle, the

full costs of protecting the environment and appropriate conditions and treatment of workers must be considered. In other words, a product should be produced to the detriment of neither the environment nor the people participating in the value chain.

For example, the global textile and electronics industries have come under scrutiny for producing inexpensive clothing and electronic equipment to the economic benefit of several global enterprises and their consumers, while using inappropriate labour practices that are socially detrimental to the people working in the production of these items. In a contrasting example, organic farming may not only be less damaging to the environment when compared to conventional farming methods (e.g., regarding chemical use) it can also improve farmers' working conditions and provide overall health benefits to society.

4.5.4   Trade-Offs Between Societies/Regions

In the globalized economy, product value chains are spread across countries around the globe. Decisions made to address an issue in one region can thus cause unexpected impacts in other parts of the world.

For example, with respect to electronic waste (e-waste), it could be said that "one person's waste is another person's gold" since electronics contain many valuable and recyclable materials (e.g., copper). The increasing popularity of electronic goods over the past two decades, and the rate at which new products are developed, has led to the creation of ever increasing amounts of e-waste to be recycled. However, acquiring the 'gold' from e-waste recycling has come at a high environmental and social cost in some developing countries. Directives for e-waste recovery and recycling in some industrialized countries led large amounts of e-waste to be recycled informally in developing countries under detrimental conditions for the environment and the people doing the recycling, due to releases of toxic materials in the process. New directives approved in the EU in 2012 have strengthened provisions against the exportation of e-waste.

4.5.5   Generational Trade-Offs

Sustainable development is about making decisions today that preserve the ability of future generations to meet their needs. The Native-American Ojibwe tribe recognized this, and as a principle, made their decisions considering, as much as possible, the lives of seven generations of children. In comparison, our current globalized economy, largely responsible for the state of the environment we live n today, typically considers a far shorter time span. Long- term business decisions are made for time periods of 10–20 years as a maximum, or, less than one generation.

A good example of this is the current debate over climate change and the fluctuating international commitment to reducing greenhouse gas emissions. Decisions made now are going to have an enormous impact, for better or for worse, on future generations and the stability of the climate in the future. In a contrasting example,

we can see the positive result of the consideration of future generations in decisions made to address the holes forming in the Earth's ozone layer. The result of the Montreal Protocol's phase out of ozone depleting substances from consumer and industrial products has largely been seen as a success in securing the future of the ozone layer, and protecting human health and well-being for generations to come.

4.5.6 Relevant Activities in Last 10 Years

The Life Cycle Initiative engaged in developing life cycle practitioner capabilities in non-OECD countries while building and supporting global and national networks of practitioners and stakeholders. Greater national capability and knowledge is the foundation for ensuring that diverse perspectives and local information/data are considered in life cycle assessments and should allow trade-offs to be more readily identified, and unexpected consequences to be avoided.

   Work with partners, such as the International Resource Panel has already resulted in work on identifying the environmental impacts of consumption and production, which pinpoints 'hotspots' such as the agriculture and fossil fuel value chains as where change is needed and unexpected consequences of current consumption and production patterns need to be addressed.

4.6 Life Cycle Initiative Networks—Growing in Numbers and Expertise

The capability development efforts of the Life Cycle Initiative aim to empower individuals and societies with the necessary skills and competences to move our societies toward more sustainable production and consumption patterns. Together with our partners we are building networks, sharing knowledge, data, experiences and best practices, and implementing projects to foster a new generation of citizens who integrate life cycle thinking in their personal and professional decisions. Target audiences of our capability development activities include: (1) scientists, (2) business, (3) governments and the (4) civil society.

   An overview of current local and national networks of life cycle practitioners and stakeholders worldwide is given in Fig. 4.3. The Life Cycle Initiative has been working over the past decade to broaden the base of practitioners and stakeholders working with life cycle approaches around the world, and to establish links between those working in the same countries and regions. The map indicates the networks with which the Life Cycle Initiative has regular contact for discussions, feedback, and assistance in the preparation and rollout of materials.

