Chapter 18
Life Cycle Thinking and the Use of LCA in Policies Around the World

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Abstract The chapter explains what Sustainable Consumption and Production (SCP) is about, why it is about taking a life cycle approach and shows that SCP-related policies have been developed at the intergovernmental level and in different regions of the world. A key element at the international level is the 10-Year Framework of Programmes on SCP adopted in 2012 and the global agreements on the Sustainable Development Goals (SDGs) adopted in 2015. Life cycle thinking has become mature, moving from its academic origins and limited uses, primarily in-house in large companies, to more powerful approaches that can support the provision of more sustainable goods and services through efficient use in product development, external communications, in support of customer choice, and in public debates. Now governments can use LCA for SCP policies. For this purpose LCA databases are needed. LCA is in particular relevant for policies focusing on design for sustainability, sustainable consumer information, sustainable procurement and waste management, minimization and prevention as well as sector-specific policies like sustainable energy and food supply. Examples of life

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cycle thinking and the use of LCA in policies are provided for numerous countries around the world but with a certain focus on the European Union. It can be expected that the use of LCA in policies for the sustainability assessment of products will further increase, also slowly covering more means of implementation such as incentives and legislative obligations.

Learning Objectives

After studying this chapter, the reader should be able to:

- Explain the basic principles of Sustainable Consumption and Production (SCP), covering exploration, extraction, product development, manufacturing, use and end of life options;
- Discuss which SCP policies have been developed at the intergovernmental level and in different regions of the world;
- Express the link to focus areas particularly relevant for LCA-based policies such as design for sustainability and sustainable consumer information;
- Value the examples of life cycle thinking and the use of LCA in policies provided for numerous countries around the world;
- Explain the opportunities of using LCA in policies for the sustainability assessment of products in the future aiming at showing the efficiency of the means used.

18.1 Introduction to Policies on Sustainable Consumption and Production

Over the last few decades, the need to transition into a more sustainable society has become more and more evident and pressing. In return, global efforts to address sustainability challenges have also significantly increased. To this end, especially 2015 was the year of sustainability, which included not only the global agreement on the Sustainable Development Goals (SDGs), but also the Paris Agreement. It was reached by the parties to the United Nations Framework Convention on Climate Change (UNFCCC) on 12 December 2015 in Paris and symbolizes a fundamentally new course in the two-decade-old global fight against climate change.

"The necessary shift tosustainable consumption and production (SCP) patterns will do much to improve the lives of some of the world's poorest people as well as protect the rich resources that nature provides. But we will not achieve this shift unless we have effective policies, social and technological innovation, public and private investment, and the engagement of governments, business, consumers, educators and the media. Each and every one of us will have a role to play …" (UNEP 2012a).

SCP is understood as the "The use of services and related products, which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of future generations" (Norwegian Ministry of Environment, Oslo Symposium 1994). It means that SCP is a holistic approach that has at its core a life cycle perspective, which is the attitude of becoming mindful of how everyday life has an impact on the environment and society.

According to UNEP (2012a) SCP focuses on resource efficiency that is about ensuring that natural resources are efficiently produced and processed, and consumed in a more sustainable way, as well as about reducing the environmental impact from the consumption and production of products over their full life cycles. By producing more well-being with less material consumption, resource efficiency enhances the means to meet human needs while respecting the ecological carrying capacity of the earth. Such improvements can also increase the competitiveness of enterprises, turning solutions for sustainability challenges into business, employment and export opportunities. The fundamental objective of SCP is to decouple economic growth from environmental degradation.

SCP policies cover all the areas highlighted in Fig. 18.1. One of UNEP's six sub-programmes is on Resource Efficiency and SCP. The overarching aim of this sub-programme (UNEP 2013a) is to detach economic growth from unsustainable resource use and environmental degradation. In general, it can be observed that governments in support of a shift to sustainable consumption and production focus more on production in developing countries and on consumption in developed countries. SCP is covered under the SDG 12 on responsible consumption and production.

By applying the life cycle approach, priorities can be identified more transparently and inclusively and policies can be targeted more effectively so that the maximum environmental benefit is achieved relative to the effort expended (CEC 2005a).

The chapter focuses first on life cycle thinking and then on LCA in policies at the international level, with a particular focus on intergovernmental organizations including the European Union (EU) and selected countries around the world.

18.2   Policies Based on a Life Cycle Thinking at the International Level and Around the World

18.2.1   10-Year Framework of Programmes on SCP

On June 2012 established a landmark in the international recognition of SCP in policies with the adoption of "the 10-Year Framework of Programmes onSustainable Consumption and Production Patterns (10YFP)" by the Heads of State at the United Nations Conference on Sustainable Development (Rio+20)—as

Fig. 18.1 SCP policies along the product life cycle (UNEP 2010a)

stated in paragraph 226 of the Rio+20 Outcome Document "The Future we Want" (UNCSD 2012a).

The 10YFP is a concrete and operational outcome of Rio+20. It is a global framework of action to enhance international cooperation to accelerate the shift towards SCP in both developed and developing countries. The framework will support capacity building and provide technical and financial assistance to developing countries for this shift. The 10YFP will develop, replicate and scale up SCP and resource efficiency initiatives, at national and regional levels, decoupling environmental degradation and resource use from economic growth, and thus increase the net contribution of economic activities to poverty eradication and social development. It responds to the 2002 Johannesburg Plan of Implementation, and builds on the 8-year work and experience of the Marrakech Process—a bottom-up multi-stakeholder process, launched in 2003 with strong and active involvement from all regions in the world. The 10YFP will also build on the work of the national cleaner production centres and other SCP best practices engaging a wide range of stakeholders (UNEP 2012b).

The adopted document in Rio+20—The Future we Want (UNCSD 2012b)—provides the vision, goals and values of the 10YFP as well as its functions, organizational structure, means of implementation, criteria for programmes design and
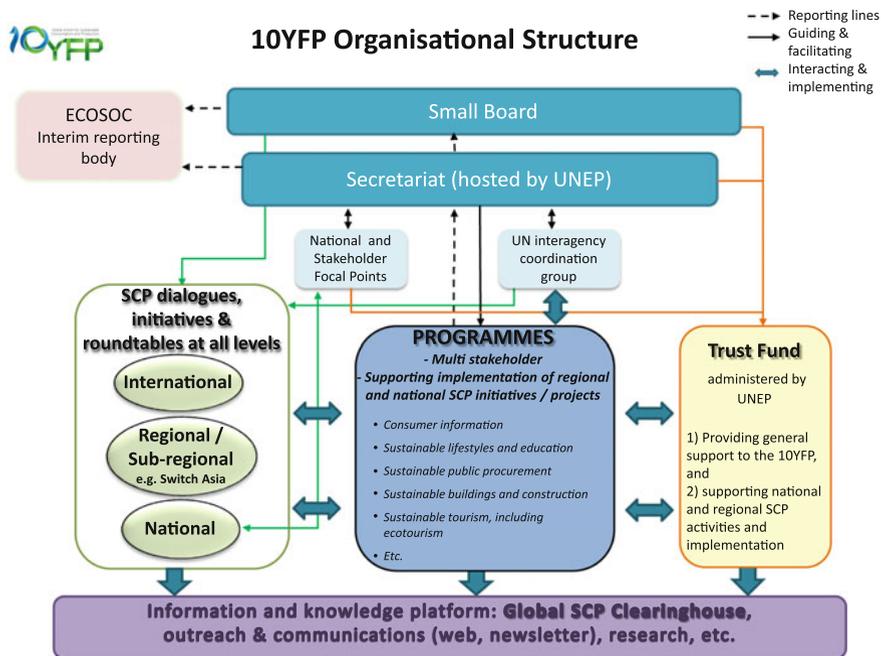
Fig. 18.2 10YFP operational structure (UNEP 2012b)

an initial, non-exhaustive list of five programmes. UNEP has been requested to serve as the 10YFP Secretariat and to establish and administer a Trust Fund to support SCP implementation in developing countries and countries with economies in transition. The 10YFP operational structure is summarized in Fig. 18.2.

