ECOTEX

Learning materials

Circular Economy Innovative Skills in the Textile Sector

Intellectual Output 4

Module 2

Environmental Performance

Dic 2019

Module 2: Environmental Performance

Index

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Introduction to the module

This module is oriented to environmental performance issues, including global metrics for the environmental performance; environmental systems analysis tools and resources to implement environmental performance in textile and clothing companies. This module provides an opportunity for the new specialist to manage the company's production systems in continuous development in an environmentally friendly manner.

Unit 2.1 Environmental performance management

2.1.1 Introduction

The environmental performance management outlines the basic principles of global metrics for environmental performance, the environmental performance index (EPI) and two dimensions of Environmental Performance - environmental health and ecosystem vitality.

2.1.2 Short description

Knowledge	**Skills**	**Competencies**
At the end of this unit the in-company trainer will:	*At the end of this unit the in-company trainer will be able to:*	*At the end of this unit, the in-company trainer will have acquired the responsibility and autonomy to:*
• Knows the terms of Environmental Performance; • Knows how to measure environmental performance index (EPI). • Knows global metrics for environmental performance and two dimensions of Environmental Performance - environmental health and ecosystem vitality.	• Finds and applies the information about environment's global metrics, Environmental Performance Index (EPI) in everyday work; • Evaluates and compares environmental performance index values; • Summarizes company's indicators needed to calculate environmental health and ecosystem vitality indexes.	• Understands information about environment's global metrics, environmental performance index (EPI) in everyday work; • Understands company's indicators needed to calculate environmental health and ecosystem vitality indexes.

2.1.3 Content unit

Topic 2.1.3.1 Environmental management systems

An Environmental Management System (EMS) is a set of processes and practices implemented in an organization to achieve its environmental goals through systematic review, evaluation, and improvement of its environmental performance, oriented to reduce its environmental impacts and increase its operating efficiency [1].

The existent standards and schemes (like ISO 14001 and EMAS) help organizations in the implementation and maintenance of an EMS. The certification of an EMS corresponds to a validation by a third part, to ensure the conformity to the EMS requirements.

ISO 14000 standards

The ISO 14000 is a global series of standards and other type of supporting documents related with environmental management. ISO 14000 has been developed so that organizations may incorporate environmental aspects into operations and products. It is a group of voluntary environmental management standards, guides and technical reports, which specifically focuses on corporate environmental management systems, operating practices, products, and services. The ISO standards generally aims to facilitate international trade and commerce. Companies can implement any or all of the ISO 14000 series standards. The aim of the standards is not to prescribe environmental performance targets, but to provide organizations with the tools to assess and control the impact of their activities, products or services on the environment. The ISO 14000 series addresses the subsequent aspects of environmental management[2]:

- Environmental Management Systems (EMS)
- Environmental Auditing & Related Investigations (EA&RI)
- Environmental Labels and Declarations (EL)
- Environmental Performance Evaluation (EPE)
- Life Cycle Assessment (LCA)
- Terms and Definitions (T&D)
- Compliance to an ISO 14000 EMS
- Assures customers of your commitment to demonstrable environmental management
- Maintains excellent public relations
- **Satisfies investor criteria and improves access to capital**
- **Obtains insurance at reasonable cost**
- Enhances your image and market share

[1] https://www.epa.gov/ems/learn-about-environmental-management-systems
[2] https://www.iso.org/iso-14001-environmental-management.html

- Meets your clients' registration requirements
- Improves cost control by identifying and eliminating waste and inefficiency
- Lessens incidents that result in liability
- Reduces your consumption of materials and energy
- Facilitates the attainment of permits and authorizations
- Decreases the cost of complying with environmental regulations
- Improves industry-government relations

ISO 14001

The international standard relating to the environmental management system, ISO 14001, is based on the principle of continual improvement by constructing and operating environmental management systems with so-called PDCA cycle (Plan, Do, Check, Act). Continual improvement is defined as "enhancement of the environmental management system for achieving overall environmental performance improvement consistent with environmental policies of the organization." It defines environmental performance as "measurable results of the environmental management systems relating to the management of the environmental aspects performed by the organization based on its environmental policies and objectives." [3] As described in Annex A of ISO 14001 standard, the objective of the implementation of environmental management systems is to improve the environmental performance. However, ISO 14001 does not discuss the particular contents of the environmental aspects to be managed and the standard of environmental performance, and it leaves the choice to each organization[4].