4.6.1 The International Life Cycle Network

One of the greatest successes of the Life Cycle Initiative's 10 years of existence has been the establishment of a global network of life cycle practitioners
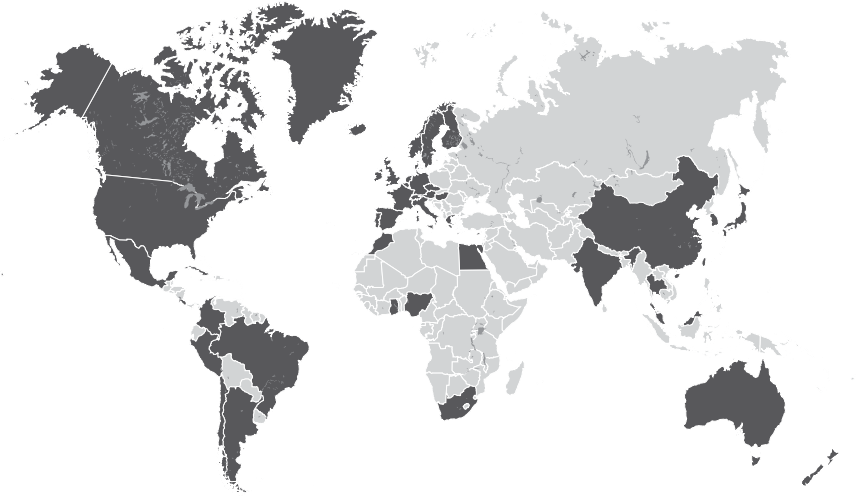
**Fig. 4.3** Overview of current national life cycle networks worldwide. (UNEP/SETAC 2012a)

(http://www.lifecycleinitiative.org/networks/). Currently with over 2,000 registered participants located in about 50 international, national and regional networks in Asia, Latin America, Europe, the USA, Africa, the Middle East and Central Asia, the network is continually growing (Fig. 4.4). The successful establishment of the network has been based on a good understanding of the needs of the users of life cycle tools attained through surveys and stakeholder consultations. Their major activities relate to knowledge sharing and communication, support of case studies, and development of life cycle inventories and impact assessment methods. The network is now a self-sustaining entity and supports the Life Cycle Initiative's work plan by providing the needed body of experts to complete peer reviews, as well as being a source of input and consensus on new tools and guidance. This first comprehensive online mapping can serve as a basis for enhancing cooperation and coordination among the LCA networks worldwide (Bjørn et al. 2013).

While the roots of life cycle thinking and expertise is found in Europe, jointly with North America and Japan, the Life Cycle Initiative has worked with partner organizations to launch regional life cycle networks in Africa and Latin America, as well as national networks in China, Argentina and Colombia. New networks are also being built in India, Russia and in some African countries.

4.6.2   Life Cycle Jobs are Green Jobs

Life cycle practitioners are in demand in a green economy. This has already been recognized by some countries, as described in the ILO submission to the RIO+20 Summit on how occupations change as an economy goes green. The report makes

Fig. 4.4 Growth of registered participants in the life cycle initiative's international network. (UNEP/SETAC 2012a)
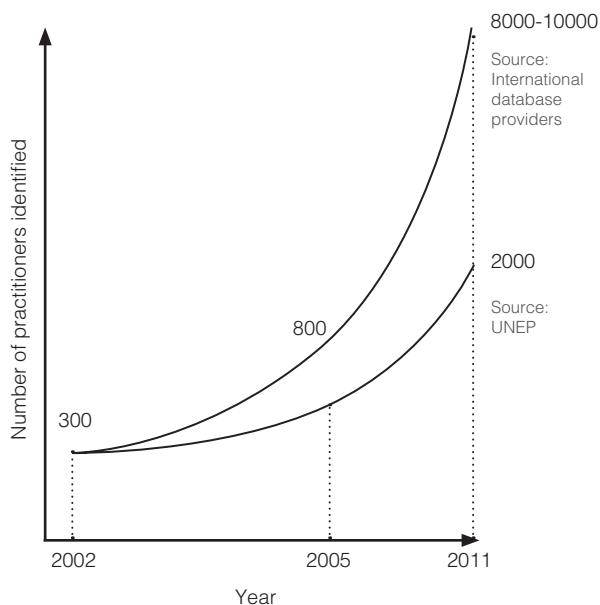
several references to need for life cycle assessment skills, for example, in the checklist of green skills identified by the UK government. In a further example, the Republic of Korea is noted to have created new 'sector skills councils', one of which provides training on sustainability assessment.