The 10YFP is called to assist countries in reaching a common vision that promotes a life cycle perspective, among other aspects of SCP. This call for LCT in the development of SCP policies in countries is demanding life cycle based expertise, data, methodologies, skills andresources and the support of stakeholders and initiatives worldwide. SCP programmes need a solid scientific andpolicy knowledge base and the use of a mix of efficient instruments such as education, training and data collection.

Need of support from the LCA expert community for implementing the 10YFP could be on result-based indicators for the 10YFP, understanding how LCA could be used better for policymaking, guidance on product sustainability information (e.g. hot spot methodology), input for the global SCP Clearinghouse on Sustainable Consumption and Production platform[1] (including south–south cooperation), and the involvement of life cycle experts and regionalstakeholders in the development of the 10YFP programmes.

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[1]www.scpclearinghouse.org/fr/.

18.2.2   UNIDO/UNEP Programme on Resource-Efficient Cleaner Production

Recognizing that resource efficiency requires Cleaner Production (CP) and vice versa, UNIDO and UNEP have moved towards Resource Efficient and Cleaner Production (RECP). RECP recognizes that CP methods and practices generate multiple benefits that are relevant to many of today's most pressing global challenges, including mitigation of GHG emissions and adapting to climate change; responding to increasing scarcity ofwater, fuels and other materials; providing decent jobs; and halting environmental degradation. RECP, therefore, builds upon CP in accelerating the application of preventive environmental strategies to processes, products and services to increase efficiency and reduce risks to humans and the environment.

UNIDO and UNEP launched in 1994 a joint programme to establish National Cleaner Production Centres/Programmes (NCPCs/NCPPs). They incorporated the lessons learned from the NCPCs in their joint RECP programme strategy. The strategy was approved in 2009 for implementation. It supports the global imperative to decouple economic development from further environmental degradation and resource depletion. The programme aims to improveresource efficiency and environmental performance of businesses and other organizations in developing and transition countries. The envisioned principal outcome is the widespread adaptation and adoption of RECP methods, practices, technologies and policies. The past decade has demonstrated that these are applicable and relevant. The challenge is now to scale-up their application so that they become common practice rather than isolated initiatives in a few selected enterprises (UNIDO/UNEP 2013).

18.2.3   OECD: Sustainable Materials Management and Green Claims

One of the policies of the Organisation for Economic Co-operation and Development (OECD) that is clearly stating a strong reference to LCT is Sustainable Materials Management (SMM). It is increasingly recognized as apolicy approach that can make a key contribution to green growth and the challenges that are posed by sustained global economic and demographic growth. One of the key challenges of the SMM approach is to effectively address the environmental impacts that can occur along the life cycle of materials, which frequently extends across borders and involves a multitude of different economic actors (OECD 2012).

The OECD Committee on Consumer Policy launched a project to examine ways to enhance the value and effectiveness of green claims in April 2009.

Environmental claims, also termed "green claims", are assertions made by firms about the environmentally beneficial qualities or characteristics of goods and services. They can refer to the manner in which products are produced, packaged, distributed, used, consumed and/or disposed of. In addition to the environmental aspects, these claims are sometimes defined to include the social responsible or ethical manner in which products are produced and distributed. The Committee's work underscores the complexity of the issues and challenges facing stakeholders in the field of environmental claims. There is agreement, however, on a number of basic principles that could enhance the value and effectiveness of claims (OECD 2010).

18.2.4   Asia/Pacific: Strategy of Green Growth and Circular Economy

In the Asia–Pacific region, SCP rides on the back of the economic growth and broader sustainable development agenda. The strategy of Environmentally Sustainable Economic Growth, or Green Growth, is an approach that is promoted by the UN Economic and Social Commission for Asia and the Pacific (UNESCAP), has been widely adopted by countries in the region. It was launched in 2005 at the Fifth Ministerial Conference on Environment and Development in Seoul, Republic of Korea, as a way to reconcile tensions between efforts to achieve two of the Millennium Development Goals, namely, poverty reduction and environmental sustainability. Green Growth promotes SCP, the development of sustainable infrastructure, and the introduction of green tax reform for reducing poverty, while UNESCAP has since provided capacity building to some national governments towards the development of Green Growth strategies (UNESCAP 2005).

An important role in Asia plays the Circular Economy promoted by the government in China and inspired by Japanese and German Recycling Economy Laws. China's rapid economic growth demands major supplies of all basic industrial commodities, in competition with other nations. China's emissions cross boundaries and oceans, impacting Korea, Japan, and North America. Its contribution to greenhouse gas emissions is rising rapidly. The Circular Economy approach to resource-use efficiency integrates cleaner production and industrial ecology in a broader system encompassing industrial firms, networks or chains of firms, eco-industrial parks and regional infrastructure to support resource optimization. State-owned and private enterprises, government and private infrastructure, and consumers all have a role in achieving the Circular Economy (Indigo Development 2009).

18.2.5   Latin America and the Caribbean (LAC): Regional Action Plan and Mercosur Policy on SCP

A Regional Council of Government Experts on SCP was set up in Latin America and the Caribbean in 2003 to support the implementation of the SCP regional strategy. The Regional Council has also provided inputs and advice to the LAC Forum of Ministers of the Environment. The LAC Forum of Minister of the Environment is the most representative and influential gathering of environmental policymakers in the region and endorsed important elements of the regional SCP strategy. In 2005 the Fifteenth Meeting of the Forum of Ministers of the Environment of Latin America and the Caribbean (Caracas, Venezuela) decided to foster the preparation of SCP policies, strategies and action plans. The Sixteenth Meeting of the Forum (in Dominican Republic in 2008) approved the regional Action Plan on SCP. The region has identified the following four priorities on SCP: National Policies and Strategies, Small and Medium-Sized Enterprises (SMEs), Sustainable Public Procurement and Sustainable Lifestyles (UNEP 2008).

Agreeing on the need for a common SCP policy with a focus on eco-efficiency and the reduction of hazards forhuman health and the environment, Mercosur member countries signed the Declaration on Cleaner Production Principles in October 2003. This led to the approval of the Mercosur Policy or Promotion and Cooperation onSustainable Consumption and Production in 2007 (Mercosur 2007). Signed by an important trade block of the world, this policy sets an important example for regional coordination on SCP. The policy contributed to the further development of national SCP action plans such as the Argentinian one (Decreto 1289, 2010).