Therefore, the environmental performance indicators that are presented in the Guidelines would be helpful for decision-making processes regarding choosing environmental aspects and viewpoints that need to be managed and the examination of environmental performance items that need to be improved. The indicators in the Guidelines do not change the requirements of the environmental management systems and the certification and registration standards[5].

Organizations may simply declare that their EMS meets the requirements of ISO 14001 (self-declaration). However, many organizations choose to have their EMS certified, usually to provide greater assurance to clients and the public, since the certification is the formal recognition of an organization's ability to conform to the requirements of an EMS[6].

[3] https://www.coursehero.com/file/p4k7j3c/The-actual-contents-of-environmental-performance-indicators-are-not-discussed/
[4] https://www.env.go.jp/policy/j-hiroba/PRG/pdfs/e_p_guide.pdf
[5] https://www.env.go.jp/policy/j-hiroba/PRG/pdfs/e_p_guide.pdf
[6] https://books.google.lv/books?id=wYi9BwAAQBAJ&pg=SA14-PA5&lpg=SA14-PA5&dq=%22Organizations+may+simply+declare+that+their+EMS+meets+the+requirements+of+ISO+14001+(

EMAS

Another way to improve companies' environmental performance is the EU Eco-Management and Audit Scheme (EMAS). EMAS includes the requirements to an environmental management system, like ISO 14001 standard, and adds four pillars to the requirements. A continuous improvement of environmental performance, a compliance system with governmental legislation, public annual reporting and involvement by employees. This makes EMAS the most robust and credible system currently available[7]. In Figure 1 is shown the complete EMAS implementation cycle, including the internal and external processes:

Figure 1. EMAS implementation cycle[8]

The key benefits that EMAS provide are[9]:

- Enhanced credibility, transparency and reputation
- Enhanced environmental risks and opportunities management
- Enhanced environmental and financial performance
- Enhanced employee empowerment and motivation

self-declaration).%22&source=bl&ots=5q4z76K1w2&sig=ACfU3U1nNBku_p-fbn5FhpvEbceoh5uU-g&hl=en&sa=X&ved=2ahUKEwixounCrMvmAhVCpIsKHWwFDpYQ6AEwAHoECAoQAQ

[7]https://ec.europa.eu/environment/emas/index_en.htm

[8] https://ec.europa.eu/environment/emas/join_emas/how_does_it_work_step0_en.htm

[9]https://ec.europa.eu/environment/emas/emas_for_you/premium_benefits_through_emas/key_benefits_en.htm

Topic 2.1.3.2 Environmental performance definition

There are several ways to define environmental performance. As example we presented the following three different definitions to capture the wider scope of the subject:

- Environmental performance is measurable results of the environmental management system, related to an organization’s control of its environmental aspects, based on its environmental policy, objectives, and targets[10].
- Environmental performance is the measurable outcome of an organization's ability to meet environmental objectives and targets set forth in the organization's environmental plan or policy[11].
- Environmental Performance means the efficiency of the consumption of energy, consumption or use of water, waste generation and management and consumption of other resources involved in the development, use and/or operation of the Property and/or the Building, measured by the extent to which the climatic or environmental impacts of such development use and/or operation are minimized or ameliorated[12].

Topic 2.1.3.3 Environmental performance index (EPI)

The first object of environmental performance indicators[13] is to measure and evaluate environmental burdens and -outcomes and environmental problems that needs to be solved, in order to promote environmental activities of organizations. Henceforth information must be obtained to help decision making towards the aforementioned activities.

The second objective is to provide a common foundation of information between an organization and interested parties, such as consumers, business partners, and residents in local communities, shareholders and financial institutions, facilitating those interested parties towards understanding environmental activities of the organization. Organizations have significant impact on the environment through their business activities. As the necessity of building a sustainable society rises, organizations have the responsibility of disclosing what environmental burdens they cause, what activities they implement towards reducing these environmental burdens, and what environmental efforts they exercise. For external interested parties, environmental information has become a necessity for their evaluation and choice of organizations. Environmental performance indicators could therefore be used in environmental reporting.

The third objective is to provide a common foundation of information for macro-level environmental policies of the national and native governments. External interested parties

[10] https://definedterm.com/environmental_performance
[11] https://definedterm.com/environmental_performance
[12]https://www.lawinsider.com/contracts/70phKIieer8Hz4g3CRbCX/coty/1024305/2016-02-04#environmental-performance
[13] https://www.env.go.jp/policy/j-hiroba/PRG/pdfs/e_p_guide.pdf

have a number of methods to evaluate environmental efforts of organizations, but there has not yet been developed a common standard. Furthermore, no definition of data, method of calculation, the boundary of data gathering, units and so on have been standardized. When an organization or external interested party evaluates environmental efforts, it is paramount to understand the background of business activities of the organization that causes the environmental burden, yearly changes of the environmental burden and environmental efforts using these performance guidelines. These guidelines do not intend to use only quantitative values of EPI to evaluate organizations[14].