4.6.2 Accomplishments in Phases 1 and 2

Phases 1 and 2 activities prioritized the strengthening of regional and international scientific networks worldwide. The network database now lists more than six times the number of entries since it debuted. Projects to expand the network and develop life cycle capability included dozens of seminars, workshops and sessions at international conferences and meetings, particularly focusing in non-OECD countries.

Another indication of the number of international life cycle stakeholders is the number of hits per month on the Life Cycle Initiative's portal with online tools, which total more than 15,000. The Global Guidance for LCA Databases, the Social LCA and LCM training materials are the most downloaded documents. Materials are broadly used in developing economies and businesses around the world for internal training.

The 'UNEP/SETAC LCA Award for non-OECD countries' acknowledges the work from academics and private companies in developing and emerging economies who have started visionary and innovative projects based on the life cycle approach. The first three editions of the prize were given in 2006, 2008 and 2010. In 2010, thirteen projects received a 1-year license of a life cycle software.

4.7   Communicating Life Cycle Information—The Right Story for Every Audience

Life cycle assessment consists of the identification and assessment of impacts along a product's value chain and then, communication of the result in a useful way so that the information can be used for decision-making. The main goal of communicating life cycle information in the transition to a green economy then is to induce change toward more sustainable decision-making from all stakeholders on process, products and organizations.

The main providers of Life Cycle information, also called Environmental Product Information, are industry and businesses, i.e. the supply side. The latter are motivated by a series of driving forces, which depend on the target audience and which include the communication of Environmental Product Information:

• Final private consumers, in order to get competitive advantage in emerging or new green markets;
• Business clients, either because requested to (this is especially the case of SMEs in the supply chain), or to compete in the business-to-business market arena;
• Societal and other stakeholders, to respond to the external pressure from environmental NGOs and consumer associations, and to convey a more holistic life cycle picture of products and services, in order to induce an appropriate use and disposal of products;
• Financial stakeholders, who are increasingly attentive to the sustainable dimensions of organizations and products;
• Public administrations, in order to apply to Green Public Procurement programmes and/or to obtain tax incentives, whenever applicable;
• Policy makers, providing credible life cycle information and reference data to support them in better-informed policy decisions and to prevent a misuse of life cycle approach and simplistic green claims, which might be highly misleading.

Life cycle information can be communicated in many ways, with varying levels of detail, considering various parts of the life cycle, different pillars of sustainable development (i.e., environmental/economic/social), and with varying levels of external verification. Some address a broad range of indicators, and some focus on one or two indicators. Some are based on full life cycle assessments and some on life cycle thinking. To bring some structure into this wide range of communication possibilities, ISO has put in place the ISO 14020 series of environmental standards. Key differences exist between communication in the form of corporate reporting, from business to business and from business to consumers as well as to motivate sustainable consumption behaviour.

In the context of the Life Cycle Initiative the brochure 'Why take a life cycle approach?' and the document 'Communication of Life Cycle Information in the Building and Energy Sectors' were published or contributed to as part of the Life Cycle Initiative's work programme on communicating life cycle information, including general awareness raising/educational materials, as well as publications for practitioners.

5 The Future of Life Cycle Thinking and Phase 3 of the Life Cycle Initiative

5.1 Consultation Process

In 2011 and 2012, the Life Cycle Initiative began an extensive consultation process involving an outreach survey, focus group discussion and a meeting with experts with the results to be used as a starting point for its Phase 3 strategy development process. More than 200 LCA practitioners and partners provided very valuable feedback, which is summarized in the following replies to the questions raised:

- What is limiting more implementation of life cycle approaches in your country or industry?
  - Easy access to reliable data,
  - Lack of business drivers,
  - Lack of awareness/understanding,
  - Cost issues,
  - Unclear relationship among a number of related tools such as LCA, carbon footprinting and water footprinting and concepts such as LCM and Corporate Social Responsibility,
  - Lack of harmonisation between methods,
  - Difficult to engage small and medium sized enterprises.
- As an LCA professional, what would be your aspirations for 2017?
  - LCA has been introduced into education programmes: e.g., life cycle thinking in schools and LCA courses in higher education;
  - LCA is daily practice in business and industry: e.g., at least all big companies use LCA results;
  - Life cycle thinking widely accepted as a basis for decision making: e.g., LCA results are used as key information for decision-making by government, industry, and by consumers;
  - Capability on LCA has been enhanced in non-OECD countries: e.g. a market for life cycle expertise has been established in all relevant emerging economies;
  - Life cycle information on products is available in one way or the other to consumers: e.g. consumers can get information on the environmental footprint of different product groups from internet.
- What are your expectations for the Life Cycle Initiative during the next 3–5 years?
  - Ensure consistency in the way data sets are developed around the world and support access to better and more data,
  - Non-OECD engagement to achieve a minimum standard of LCA usage worldwide,
  - Harmonisation/consensus building on methodologies,
  - Continued methodological development,

Fig. 4.5 Programme areas to achieve the objectives of phase 3
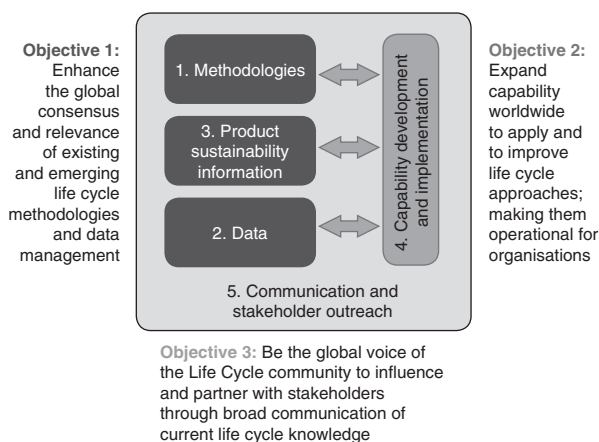
- − Training of practitioners,
- − Communication/awareness raising/lobbying,
- − Education of key decision-makers in industry and government,
- − Partnering, Case study development, Dissemination, Engaging stakeholders.

5.2   New Strategic Approach and Programmes

Building on the results of the expert consultation and on an assessment of strengths, weaknesses, opportunities and threads, the Life Cycle Initiative has developed the new vision of 'a world where life cycle approaches are mainstreamed' with a supporting strategic approach. The Life Cycle Initiative started Phase 3 in 2012 with a mission to "enable the global use of credible life cycle knowledge for more sustainable societies". Its overarching goal is to "facilitate the generation and uptake of science-based life cycle approaches and information for products and organization by business, government and civil society practice worldwide as a basis for sustainable consumption and production".

As illustrated in Fig. 4.5, the overall objective is backed by three specific objectives that are related to five programme areas for implementation, within which flagship projects have been identified. Although flagships have been recognised other relevant activities such as the consolidation of USEtox, the further development of characterization factors for water and land use in LCA and the dissemination of the LCM capability maturity model will continue as renewed projects in Phase 3. Also ideas for new 'normal' projects have been retained such as the development of a code of conduct for LCA professionals, the provision of guidance on the use of input-output/hybrid data and the set up of multistakeholder roundtables to address relevant challenges.

The following seven flagship projects have been prioritized and articulated within the five programmes.

5.2.1 Programme on Data

A. Data and database management—The focus of this flagship is on promoting a consistent approach at the global level to the creation and maintenance of LCI datasets and the development and management of LCA databases based on the existing global guidance principles for LCA databases. This is done by (a) producing a comprehensive set of training material in support of the Shonan guidance principles and using this material in various countries and regions, (b) preparing and providing consistent and accessible informational resources on databases and contained datasets and (c) establishing and supporting regional and global networks of database developers and managers (in close cooperation with the activities on capability development, see flagship G). The flagship includes also technical assistance activities if requested as well as the expansion and enhancement of the LCI database registry (in close cooperation with the new life cycle platform, see flagship H).