18.2.6   Africa: African 10-Year Framework of Programmes on SCP

SCP activities in Africa started in the mid-1990s. The UNIDO and UNEP established National Cleaner Production Centres (NCPCs) in 1995, which have remained the major institutions for promoting SCP in the region. Since 2000, the African network of NCPCs started to convene biannual regional roundtables on SCP. In 2004, the NCPCs formed the African Roundtable on SCP (ARSCP) as a not-for-profit regional institution to promote SCP. The ARSCP is a multi-stakeholder forum and its activities include, but are not limited to, the organization of national and sub-regional SCP roundtables developing sub-regional and regional programmes and projects on SCP, and organizing trainings on selected SCP topics. The ARSCP pioneered the development of the African 10-Year Framework of Programmes (10YFP) on SCP adopted by the African Ministerial Conference on Environment (2005). Thestrategic focus of the 10YFP is linking SCP with the challenges of meeting basic needs in a more sustainable manner. The

major achievements of the African 10YFP on SCP fall under five categories: (i) Mainstreaming, (ii) Energy, (iii) Water, (iv) Information-based instruments and (v) Sustainable Public Procurement (UNEP 2013b).

18.2.7   Reference to Life Cycle Thinking in Different SCP Policies Around the World and the Role of Trade

From the policy examples described above, we can conclude that the topic of addressing environmental impacts of products, materials and resources throughout their life cycles in an integrated way is mainly covered in the SCP policy framework of developed countries. In contrast, in general, the SCP policy programmes of the developing regions of the world focus on national policies, specificresources and business development.

The expansion of life cycle based environmental standards andregulations in industrialized countries could have significant impacts on market access of developing countries. Therefore, the fear in many developing countries is that stricter product standards in the markets of developed countries will act as trade barriers for their exports. Moreover, there is widespread suspicion that environmental restrictions are sometimes used as indirect means of protecting the industries in developed countries (Verbruggen et al. 1995).

18.3   LCA Promotion and Policies at the International Level

18.3.1   UNEP/SETAC Life Cycle Initiative

In 2002 UNEP jointly with 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. After the publication of the ISO 14040 standard dealing with LCA, 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 LCT and established the UNEP/SETAC Life Cycle Initiative (Toepfer 2002).

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 Life Cycle Impact Assessment (LCIA), as well as the cross-cutting area of social impacts along the life cycle. 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. 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 (UNEP/SETAC 2012).

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 (2012–2017) was coined as 'a world where life cycle approaches are mainstreamed'. Activities in phase 3 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. Five flagship projects have been defined in the areas of (i) data and databases management, (ii) global guidance on environmental life cycle impact assessment indicators, (iii) product sustainability information 'meta' guidance, (iv) LCA for organizations and (v) global capability development and implementation. Moreover, a special effort on communication and stakeholder outreach has been initiated. These activities are expected to be implemented jointly with a number of other projects. Progress made in phase 3 are monitored every 2–3 years by key indicators and compared to a baseline survey carried out in 2012.

A crucial deliverable and ongoing activity of the UNEP/SETAC Life Cycle Initiative (Sonnemann et al. 2011) is to help overcoming the lack of consistent and high-quality LCA data worldwide and to support capacity building for developing countries is the Global Guidance Principles for Life Cycle Assessment databases published in 2011 by UNEP/SETAC (2011) and the follow-up activities in phase 3. 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. Life cycle data availability had been recognized by UNEP as a strategic element for advancing SCP through the development and implementation of life cycle based tools and approaches that need these data.

18.3.2 International Resource Panel

The International Resource Panel was established in 2007 to provide independent, coherent and authoritative scientific assessment on the sustainable use of natural resources and the environmental impacts of resource use over the full life cycle and to contribute to a better understanding of how to "decouple" economic growth from environmental degradation (UNEP 2010a).

By providing up-to-date information and best science available information contained in the International Resource Panel's reports is intended to be policy relevant and support policy framing, policy and programme planning, and enable evaluation and monitoring of policy effectiveness (UNEP 2012c).

The broad scope of the Resource Panel requires a wide range ofsustainability experts who organize, review, validate, integrate and communicate findings from studies by appropriate scientists through activities at the working group level. The Resource Panel may limit its size to 30–50 members, while many more scientists are expected to be engaged in the various working groups.

Reports of the International Resource Panel include the following:

- Environmental Risks and Challenges of Anthropogenic Metals Flows and Cycles (2013);
- Measuring Water Use in a Green Economy (2012);
- Decoupling naturalresource use and environmental impacts from economic growth (2011);
- Priority products and materials: assessing the environmental impacts of consumption and production (2010);
- Assessing biofuels: towards sustainable production and use of resources (2009).

These reports take a life cycle perspective and often refer to LCA studies reviewed. The report on assessing the environmental impacts of consumption and production, for example, identifies priorities amongst global consumption activities, industrial sectors and materials from primary industries in terms of their environmental impacts and their resource use. This can play a role in directing environmental and resource policy to those areas that really matter. There is a significant opportunity to improve the basis for decision-making by assessing best available scientific information from a global perspective in order to direct the attention of decision-makers to the big problems first, while avoiding burden shifting in time, space and between environmental impacts (UNEP 2010b).

18.3.3 FAO Partnerships on Bioenergy and Livestock

Bioenergy
The Global Bioenergy Partnership (GBEP) was established to implement the commitments taken by the G8 in the 2005 Gleneagles Plan of Action to support

"biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent". Following a consultation process among developing and developed countries, international agencies and the private sector, the GBEP was launched at the 14th session of the Commission on Sustainable Development (CSD 14) in New York on 11 May 2006 (FAO 2009).

From 2007 to 2012 GBEP received a renewed mandate by the G8. The Camp David Summit declared to applaud the Global Bioenergy Partnership (GBEP) for finalizing a set of sustainability indicators for the production and use of modern bioenergy and for initiating capacity building activities through a Regional Forum in West Africa and to invite GBEP to continue implementing capacity building activities that promote modern bioenergy for sustainable development (The White House 2012).

In line with GBEP's Terms of Reference and the state of the international debate on bioenergy, a Task Force on GHG Methodologies was established under the leadership of the United States of America, co-chaired by United Nations Foundation, to analyse the full life cycle of transport biofuels and solid biomass, and to develop a common methodological framework for the use of policymakers and stakeholders when assessing GHG impacts by which the methodologies of GHG life cycle assessments could be compared on an equivalent and consistent basis (FAO 2013).

Livestock

The Partnership on the environmental benchmarking of livestock supply chains is looking to improve how the environmental impacts of the livestock industry are measured and assessed, a necessary first step in improving the sustainability of this important food production sector. At the Rio+20 sustainable development conference, governments agreed on the necessity of making agricultural production more sustainable, and stressed in particular the need to shift to more sustainable livestock production systems (FAO 2012).

FAO and governmental, private sector, and nongovernmental partners work together on a number of fronts to strengthen the science of environmental benchmarking of livestock supply chains. Activities planned for the initial 3-year phase of the project include the following (FAO 2012):

- Establishing science-based methods and guidelines on how to quantify livestock's carbon footprint, covering various types of livestock operations and rearing systems;
- Creating a database of greenhouse gas emission factors generated for the production of different kinds of animal feed–feed production and use offer significant opportunities for reducing livestock emissions;
- Developing a methodology for measuring other important environmental pressures, such aswater consumption and nutrient losses.