The **Environmental Performance Index** (EPI)[15] is a method of quantifying and numerically marking the environmental performance of a state's policies. This index was developed from the Pilot Environmental Performance Index, first published in 2002, and designed to supplement the environmental targets set forth in the United Nations Millennium Development Goals[16].

EPI calculation variables change often as it is shown in table below. It is a factor that has to be taken into account when observing country performance through several reports, as the methodology modifications can lead to score and ranking changes.

EPI	Objective	Issue Category	Indicator
Environmental Performance Index (EPI)	Environmental health (40%)	Health Impacts (33%)	Environmental Risk Exposure (100%)
		Air quality (33%)	Household Air Quality (30%)
			Air pollution - Average Exposure to PM2.5 (30%)
			Air pollution - PM2.5 Exceedance (30%)
			Air pollution - Average Exposure to NO2 (10%)
		Water and sanitation (33%)	Unsafe Sanitation (50%)
			Drinking Water Quality (50%)
	Ecosystem vitality (60%)	Water resources (25%)	Wastewater treatment (100%)
		Agriculture (10%)	Nitrogen use efficiency (75%)
			Nitrogen balance (25%)
		Forests (10%)	Change in forest cover (100%)
		Fisheries (5%)	Fish stocks (100%)
		Biodiversity and habitat (25%)	Terrestrial Protected Areas (National Biome Weights) (20%)

[14] https://www.env.go.jp/policy/j-hiroba/PRG/pdfs/e_p_guide.pdf
[15] Yale Center for Environmental Law & Policy, and Center for International Earth Science Information Network at Columbia University. "Environmental Performance Index". Retrieved 2008-03-16.
[16] Yale Center for Environmental Law & Policy, and Center for International Earth Science Information Network at Columbia University. "Environmental Performance Index". Retrieved 2008-03-16.

			Terrestrial protected areas (Global Biome Weights) (20%)
			Marine protected areas (20%)
			Species protection (National) (20%)
			Species protection (Global) (20%)
		Climate and energy (25%)	Trend in carbon intensity (75%)
			Trend in CO2 emissions per kWh (25%)

Figure 2. Table with 2018 EPI variables[17]

The EPI reveals a tension between two fundamental dimensions of sustainable development: environmental health, which rises with economic growth and prosperity, and ecosystem vitality, which comes under strain from industrialization and urbanization. Good governance emerges as the critical factor required balancing these distinct dimensions of sustainability[18].

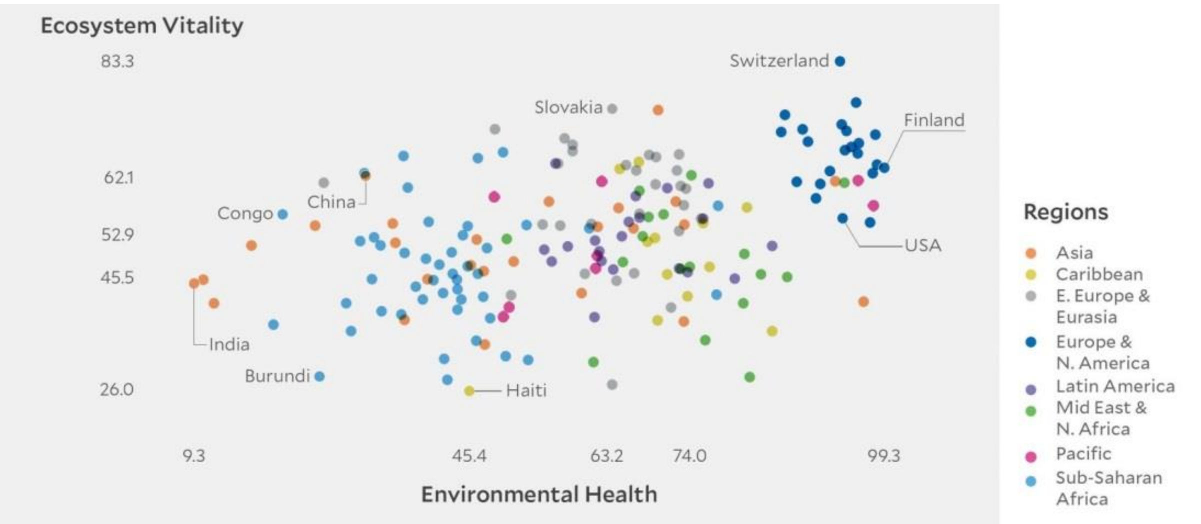

Figure 3. Tracking two fundamental dimensions of sustainable development: environmental health and ecosystem vitality[19]