5.2.2 Programme on Methodologies

B. Life Cycle Sustainability Approaches and Organisations– Some of the tools developed during Phase 2 have not yet reached full maturity in order to be used on a broad scale. Efforts of this flagship will focus on further development and testing of S-LCA and LCSA in particular and also on challenges with regards to LCA for organisations.
C. Environmental life cycle impact assessment indicators—The objective of this flagship project is to run a global process aiming at global guidance and consensus building on a limited number of life cycle impact category indicators developed within a consistent framework and to identify the related research agenda. The deliverable would be one or more global guidance publications with a supporting web system that includes a limited number of six to ten LCA based environmental impact category indicators and the characterisation factors (for various regions). It may also include guidance how to best establish a particular regional impact category indicator in case global consensus on characterisation factors cannot be achieved or makes no sense.

5.2.3 Programme on Product Sustainability Information

D. Product environmental information meta 'specification'—Multiple efforts are on-going in different parts of the world to develop an authoritative identification of the hotspots and most relevant environmental impacts and resource uses for a certain product categories or group. This flagship project seeks to provide guidance on the broader considerations that should be taken into account, and the key principles that could be applied for different product sustainability information systems to allow more informed decision making by purchasers.

E. Knowledge mining guidance—There are hundreds of existing LCA studies that, taken together, represent a significant base of knowledge that can be tapped into. The aim of this flagship is to provide a methodology for mining knowledge from these LCA studies, using one or more pilot studies to demonstrate the value of this process (starting with food packaging sector). Can we use the review of existing studies to identify critical messages or themes that might inform policy makers in government and industry? What institutional buyers or consumers can learn from these studies with regard to how they have translated the technical and scientific information into a language that can be understood?

5.2.4   Programme on Capacity Building and Implementation

F. Global capability development—This flagship project has the aim to strengthen and consolidate the life cycle work in the regions, including documentation of local consultants and databases available. Focal points at Governmental offices (including national statistic offices for data management aspects) and chambers of commerce will be identified and linked to the national networks. Some deliverables identified for this flagship include:

  − Establishing a baseline on the level of life cycle thinking worldwide, assessing the current capabilities on life cycle approaches in non-OECD countries, with updates planned for every 3 years to trace the evolution;
  − Life cycle tools (i.e. on life cycle management, life cycle based footprinting indicators and ecodesign) spread across the emerging and rapidly growing economies via the Life Cycle Initiative's or local platforms;
  − South-South (e.g. in Latin America) cooperation for increased implementation and North-South cooperation for methodologies' enhancement, data generation and exchange;
  − Life cycle experts and practitioners network established in each region of the world;
  − Online tools, if possible, translated into several languages including Chinese, French, Portuguese, and Spanish, in addition to English.

5.2.5   Programme on Communication and Stakeholder Outreach

G. Communicating life cycle knowledge—The main deliverable for this flagship is an improved, informative, interactive and educational virtual platform with a communication strategy based on social media tools. The new life cycle platform at http://www.lifecycleinitiative.org will contribute to the life cycle awareness by sharing relevant knowledge and data. Information to be shared can be extracted from significant life cycle studies, key business websites presenting clear benefits (and challenges) from implementing life cycle approaches, the life cycle inventory database registry, appropriate websites from similar and related

initiatives sharing online tools, and so on. The life cycle platform will also help identifying the most relevant life cycle trends. A next step is the stakeholder outreach by various means, including the above-mentioned multi-stakeholder roundtables. New features of the website include Facebook, twitter and LinkedIn applications.

5.3   Setting up the Baseline for Phase 3 of the UNEP/SETAC Life Cycle Initiative—Monitoring Progress by Key Indicators

The Phase 3 elements of the strategic document and the action plan developed for flagship projects' implementation will guide the work of the UNEP/SETAC Life Cycle Initiative from 2012 through 2017. In order to monitor progress of their implementation, outcome indicators are essential. UNEP and SETAC suggested using them and the International Life Cycle Board and the life cycle community supported this proposal. The outcome indicators are expected to measure the quantity and quality of the results achieved by the activities deployed by the UNEP/SETAC Life Cycle Initiative.

Essentially the indicators reflect how the business, local and national Governments, academia and civil society are taking up the recommendations and deliverables produced by the UNEP/SETAC Life Cycle Initiative. Examples of outcome indicators include number of life cycle network and associations worldwide being in contact with the initiative or number of individuals or organisations using the USEtox model.