18.3.4 ITU Sustainability Standards for the Information and Communications Technology Industry

A number of global companies in the information and communications technology (ICT) sector are increasingly being asked by their customers, investors, governments and other stakeholders to report on their sustainability performance. In response to this growing demand, the Toolkit on environmental sustainability for ICT companies is an International Telecommunication Union (ITU) led initiative; that means it is carried out by ITU together with over 50 partners. The Toolkit provides plenty of detailed support on how ICT companies can build sustainability into the operations and management of their organizations, through the practical application of international standards and guidelines. The Toolkit provides a set of agreed upon sustainability requirements for ICT companies that allows for a more objective reporting of how sustainability is practiced in the ICT sector in these key areas: sustainable buildings, sustainable ICT in corporate organizations, sustainable products, end of life management, general specifications and Key Performance Indicators (KPIs), and an assessment framework for environmental impacts of the ICT sector. It puts international standards and guidelines into context and brings them to life with real-life examples, showing how ICT organizations around the world are dealing with their sustainability challenges (ITU 2012).

18.4 Examples of LCA Promotion and Use in Policies Around the World

18.4.1 Introduction

According to a recent survey done by theLife Cycle Initiative (UNEP/SETAC 2016), the main role of LCA in policies in the last years has been in environmental labelling and the formulation of regulations on product use and waste management mostly in developed countries and still in a very limited way in developing ones. Also, certain governments have been promoting life cycle based policies and encouraging the use of life cycle assessment, for example, to estimate GHG and other emissions of biofuels. Legislation and certification schemes for biofuels are currently emerging, like the global RSB[2]-certification, and mineral oil tax exemption for biofuels of national authorities (UK, Switzerland, Netherlands, Germany, California, etc.); these certification schemes include a range of life cycle impact assessment indicators (SQCB 2013). Policymakers in Denmark and Germany are using interpretations of LCA studies to distinguish between more or less environmentally friendly packaging systems and/or materials; and LCA has

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[2]Roundtable on sustainable biofuels.

already been successfully used for the case of the Swedish waste incineration tax (Björklund and Finnveden 2007). However, there is a perceived risk that they are ignoring the uncertain and subjective nature of LCA assessments, which raises questions about the appropriateness of using an LCA-based estimate as a performance metric in public policy.

The examples show that there are high expectations of the future use of LCA in SCP policy areas—such as sustainable public procurement and eco-design directives as well as consumer information. However, there are still certain challenges to overcome such as the lack of good quality and available data, more capacity building and resources. International dialogue and consensus on those issues are required for advancing more life cycle based policies to influence the marketplace, in particular taking into consideration the special context of developing countries. The following examples from different regions of the world provide an overview of LCA promotion and use in policies with quite some detail for the European Union and for selected countries with a certain focus on databases.

18.4.2   Europe: EU and Switzerland

EU Policies Integrating Life Cycle Thinking and Life Cycle Assessment

In the EU at European and national level, over the last 20 years, there has been an increasing emphasis on integrated approaches in environmental policy. Policy has been focusing on linkages between environmental media (air, water, soil) and cross-cutting environmental themes (e.g. climate change, biodiversity etc.) that pay more attention to sustainable resource use. All of these policies aim at fostering the reduction of environmental impact and at further integrating resource use issues and the negative impacts associated to their use in a coordinated way (CEC 2005b). In a growing number of policies and business instruments, LCT and LCA have been recognized as useful approaches in policy support in terms of impact assessment, implementation measures and monitoring needs.

Since 1990, the European Council resolution of 7 May 1990 on waste policy invited the European Commission to submit as soon as possible a proposal for a European-wide eco-labelling scheme covering the environmental impact during the entire life cycle of the product. This resulted in the first EUregulation regarding Eco-label (CEC 1992) where the evaluation of the impact associated with product life cycle is the core of the label scheme. Hence, the first area integrating LCT and eco-design concepts was related to waste policy and to the need of informing consumers. Since then several policy initiatives integrated LCT.

It can be interpreted that the EU has already made significant steps, through various policies building from the Integrated Product Policy (IPP) (CEC 2003). In the IPP, the European Commission (EC) concluded that LCA provides the best framework for assessing the potential environmental impacts of products that are currently available. However, the need for more consistent data and consensus on LCA methodologies was underlined. The further integration of LCT and LCA

within policies builds on achievements made in the context of the Thematic Strategy on the Prevention and Recycling of Waste (CEC 2005a), the Thematic Strategy on the Sustainable Use of Natural Resources (CEC 2005b), the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan of 2008 (CEC 2008a). In 2005, the IPP Communication was particularly strengthened by the EC's Thematic Strategy on the Sustainable Use of Natural Resources (CEC 2005b). It focuses on decoupling economic growth from environmental impacts. LCT is a core to this thematic strategy, being a foundation of the indicators that will be developed to monitor progress across the community. The global dimension is equally recognized through UNEP recommendation to establish the International Resource Panel. Among others, the Action Plans on Sustainable Consumption and Production and on Sustainable Industrial Policy (SCP/SIP) (CEC 2008a) helped to identify and overcome barriers for SCP. The plans built upon ongoing European initiatives and instruments, including the Eco-Management and Audit Scheme (EMAS), the Eco-Label Scheme, the Environmental Technology Action Plan (ETAP), Green Public Purchasing (GPP), the Eco-design of Energy-using Products (EuP) Directive as well as others. This was done in light of increasing coherence among the different related policy areas, while addressing gaps and supporting global interaction. In more recent updates more overarching policy documents such as the Resource Efficiency Flagship Initiative of the Europe 2020 Strategy (CEC 2011a), and another related Roadmap (CEC 2011b) that state, by 2050, the EU economy shall have developed in such a way as to accommodate resource constraints and planetary boundaries. In 2013, a landmark communication has been released: the Single Market for Green Products (CEC 2013a, b).

A brief description of the main initiatives over the last 10 years is given below, entailing initiatives of several EC Directorates General (DGs) such as DG Environment, DG Enterprise and Industry and DG Climate:

- *Integrated Product Policy Communication Building on Environmental Life Cycle Thinking*—Integrated Product Policy (IPP) seeks to minimize environmental impacts by looking at all phases of a products' life cycle and taking action where it is most effective (CEC 2003).
- *Stimulating technologies for sustainable development*—Assessments of technologies should verify the technological performance and the claimed performance from an economic and environmental viewpoint, taking into account the whole life cycle of the technology (CEC 2004).
- *Thematic Strategy on the Prevention and Recycling of Waste*—In order to secure a higher level of environmental protection, the proposal is to modernize the existing legal framework—i.e. to introduce life cycle analysis in policy-making and to clarify, simplify and streamline EU waste law (CEC 2005a).
- *Thematic Strategy on the Sustainable Use of Natural Resources*—To have a higher impact in reversing unsustainable trends, containing environment degradation and preserving the essential services that natural resources provide, environment policy needs to move beyond emissions and waste control (CEC 2005b).