The Environmental Performance Index (EPI) identifies targets for environmental performance and measures how close each country comes to these goals[20]. The 2018 EPI scores 180 countries on 24 performance indicators across ten issue categories covering environmental health and ecosystem vitality. These metrics provide a gauge at a national scale of how close countries are to established environmental policy goals. Now in its tenth iteration, policymakers, scholars, non-governmental organizations, and therefore the media have relied upon the biennial release of the EPI for policy insights and tracking of trends in

[17] "EPI 2018 variables". "2016 EPI Raw Data". Yale University. 2016.
[18] https://epi.envirocenter.yale.edu/
[19] https://epi.envirocenter.yale.edu/
[20] https://www.ecologic.eu/1711

sustainability. The EPI turns the newest advances in environmental science with worldwide datasets to make into a strong summary of the state of sustainability round the world[21].

Data analysis for the 2018 EPI is predicted on creating a composite index. It begins by gathering data on 24 individual metrics of environmental performance, as shown in Figure 4. These metrics are aggregated into a hierarchy beginning with ten issue categories: Air Quality, Water & Sanitation, Heavy Metals, Biodiversity & Habitat, Forests, Fisheries, Climate & Energy, Air Pollution, Water Resources, and Agriculture. These issue categories are then aggregated into two policy objectives – Environmental Health and Ecosystem Vitality – and then finally the overall EPI. To allow for meaningful comparisons, it is constructed scores for every each of the 24 indicators, placing them onto a standard scale where 0 indicates worst performance and 100 indicates best performance. How far a country is from achieving international targets of sustainability determines its placement on this scale. The indicator scores are then multiplied by weights, shown in parentheses in Figure 4, and added together to produce scores at the levels of the issue categories, policy objectives, and the final EPI. These scores serve as the basis for country ranks. Indicators are constructed from the most recently available data for each of the 24 metrics of environmental performance. To track changes over time, it is also applied the same methods to historic data, in order to show what the EPI score for each country would be in a baseline year, generally ten years prior to the current report. The performance of every country it is taken and those data aggregated into measurements of global performance. It is scored these global aggregates on the same 0–100 scale as individual countries, showing the state of the world on each indicator. The results of the 2018 EPI – the scores, rankings, trends, and global aggregates – translate environmental data into terms that are comprehensive and comprehendible[22].

[21] https://epi.envirocenter.yale.edu/
[22] https://epi.envirocenter.yale.edu/2018-epi-report/introduction