6   Conclusions and Perspectives

The key achievements of the UNEP/SETAC Life Cycle's Phase 1 and 2 activities are summarised below.

- Global life cycle community—the activities of the Life Cycle Initiative such as the various editions of the LCA Award for non-OECD countries have been crucial for the dissemination of LCA worldwide and the creation of a global community, including the set up of national and regional life cycle networks in different parts of the world.
- The Life Cycle Inventory Database Registry—this is a global repository for finding and offering LCA related datasets of high quality. The project motivated the European Commission to develop their ILCD Data Network.
- Life Cycle Impact Assessment Midpoint-damage framework—this framework links a product's environmental interventions or impacts to the ultimate effects on human health, ecosystem quality and resource depletion.

- USEtox—an environmental model for characterization of human and ecotoxic impacts in Life Cycle Impact Assessment and for comparative assessment and ranking of chemicals according to their inherent hazard characteristics.
- Life Cycle Management guide—the guide provides a coherent methodology for implementing life cycle approaches and activities with the goal of continual performance improvement. Life cycle thinking is made operational through Life Cycle Management. LCM is a management approach that puts the tools and methodologies in the life cycle thinking basket into practice.
- Life Cycle Management Capability maturity framework—the framework shifts the focus from driving performance on prescriptive sustainability metrics to building the capacity of organizations in a supply chain to identify and manage social and environmental issues in a manner that is tailored to their business strategy. It helps the supplier to identify where and how to start and continue their journey towards sustainability.
- Guidelines on Social LCA—these guidelines set out the key elements, indicators, and limitations for assessing the positive and negative social impacts of a product over its life cycle, with consideration of human rights, working conditions, health and safety, among others. This is a final key element that will enable a full triple-bottom-line approach to product sustainability assessment.
- Life Cycle Sustainability Assessment—this framework brings together the two established product assessment tools of environmental LCA and life cycle costing with the newly developed social LCA to establish the process for a triple-bottom-line assessment of a product's life cycle impacts.
- Global Guidance Principles for Life Cycle Assessment databases: these principles give guidance for proper gathering and management of data, which enable better, more reliable life cycle assessment results and improve their use for decision-making.
- Work on methodologies with regard to carbon footprinting to bridge the standard developments with regard to LCA done by the WBCSD/WRI Greenhouse Gas Protocol and ISO as well as on water and land use in LCA have ensured that the available LCA knowledge in the life cycle community is considered for carbon footprinting and water footprinting standards and that new widely accepted characterisation factors are about to be developed for water and land use impacts on biodiversity and ecosystem services.

Building on the achievements from Phases 1 and 2 and in particular the results of a stakeholder consultation process in 2011 and 2012, the vision for Phase 3 was coined as 'a world where life cycle approaches are mainstreamed'. The journey of 10-years Life Cycle Initiative is illustrated in Fig. 4.6. Activities in Phase 3 will focus on creating the enabling conditions to (a) enhance the global consensus and relevance of existing and emerging life cycle methodologies and data management; (b) expand capabilities worldwide and make life cycle approaches operational for organizations; and (c) communicate current life cycle knowledge to influence and partner with stakeholders. In consultation with the International Life Cycle Board, seven flagship projects have been defined in the areas of methodologies, data, product sustainability