- **REACh Regulation on Chemicals**—Risk assessment and management of chemicals have integratinglife cycle thinking (EC 2006).
- **Sustainable Consumption and Production and Sustainable industrial policy Action Plan**—The Action Plan aims to reduce the overall environmental impact and consumption of resources associated with the complete life cycle of goods and services (CEC 2008a).
- **Public procurement for a better environment**—Procurement is described as a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured (CEC 2008b).
- **Waste framework directive**—the directive aims at clarifying key concepts like the waste hierarchy; strengthening the measures that must be taken in regard to waste prevention; introducing an approach that takes into account the whole life cycle of products and materials and not only the waste phase (EC 2008).
- **Eco-design directive**—The Eco-design Directive provides with consistent EU-wide rules for improving the environmental performance of energy-related products through eco-design (EC 2009a).
- **Community Eco-Management and Audit Scheme**—The EMAS IIIregulation prescribes that for non-industrial organizations, such as local authorities or financial institutions, it is essential that they also consider the environmental aspects associated with their core business, these include, amongst others, product life cycle-related issues (EC 2009b).
- **Eco-label**—The EU aims at establishing a voluntary eco-label award scheme intended to promote products with a reduced environmental impact during their entire life cycle (EC 2010a).
- **Energy labelling directives**—In the directive text is stated that when the Commission reviews progress and reports on the implementation of the SCP/SIP Action Plan in 2012, it will in particular analyse whether further action to improve the energy and environmental performance of products is needed, including the products' environmental impact during their life cycle (EC 2010b).
- **Resource efficiency flagship**—In the resource efficiency manifesto, one of the road map aims is to create better market conditions for goods and services that have lower impacts across their life cycles, (CEC 2011a, and the related road-map CEC 2011b).
- **Building sector and Construction work regulation and Strategy for the sustainable competitiveness of the construction sector and its enterprises**—One of the basic requirements for construction works set in EU regulation (EC 2011b) state that the construction works must be designed and built in such a way that they will, throughout their life cycle. Moreover, in the strategy for thesustainability of the building sector (CEC 2012a), a coherent and mutually recognized interpretation of the performances through harmonized indicators is advocated.
- **Proposal for a General Union Environmental programme to 2020**—Measures will also be taken to further improve the environmental performance of goods

and services on the EU market over their whole life cycle through measures to increase the supply of environmentally sustainable products and stimulate a significant shift in consumer demand for these products (CEC 2012b).

- **Communication on Bioeconomy**—Actions are set towards the enhancement of bioeconomy markets, taking into account added value, sustainability, soil fertility and climate mitigation potential; supporting the future development of an agreed methodology for the calculation of environmental footprints, e.g. using LCA (CEC 2012c).
- **Building the single market for green product**—The Single Market for Green Products initiative proposes a set of actions, establishing two methods to measure the environmental performance throughout the life cycle of products and organizations, theProduct Environmental Footprint (PEF) and the Organization Environmental Footprint (OEF); providing principles for communicating environmental performance, such as transparency, reliability, completeness, comparability and clarity; supporting international efforts towards more coordination in methodological development and data availability (CEC 2013a, b).

In the wide policy context presented before, there is an increasing need of life cycle based policy support activities. It is considered of the utmost relevance to develop a science-to-policy interface, due to the broad implications of the decisions supported by LCA. In this context, the Joint Research Centre of the European Commission (EC-JRC) is leading a "science-to-policy" process: gathering, capitalizing and evaluating existing knowledge in order to provide robust support to policy decision-making (Sala et al. 2012). The EC-JRC is working towards providing this policy support through a number of project and initiatives, such as follows:

- European Platform on LCA;
- Support for the product and organization environmental footprint;
- Development of life cycle based indicators for resources, products and waste (EC-JRC 2012);
- Definition of methods to include LCT in waste management (EC-JRC 2011a, b, c);
- Definition of methods to include resource efficiency criteria for energy using products (Ardente and Mathieux 2012);
- Use of LCA for building futurescenarios for policy evaluation (EC-JRC 2013).

The European Platform on LCA

In its Communication on Integrated Product Policy (CEC 2003), the European Commission concluded that LCA provides the best framework for assessing the potential environmental impacts of products currently available. In the document, the need for more consistent data and consensus LCA methodologies was underlined. It was therefore announced that the Commission will provide a platform to facilitate communication and exchanges on life cycle data and launch a coordination initiative involving both ongoing data collection efforts in the EU and existing

harmonization initiatives. In 2005, DG Environment together with the Institute for Environment and Sustainability established the European Platform on Life Cycle Assessment (EPLCA). This Platform promotes the availability, exchange and use of quality-assured life cycle data and methods. The EPLCA aims to improve the credibility, acceptance and use of LCA in business and public authorities; to ensure greater coherence across LCA-based instruments and to provide robust decision support to a range of environmental policies and business instruments (see Fig. 18.3).

The main deliverables of the EPLCA are the International Reference Life Cycle Data System (ILCD), the European Reference Life Cycle Database (ELCD), the LCA Resources Directory and LCT Forum mailing list. The ILCD Handbook, launched in 2010, is a series of detailed technical documents, providing guidance for good practices in LCA in business and government, serving as a "parent" document for the development of sector- and product-specific guidance documents, criteria and simplified tools.

The European Commission's Environmental Footprint for Products and Organizations

To date, a company wishing to market its product as green in several EU Member State markets faces a confusing range of choices of methods and initiatives, and might find its needs to apply several of them in order to prove the product's green credentials. This is turning into a barrier for the circulation of green products in the Single Market. The recent EC initiative "Building the Single Market for Green Products—Facilitating better information on the environmental performance of products and organisations" is a step towards removing this ambiguity by improving the way how environmental performance of products and organizations is measured and communicated (CEC 2013a).

Within this initiative, the EC Environmental Footprint was adopted as a harmonized method for multi-criteria (i.e. multi-impact category) environmental LCA of products and organizations. Environmental Footprint (EF) is a new harmonized scheme for multi-criteria life cycle environmental assessment of products and organizations developed by the European Commission's JRC in close cooperation with Directorate-General for the Environment.

The two guidelines on Product EF (PEF) and Organization EF (OEF) provide specific and practical guidance for comprehensive, robust and consistent environmental assessment of products and organizations. To further support comparisons and comparative assertions within product groups and sectors, Product Environmental Footprint Category Rules (PEFCRs) and Organization Environmental Footprint Sector Rules (OEFSRs) are developed in a 3-year pilot phase starting in 2013. Chapter 24 offers more details on the PEF/OEF.

EU Policy Background and Rationale

The EC Environmental Footprint fits within the integrated product policy (IPP) and the SCP/SIP Communication of the European Union. More recently, in December 2010, the environmental ministers of the Member States of the EU met in the Environment Council and invited the European Commission to "develop a common
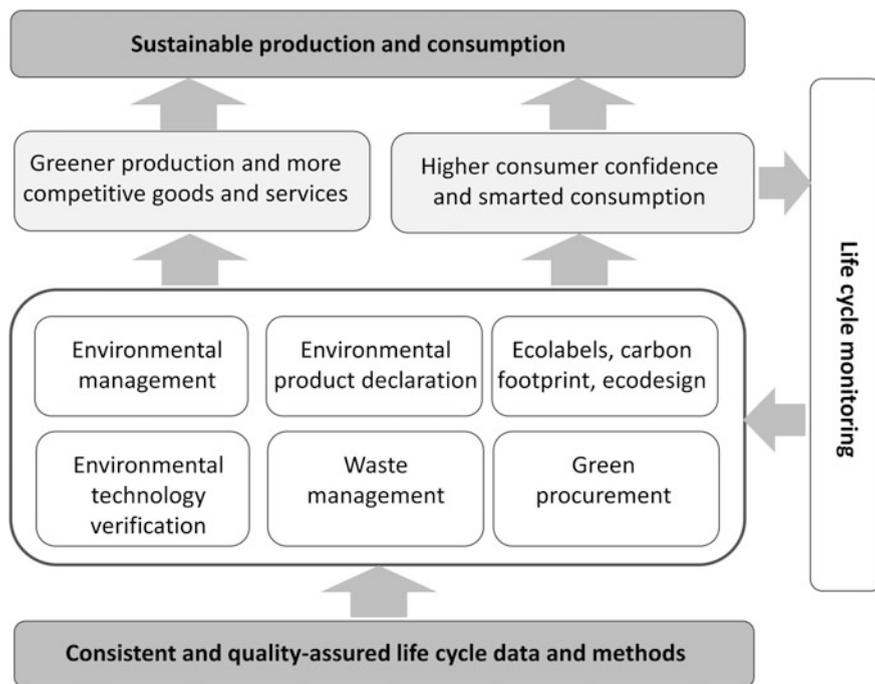
Fig. 18.3 Life cycle data and methods as the basis of tools and approaches for supporting sustainable production and consumption policies

methodology on the quantitative assessment of environmental impacts of products, throughout their life-cycle, in order to support the assessment and labelling of products" (Council of the European Union 2010).