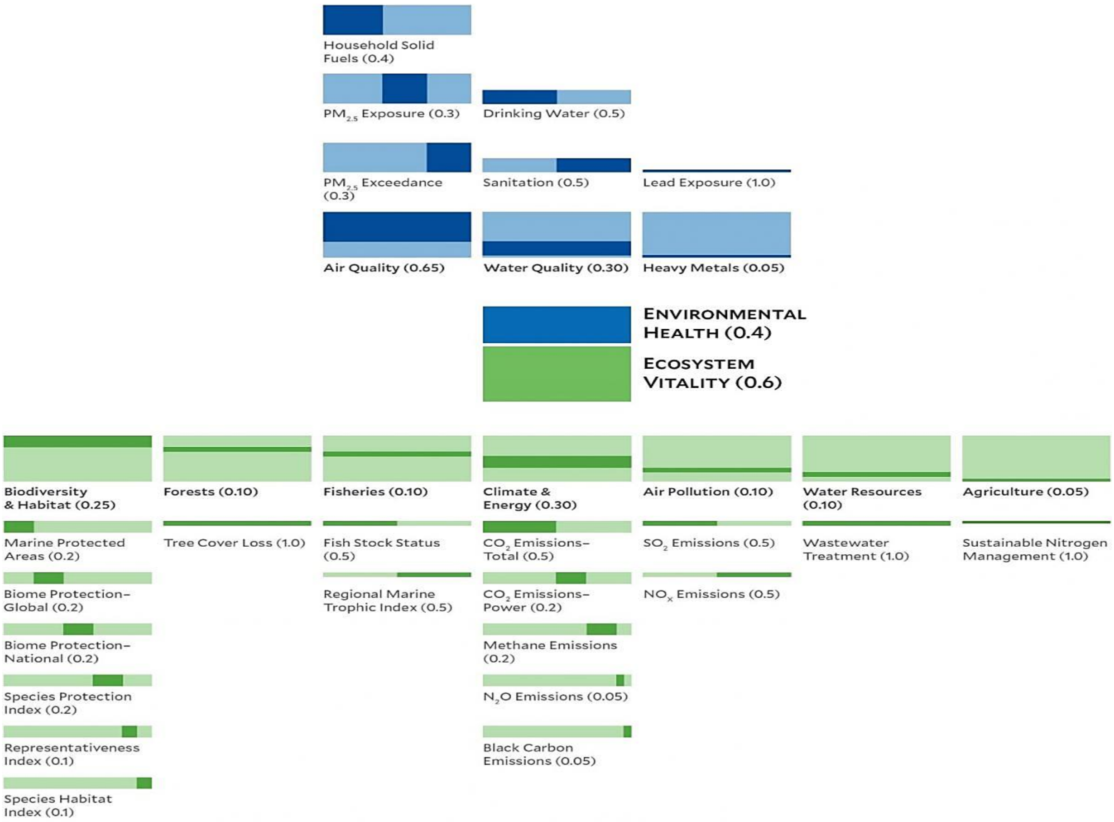

Figure 4. The 2018 EPI Framework organization in 24 indicators/ 10 issue categories/ 2 policy objectives[23].

Companies specifically can use Environmental Performance Indicators (EPIs) to track how aspects of company operations affects the environment. Environmental performance indicators improve internal and external communication about the status of, and changes to, a company's environmental impacts. Figure 5 summarizes the different roles EPIs play for various stakeholders[24].

[23] https://epi.envirocenter.yale.edu/2018-epi-report/introduction
[24] https://web.wpi.edu/Pubs/E-project/Available/E-project-030217-175336/unrestricted/CR17_Corporate_Environmental_Indicators_Final_Report.pdf

Corporate Managers	• Have a better ability to monitor their firm's environmental impacts with respect to their goals
Production Plant Managers	• Are more able to identify opportunities for improvement and efficiency in plant operations
Marketing Managers	• Can make use of new "green" market opportunities
Purchasing Managers	• Can make more environmentally accountable business decisions
Environmental Authorities	• Are able to better evaluate compliance of firms with public policy
National Policy Makers	• Have more clear information for creating public environmental policy
Investors and Shareholders	• Have more information available to make responsible investments
Consumers	• Have more information to make responsible purchases

Figure 5. Roles of EPIs for Various Stakeholders[25]

It is recommended to implement four level system to categorize companies[26] with respect to environmental performance, as shown in Figure 6.

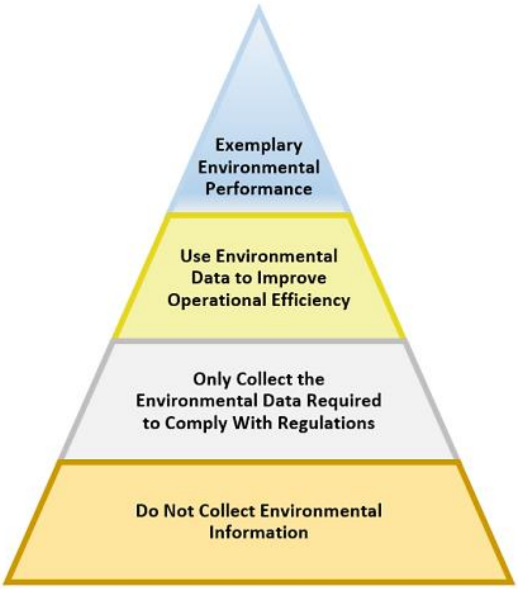

Figure 6. Four Levels of Environmental Performance[27]

[25] https://web.wpi.edu/Pubs/E-project/Available/E-project-030217-175336/unrestricted/CR17_Corporate_Environmental_Indicators_Final_Report.pdf
[26] https://web.wpi.edu/Pubs/E-project/Available/E-project-030217-175336/unrestricted/CR17_Corporate_Environmental_Indicators_Final_Report.pdf
[27] https://web.wpi.edu/Pubs/E-project/Available/E-project-030217-175336/unrestricted/CR17_Corporate_Environmental_Indicators_Final_Report.pdf

The new EPI assesses key environmental policy outcomes using trend analysis and policy targets linked to the United Nations Millennium Development Goals (MDGs)[28].