Fig. 4.6 The key achievements of the UNEP/SETAC life cycle in its journey of 10 years. (UNEP/SETAC 2012a)
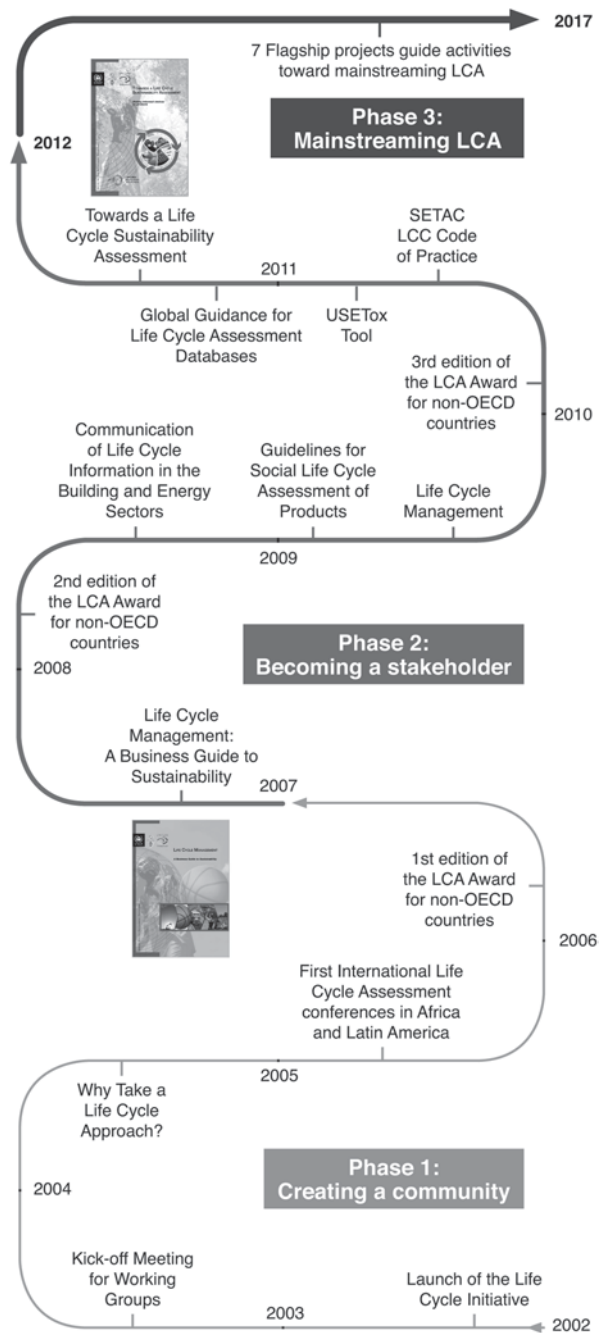
information, capability development and implementation, and communication and stakeholder outreach. They are expected to be implemented jointly with a number of other projects. Progress made in Phase 3 will be monitored every two to 3 years by key indicators and compared to a baseline survey carried out in 2012.

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Appendix—Glossary

10YFP	10-Year Framework of Programmes on sustainable consumption and production adopted during the last so-called Rio +20 World Summit on sustainable development in June 2012
Apeldoorn declaration	Declaration by a group of specialists in LCA and Risk Assessment on practices and complications of life cycle impact assessment methodologies for non-ferrous metals
CILCA	International Conference on life cycle assessment in Latin America
CML	Institute of Environmental Sciences, an institute of the Faculty of Science of the Leiden University
E-LCA	Environmental Life Cycle Assessment
EPFL	Ecole Polytechnique Fédérale de Lausanne
ICMM	International Council on Mining and Metals
ISO	International Organization for Standardization
ILCB	International Life Cycle Initiative Board
ILCD	International Reference Life Cycle Data System developed by the European Commission
ILCP	International Life Cycle Initiative Panel
IRP	International Resource Panel
Life Cycle Initiative	UNEP/SETAC Life Cycle Initiative
LCC	Life Cycle Costing
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment

LCM	Life Cycle Management
LCSA	Life Cycle Sustainability Assessment
Marrakech Process	A global process as called for by the World Summit on sustainable development's Johannesburg plan of action to support the elaboration of a 10-Year framework of programmes on sustainable consumption and production
OECD	Organisation for Economic Cooperation and Development
PMO	Project Management Office
SCP	Sustainable consumption and production
SETAC	Society of Environmental Toxicology and Chemistry
Shonan Guidance Principles	Global guidance principles for life cycle assessment databases
S-LCA	Social life cycle assessment
TF	Task force
UNEP	United Nations Environment Programme
USEtox	Environmental model for characterization of human and ecotoxic impacts in life cycle impact assessment and for comparative assessment and ranking of chemicals according to their inherent hazard characteristics developed by a team of researchers from the Phase 1 Task force on toxic impacts under the UNEP-SETAC life cycle initiative
WAIG	Work Area Interest Group
WBCSD	World Business Council for Sustainable Development
WRI	World Resource Institute

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