The EC "Roadmap to a Resource Efficient Europe" (CEC 2011a) was an answer to this invitation and 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 EC published the communication on "Building the Single Market for Green Products—Facilitating better information on the environmental performance of products and organisations" (CEC 2013a). The Commission Recommendation (CEC 2013b) that encourages EU Member States and the private sector to use the EC PEF and OEF methods to measure and communicate the environmental performance of products and organizations accompanies the communication. The PEF and OEF methods based on LCA are integral part of the

Recommendation. This is seen as an important step forward to ensure robust decision support for consumers, industry and policymakers.

France

France is among the European countries that are active in the transition towards sustainable production and consumption patterns. In recent years, many public and private initiatives were launched: "Grenelle environment" and "French Energy Transition" are among these initiatives.

Grenelle Environmental Labelling

Based on the Grenelle II law (French Ministry of Ecology, Sustainable Development and Energy 2010), in 2011–2012 France conducted a national experimentation on consumer product environmental information. The experimentation covered the quantification of environmental impacts and the communication of environmental footprints to the consumer. More than 160 companies participated. All sectors were represented, with about one-third from the food and beverage area. Several foreign companies—from Chile, Colombia, Sweden, etc.— were part of the experimentation.

The French governmental conclusion report now constitutes the roadmap for additional future developments including the development and consolidation of the technical tools (database, PCR, calculators). Furthermore, the French Government participate and contribute actively to the EU "PEF/OEF" Environmental Footprint pilot phase.

Energy Transition for Green Growth Act

The Energy Transition for Green Growth Act represents the French government's aim—linked to the Paris Agreement (COP21)—to reduce its greenhouse gas emissions, diversifying its energy model and increasing the deployment ofrenewable energy sources (French Ministry of Ecology, Sustainable Development and Energy 2015).

The actions focus on the buildings, transport, Circular Economy, renewable energy and nuclear energy. The initiative also aims to remove regulatory constraints. The government aims to implement the energy transition with the involvement of all stakeholders.

Even though the role of Life Cycle Thinking has been highlighted in these initiatives, the application of Life Cycle approaches in is yet far from being mainstream. Many LCA-related activities were conducted by private and public key actors including networks in France in recent years, either directly linked to or from beyond the aforementioned initiatives.

Switzerland

Federal Office for the Environment (FOEN) jointly with other Swiss Federal Offices backs ecoinvent, the Centre for Life Cycle Inventories, which is a Competence Centre of the Swiss Federal Institute of Technology Zürich (ETH Zurich) and Lausanne (EPF Lausanne), the Paul Scherrer Institute (PSI), the Swiss Federal Laboratories for Materials Testing and Research (EMPA) and the Swiss Federal Research Station Agroscope Reckenholz-Tänikon (ART). The ecoinvent centre

holds one of the world's leading LCA databases. The centre's mission is to establish and provide scientifically sound and transparent international life cycle assessment and life cycle management data and services to industry, consultancies, public authorities and research institutions. Switzerland provides also technical assistance to other countries aiming at building up LCA knowledge.

Switzerland supports an international approach through the use of the Global Guidance Principles delivered by the UNEP/SETAC Life Cycle Initiative, as well as the development of Product Category Rules and the environmental Life Cycle Impact Assessment Indicators under development. Another key issue is global interoperability; in this context FOEN supports activities to increase data availability, transparency, capabilities and the use of gate-to-gate unit process data in a "Lego bricks" approach to enhance the interoperability among databases (UNEP 2013b).

18.4.3   The North American Free Trade Agreement Countries: USA and Mexico

USA

The USA has developed LCA databases to support the work of the private and public sectors on sustainability. The most recent activity is the LCA Digital Commons Project at the UNDA National Agricultural Library. The goal is to develop a database and toolset intended to provide data for use in LCAs of food, biofuels, and a variety of other bio-products. Researchers at the University of Washington Design for Environment Laboratory have developed initial unit process data. OpenLCA provides core software for the Commons database. The development of visualization tools is underway with Earthster. Listed below are some of the organizations and resources data, which are contributing to the LCA Digital Commons project (UNDA National Agricultural Library 2013).
Organizations involved are:

- US EPA promotes the use of LCA to make more informed decisions through a better understanding of the human health and environmental impacts of products, processes, and activities and supported the development of the Global Guidance Principles on LCA Databases.
- National Renewable Energy Laboratory—created and maintains the U.S. Life Cycle Inventory (LCI) Database to help LCA practitioners answer questions about environmental impact.
- The Sustainability Consortium drives scientific research and the development of standards and IT tools, through a collaborative process, to enhance the ability to understand and address the environmental, social and economic implications of products.
- The OpenLCA Project creates modular software for life cycle analysis and sustainability assessments. The software is available as open source and is free.

- New Earth is a non-profit organization initiating, facilitating and implementing innovative strategies and tools to help achieve sustainable development on a global level such as Earthster.
- The American Centre for Life Cycle Assessment is a non-profit membership organization formed in 2001 to increase awareness of and to promote the adoption of Environmental LCA among industry, government and NGOs.
- The Innovation Centre for U.S. Dairy is working with the entire dairy industry to foster innovation and give consumers more of what they want, when and where they want it.

Data resources available include the following:

- Earthster—This website is the home of a new system that is web-based, free and open source (non-proprietary). It begins by inviting participation purely on the basis of providing zero-cost access to markets; this is something that any business can respond positively to. Next, buyers and consumers at one end of the system have the ability to send signals to producers about the desired environmental and social attributes or characteristics of products and their life cycles. Third, producers have the ability to download and use free software to rapidly benchmark themselves versus industry averages, and optionally to click-to-report environmental and social attributes of their processes and products to the marketplace. Fourth, LCA data providers, and developers of methodologies, scorecards, labelling systems, etc., all have the ability to process the publicly provided information using their own systems, providing decision-makers with customized reports with only the data of interest to the decision-maker.
- US Life Cycle Inventory Database provided by the National Renewable Energy Laboratory is publicly available and contains data modules for commonly used materials and processes, such as primary fuel production and combustion, electricity generation and transformation processes.
- The ecoinvent Database provided by the Swiss Centre for Life Cycle Inventories, which was and is supported by Swiss Federal Offices.
- GaBi Databases generated by PE International.
- ELCD Core Database provided by the Joint Research Centre of the European Commission.