The EPI is a performance-oriented composite index designed to supplement the environmental targets set forth in the MDGs to help governments' measure progress toward a comprehensive set of pollution control and natural resource management goals by focusing on environmental policy outcomes. Supplementation is necessary since the MDGs are not intended nor designed to allow for comprehensive performance assessment at the national level.

Topic 2.1.3.4 Environmental performance evaluation standard (ISO 14031)

The International standard ISO 14031 (environmental performance evaluation) gives guidance on the design and use of environmental performance evaluation (EPE) within an organization, regardless of type, size, location and complexity[29]. This standard does not establish environmental performance levels, however can be used to support an organization's own approach to EPE, including its commitments to compliance with legal and other requirements, the prevention of pollution, and continual improvement. The environmental performance evaluation is presented in this standard as a decision process that helps management decisions regarding environmental performance, supported by an PDCA cycle (Plan, Do, Check, Act), which includes the phases of selecting environmental indicators (plan), collecting and analysing data, assessing information about environmental performance, reporting and communicating (Do), and periodically review of the process and improving it (check and act). The indicators according to ISO 14031 are Environmental condition indicators (ECI) and Environmental Performance Indicators (EPI). EPI divides even further into Management Performance Indicators (MPI) and Operational Performance Indicators (OPI). Environmental performance should be assessed according to the process specified in ISO 14031 by using the Guidelines as the reference. For more information, it is requested to refer to the "Annual Report for Environmental Conditions (Environmental White Paper)" prepared by the Ministry of the Environment and each local government and "the comprehensive environmental indicators" that are described above[30].

2.1.4 Suggested readings

- https://epi.envirocenter.yale.edu/downloads/epi2018policymakerssummaryv01.pdf

[28] Global metrics for_the_environment_The_Environmental_Performance_Index_ranks_countries https://wedocs.unep.org/bitstream/handle/20.500.11822/7501/-Global_metrics_for_the_environment_The_Environmental_Performance_Index_ranks_countries%E2%80%98_performance_on_high-priority_environmental_issues-2016glob.pdf?sequence=3&isAllowed=y
[29] https://www.iso.org/standard/52297.html
[30] https://www.env.go.jp/policy/j-hiroba/PRG/pdfs/e_p_guide.pdf

- https://epi.envirocenter.yale.edu/
- https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1528981579179&uri=CELEX:32018L0851
- http://www.textile-platform.eu/
- https://lindstromgroup.com/lv/raksti/tekstiliju-atkritumi/
- http://www.europarl.europa.eu/RegData/etudes/BRIE/2019/633143/EPRS_BRI(2019)633143_EN.pdf
- https://dnr.wi.gov/topic/GreenTier/Participants/ECPP/ecpp3MExtended.pdf#environmental-performance
- https://www.researchgate.net/publication/6438363_Environmental_Performance_Indicators_An_Empirical_Study_of_Canadian_Manufacturing_Firms
- https://www.nqa.com/en-gb/certification/standards/emas
- http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=GREEN_TAS_D6.pdf
- https://pdfs.semanticscholar.org/ac43/86e2526d66a39d8f459d82485de452afd14f.pdf
- https://www.process.st/iso-14000/
- Christine Maria Jasch “Environmental and Material Flow Cost Accounting: Principles and Procedures”

2.1.5 Quiz

Self-evaluation Quiz

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1. What are the two dimensions considered in the Environmental Performance Index? (select the most suitable option)
    a. <u>Environmental health and ecosystem vitality</u>
    b. Human health and environmental safety
    c. Human health and ecosystem vitality
2. Which of the following stakeholders are interested in EPI? (select the most suitable option)
    a. Customers & communities
    b. Investors & special interest groups
    c. Employees
    d. Suppliers

e. All of the above

3. What happens in PDCA cycle? (select the most suitable option)
    a. selection of environmental indicators
    b. collecting and analysing data
    c. reporting and communicating
    d. review and improvement of the process
    e. all of the above

Unit 2.2 Remanufacturing and Eco efficiency

2.2.1 Introduction

This unit is focus on understanding the factors driving and shaping the management of environmental effects in the textile industry. In addition, the unit aims at giving an overview of different strategies and methods in Environmental Performance Manufacturing and Remanufacturing Systems and Technologies.