Mexico

Major barriers and needs for LCA in Mexico consist in lack of information, regulations and capacities on LCA, as well as a lack of diagnosis of the market and its requirement for a good LCA and the right private–academic–public partnership. Conditions required to overcome these barriers are to establish the structure of global life cycle policies according to internal needs and to get the training for its development as well as open LCA to different sectors in order to promote partnership for the development of tools that can support the design, development and implementation of policies. Issues and deliverables needed for advancing LCA-based policies include the following:

- Diagnosis and assessments about how to introduce LCT and LCA in policies according to conditions in Mexico,
- Identification of which policies and sectors must be influenced to do so, as well as life cycle experts available in the country.

With regard to life cycle inventory datasets, from 2005 onwards data was collected from public and private sources. In 2010 the database format was designed in compliance with existing documentation formats. From 2010 the IT platform and data management have been implemented such as the identification of policies and sectors that need to be targeted (e.g. energy, transport). Since then data are available in the national database called the Mexican Life Cycle Inventory Mexicaniuh (UNEP 2013b).

In Mexico, a regulation for sustainable buildings (NMX 2013) on criteria and minimum environmental requirements needs the impact assessment of the whole life cycle of buildings (including the use phase). In case of the replacement of building materials, it is also demanded the use of third-party reviewed LCAs of alternative materials for comparative assertion purposes (Güereca et al. 2015).

18.4.4   Other OECD Countries: Japan and Australia

Japan

Since 2000 Type III-based Environmental Declarations have been developed in the so-called EcoLeaf programme. Moreover, since 2008 the Carbon Footprint Programme (CFP) has been developed. The business is aware of these programmes but their uptake is faced with challenges. It is not easy for consumers to understand the label so that they could be willing to buy labelled product. Therefore, it is needed to prepare the grounds for sales promotion with cost-efficiency. In addition, a carbon offset pilot programme based on the CFP where communities can collect credits has been developed, as were general guidelines on Supply Chain GHG Emission Accounting.

Two international LCA workshops were organized in Japan in February 2013, which focused on Future Utilization of Visualized Information on Environmental Impacts in Product Life Cycle and Corporate Value Chain as well as Sharing of experience and findings of world's major initiatives. Concerns were raised about the appropriate criteria for the selection of a large number of environmental impact categories and the corresponding data availability, in particular in developing countries. Moreover, before using the results for comparative assertion on uncertainly and accuracy of databases as well as the methodologies behind the data collected need to be discussed between database managers, developers and policymakers. Finally, the impact categories to be addressed will differ according to the

product category. Hence, there is a need to get global consensus in developing Product Category Rules (PCRs) (UNEP 2013b).

Australia

The National AusLCI Initiative was set up to support national goals coming from the public and private sectors.

LCA database guidance has been developed with Australian industry and practitioners and is generally compliant with Ecoinvent guideline and UNEP-SETAC Global Guidance Principles on LCA Databases. The datasets are being presented in EcoSpold andILCD format. Unit process and system processes are both being provided. AusLCI next steps are to increase the coverage of building products by migrating data from the BPIC database into the AusLCI to allow access for more sectors, to further increase building and agriculture coverage and to begin publishing data in ecoinvent as part of a National Project Agreement. LCA has been successfully used in the Voluntary Green Building Rating. Challenges and opportunities cover the regional and international data harmonization and interoperability, acceptance of user-friendly decision support tools for different stakeholders, policy support lessons, including public procurement, as well as value and risk case studies as relevant areas (UNEP 2013b).

18.4.5   Emerging Economies in Asia: China and Thailand

China

The policies in China based on LCA are all very recent, from 2012: Technology assessment and implementation for energy conservation and emission reduction, evaluation and recommendation of energy efficiency products and eco-design of products. These policies are all supporting the Chinese policy approach aiming at the establishment of a circular economy.

Also encouraging is the policy on the Eco-design of Industrial Products Guidance of 2013 (MIIT/MEP/NRDC 2013) which is boosting mainstreaming of LCA in China by promoting its use in product design.

The Chinese Life Cycle Database (CLCD) has been developed since 2007 and published in 2010 by Sichuan University and IKE Technology. The goal is to have a fundamental LCA database representing Chinese technology and market average with more the 600unit processes of fundamental products in one core model.

More global agreements and practical guidelines are desirable, such as the UNEP/SETAC Global Guidance Principles for LCA Database that are a starting point and need to be actively disseminated. Overall in China, there is a huge need for capacity building and technical assistance, although a number of university, research centres and companies have identified the life cycle topic as a promising approach for the future and are catching up with regard to theinternational level (UNEP 2013b).

Thailand

Thai National Science and Technology Development Agency (NSTDA), which is part of the Ministry of Science and Technology, has a leading role in the development of a Thai LCA database. Progress has been made in LCT and LCA through the introduction of the Thai Green Label (Type 1), the green procurement activities, the promotion of biofuels (ethanol 2001, biodiesel 2005) and the National Green Growth Strategies (2013–2018). These topics are covered and need to further be implemented as LCA-related actions in the SCP and Green Economy Roadmap. Thailand is using life cycle inventory data to quantify the Green Gross Domestic Product (GDP) of its industrial sectors, as well as LCA and Life Cycle Costing to assess Phase 1 (2008–2011) of the Thai Green Public Procurement Plan (ORDER PRE/116/2008 2008) to decide whether and how to implement phase 2 (2014–2017) (Mungcharoen 2013).

As next steps, more capacity building activities, for example, on indicators for Life Cycle Impact Assessment in the field of agri-food, decoupling and Green GDP are needed as well as joint activities with other Asian countries, such as the set-up of the LCA Agri-Food Asia Network (UNEP 2013b).

18.4.6 Emerging Economies in Latin America and Africa

Brazil

At present LCA-based policies in Brazil include, for instance, the Brazilian Life Cycle Assessment Programme (2010), the National Solid Waste Policy (Federal Law No. 12.305, 2010, and Decree No. 7.404, 2010, MMA 2010) and the Brazilian Eco-label Type 1 Scheme. For example, the National Solid Waste Policy calls for shared responsibilities among relevant stakeholders along the life cycle of wastes and the use of LCA to promote products with fewer environmental impacts. Proposed future policies cover GHG inventory and Green Procurement.

The major needs and barriers for implementing LCA-based policies in Brazil and the conditions to overcome these barriers are as follows: (i) governmental funding to the National LCA Programme; (ii) private funding from industrial sectors; (iii) industrial awareness of main achievements, in terms of economic and environmental profits, using the methodology as a management tool; and (iv) public awareness and capacity building for policymakers. Focus areas the government needs to work on to advance the uptake of LCA are the following:

- Governmental funding for applied research and technological development projects during the next 10 years.
- Increasing participation of the private/industrial sectors in the development of Life Cycle Inventories, aiming to build a Brazilian primary data LCI database.
- Capacity building of policymakers and private sector through specific industrial associations support (similar approach used by EU with European associations).

The Brazilian government has made a major effort to develop a national LCA database (UNEP/SETAC 2011), working among others with UNEP and reviewers provided by the UNEP/SETAC Life Cycle Initiative to increase the quality of the datasets in this emerging database.

Needs for capacity building include the promotion of specific courses on LCA topics in the academy (undergraduate and graduate level) and in the industry educational system (professional level). Moreover, the organization of international seminars, in coordination with the European Commission and UNEP/SETAC, to disseminate successful case studies of industry in OECD countries on the utilization of LCA in their supply chain management and to train on international and global guidelines, data acquisition approaches and reviewing schemas are also required (UNEP 2013b).