2.2.2 Short description

Knowledge	**Skills**	**Competencies**
At the end of this unit the in-company trainer will:	*At the end of this unit the in-company trainer will be able to:*	*At the end of this unit, the in-company trainer will have acquired the responsibility and autonomy to:*
• Knows the terms: Manufacturing and remanufacturing systems. • Knows the concept of eco-efficiency, its importance as a measureable indicator of sustainability performance. • Knows the technologies and systems for textile and clothing manufacturing and remanufacturing.	• Uses the concept of eco-efficiency as a measureable indicator of sustainability performance and as a benchmark in comparing alternative technologies and production systems. • Decides and designs eco-efficient technological processes and systems for Manufacturing and Remanufacturing of textile and clothing goods.	• Understands the factors driving and shaping the management of environmental efforts in the textile industry. • Understands how to develop production processes using lower amounts of water, pesticides, insecticides, hazardous chemicals or lower releases of GHG etc. • Understands the concept of Eco-Efficiency and the roles it can play.

2.2.3 Content unit

Topic 2.2.3.1 Concept of manufacturing and remanufacturing

Man's habitation of the earth and his activities such as agricultural and industrial revolutions followed by the current high-tech world of synthetic and man-made materials have had a negative impact on the environment and biodiversity. All around the world, environmental considerations are now becoming vital factors during the selection of consumer goods, which include textiles.

The industrial revolution led to the birth of various industries, among them the textile industry. Textile industries have two divisions:

- Dry process—mostly engineering and assembling departments, which do not use water for all practical purpose (e.g., blowroom, carding, weaving).
- Wet process—departments that use water as raw material or in their processes or for both (e.g., chemical processing like dyeing, printing, garment washing).

The dyeing of textiles involves a set of dyes, namely acid, direct, reactive, and metal: complex, vat, sulphur, disperse and pigment. Usually, colorants are complex organic or inorganic chemicals, and they can be applied to textiles through different methods; however, dye exhaustion is diverse from 50 to 85%; therefore, dyes will be discharged in the effluent as a pollutant, which seriously affects the nearby water streams.

EU Water Framework Directive aims to prevent and reduce pollution, promote sustainable water use, protect and improve the aquatic environment. The overall objective is to achieve good environmental status for all waters[31].

Remanufacturing is often considered as an environmental preferable choice of end-of-life option in comparison to material recycling or manufacturing new products. However, there is not a standardised process of making these environmental calculations. The results show that remanufacturing is in general a preferable option due to environmental gains of: alleviation of depletion of resources, reduction of global warming potential and chances to close the loop for safer handling of toxic materials[32].

Remanufacturing is positioned one level up from recycling in the end-of-life hierarchy, see Figure 7.

[31] https://www.europarl.europa.eu/factsheets/en/sheet/74/water-protection-and-management

[32] Sundin E., Lee H.M. (2012) In what way is remanufacturing good for the environment?. In: Matsumoto M., Umeda Y., Masui K., Fukushige S. (eds) Design for Innovative Value Towards a Sustainable Society. Springer, Dordrecht. https://link.springer.com/chapter/10.1007/978-94-007-3010-6_106