South Africa

Carbon footprints are much debated and many private firms have theirs assessed, albeit most often not based on LCA and not captured in any national policy. There is some concern about trade barriers based on carbon footprints, and at sub-national government level it is especially the fruit- and wine-exporting Western Cape where this is a serious concern.

Some kind of 'life cycle thinking' is embodied in the Mineral Resources Development Act of 2002 through the 'planning for mine closure' regulations, but this is more of a temporal type of life cycle thinking, not one of shiftings of burdens to other players in the supply chain (e.g. through fuel switching) or between environmental compartments. The recently promulgated national waste management strategy is very strongly aligned to the waste hierarchy.

Environmental considerations were somehow considered in the establishment of the biofuels industrial strategy of 2007; the Energy Information Administration for a fuel ethanol plant has included a GHG balance. The umbrella environmental legislation, called the 'national environmental management act' (NEMA 1998) probably does include some loose reference to LCT and principles.

The ecoinvent project for developing a South African database is seen as a starting point for a possible national database. Participants of a roadmap discussion for a South African LCA Database organized in Cape Town on 3 and 4 Feb 2015 identified the potential key role of the National Cleaner Production Centre (NCPC) for access to the Department of Trade and Industry (DTI) and the Department of Environmental Affairs (DEA), as well as to its large industry network to take advantage of this seed project. In the longer term, it might make sense to create an independent national LCA database. In the short term, also capacity building on life cycle thinking and LCA is important to increase the maturity of those approaches in the country in order to provide the basis for the development of LCA-based policies.

Colombia

A SCP action plan explicitly incorporates LC thinking (MAVDT 2010). Also in the same year, a national public procurement policy (MinAm 2010) was issued which updates and integrates the national plan on green markets with the national SCP

action plan. The national public procurement policy aims at providing life cycle based criteria for sustainable purchasing by public offices and at supporting the implementation of these criteria. No national database is under development in Colombia.

18.5   Conclusions

The present chapter explains what Sustainable Consumption and Production is about, why it is about taking a life cycle approach and shows that SCP-related policies have been developed at the intergovernmental level and in different regions of the world since the Johannesburg World Summit on Sustainable Development in 2002. A key element at the international level is the 10-Year Framework of Programmes on SCP that has been adopted in Rio+20 and provides multiple opportunities for promoting policies based on life cycle thinking and using LCA.

Life cycle thinking has been considered mature, moving from its academic origins and limited uses primarily in-house in large companies to more powerful approaches that can efficiently support the provision of more sustainable goods and services through efficient use in product development, external communications, in support of customer choice, and in public debates (Pennington et al. 2007).

Now governments can use LCA for SCP and resource efficiency policies. LCA is in particular relevant for policies focusing on design for sustainability, sustainable consumer information, sustainable procurement and waste management, minimization and prevention as well as sector-specific policies like sustainable energy and food supply. The execution of LCA studies is directly required in policies evaluating the environmental preference of biofuels in different countries. It can be expected that the use of LCA in policies for the sustainability assessment of products will further increase.

Conflicts between free trade and environmental requirements to products have become evident (e.g. ISO process on carbon footprinting) and need to be taken seriously. LCA as an analytical tool is not much the problem but its use in certification and trade relevant polices will continue to generate conflicts. Environmental standards and regulations have penitential impact on the market access of developing countries; hence, there is a fear in those countries that any further strictness on product standards in the developed countries' market could result in creating a significant trade barrier for their exports. In this context the International Organization for Standardization (ISO) has an important role to play. Under the World Trade Organization (WTO) Agreement (l994), Members (governments) are obliged to adopt international standards wherever feasible and this includes ISO standards. One consequence is that businesses (including governments as trading parties) can make adherence or certification/registration under ISO standards a term or condition of trade with a foreign business (UNEP 2013b). In particular, the European Commission is moving rather quickly in putting LCA into policy use.

18.6   Perspectives

Overall, we see that definitely some areas still need improvements to ensure better integration in policymaking, even in Europe. It is often considered a critical task to find the right balance between, e.g.

- Enhancing the comparability of LCAs by being prescriptive versus providing the required flexibility in order to apply LCA for many different types of applications in very diverse product groups or sectors.
- Allowing limited assessments on a few impact categories with a high degree of certainty versus pushing towards more comprehensive assessments including impact categories with a lower degree of certainty whilst being transparent about their need for improvement;
- Scientific robustness of available Life Cycle Impact Assessment models versus applicability and feasibility aspects;
- Cementing the status quo, towards "stability" of the recommendations over time, versus encouraging further improvements related to both LCIA method development and related;
- LCI data availability and quality;
- Ensuring sufficiently robust quality of LCA results, including the methods and underlying data used, via review and verification requirements versus applicability and feasibility aspects.

The above-mentioned aspects are crucial for any sustainability assessment methods and require actions by several stakeholders (from methods developed to policymaking) to ensure applicability and efficacy. From the policymaking side, there is a need to balance the stability of the recommendation (to be applied in a business and policy context) and the thriving scientific development, for example, in the field of impact assessment. Furthermore, finding the best solution to guarantee comparability among studies and being open to updated data, models and factors are of paramount importance.

Mainstreaming the use of LCA in such policies is currently hampered by the missing availability of high-quality data worldwide. There are concerns related to data availability for running the evaluations, ensuring robustness and representativeness of data. Knowledge mining and review of existing studies are extremely crucial for supporting policies.

Opportunities for the future of national databases are emerging through the Global Network of interoperable LCA Databases that is an initiative from the International Forum on LCA Cooperation International started by the EC and UNEP in 2012, and now supported by a number of national governments around the world. Its vision is to establish "a global network comprised of independently-operated and interoperable LCA databases that connects multiple data sources to support life cycle assessment in a way that facilitates sustainability-related decisions". More detailed objectives include to define and contribute to the availability of an electronic system and protocol to enable access

by users to the majority of the LCA databases and other relevant sustainability data, meaning that the LCA datasets and other data therein can be easily accessed in an exchange format that allows to use them seamlessly in LCA software, with sufficient documentation of metadata that allows defining fitness for purpose by any user.

However, for this to happen it is not only necessary to contribute to the availability of an electronic system and protocol but also to foster capacity building in emerging economies and developing countries, in which more and more of the global production and consumption is taken place. For such capability development efforts to be successful they need to focus as much on the demand side by training on life cycle management in business and life cycle thinking in policies as on the technical aspects with regard to national LCA databases and regionalized life cycle impact assessment methods. These needs are addressed further in Chap. 19 on Globalisation and mainstreaming of LCA.

Finally, life cycle based policymaking in the future will have to address also the means to implement policies (incentives, legislative obligations and thresholds, etc.) based on life cycle assessment results. This implies that upcoming opportunities of using LCA in policies for the sustainability assessment of products need to be accompanied by ways to show the efficiency of the policies put in place.

SCP policies based on life cycle thinking are starting to be well developed at the international level and around the world, while there is a need for further promotion of LCA-based policies based on a widely accepted analysis of the benefits and limits of such polices. Our expectation, based on the past experience of using life cycle thinking and LCA for policy support, is that the use of life cycle methodologies and related methods and tools in policy support will continue to grow in influence in the foreseeable future.

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