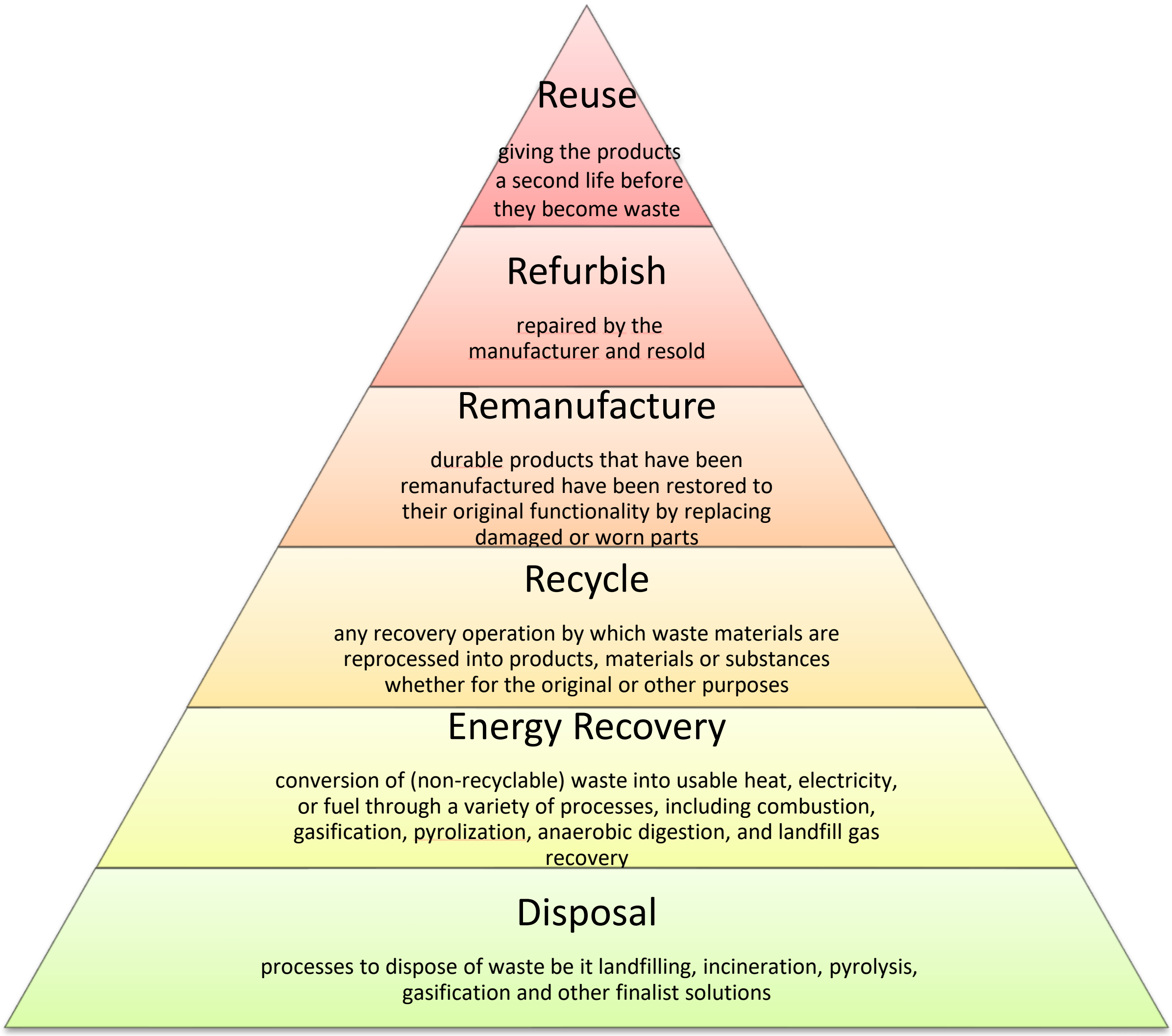

Figure 7. End-of-life hierarchy[33],[34],[35]

The end-of-life hierarchy is arranged according to the environmental impacts of the various end-of-life options and in general, it is always more preferred to choose the option on the top before moving down the hierarchy. There has been a lot environmental calculations where comparisons between remanufacturing and material recycling have been conducted. Material recycling then builds on technologies that shred the products and components into smaller parts, which then can be separated through various manual and automatic processes. In the material recycling case the materials used in manufacturing are salvaged but not the embodiment energy used for making the parts and assembling them together, which also is

[33] Sundin E., Lee H.M. (2012) In what way is remanufacturing good for the environment? In: Matsumoto M., Umeda Y., Masui K., Fukushige S. (eds) Design for Innovative Value Towards a Sustainable Society. Springer, Dordrecht. https://link.springer.com/chapter/10.1007/978-94-007-3010-6_106
[34] https://homeguides.sfgate.com/difference-recycling-remanufacturing-79389.html
[35] https://docs.european-bioplastics.org/publications/bp/EUBP_BP_Energy_recovery.pdf

salvaged when performing remanufacturing. In addition, comparisons are quite often made with the manufacturing of new components and products[36].

Topic 2.2.3.2 Concept of eco-efficiency

Eco-Efficiency has been proposed as one of the main tools to promote a transformation from unsustainable development to one of sustainable development37. It is based on the concept of creating more goods and services in the textile industry while using fewer resources and creating less waste and pollution. “It is measured as the ratio between the (added) value of what has been produced (e.g. gross domestic product (GDP)) and the (added) environment impacts of the product or service (e.g. S02 emissions)” [38]. The term was coined by the World Business Council for Sustainable Development (WBCSD) in its 1992 publication “Changing Course,” and at the 1992 Earth Summit, eco-efficiency was endorsed as a new business concept and means for companies to implement Agenda 21 in the private sector[39]. Term of eco-efficiency has become synonymous with a management philosophy geared towards sustainability, combining ecological and economic efficiency[40].

Eco-efficiency means doing more with less, or producing economic outputs with minimal natural resources and environmental degradation (Kuosmanen, 2005). Although there are varying opinions regarding the proper usage and application of eco-efficiency frameworks (Ehrenfeld, 2005, Hukkinen, 2001), some eco-efficiency indicators remain widely used today (e.g., resource productivity, one type of eco-efficiency indicator, has been adopted by many countries as an important tool for resource management). The measurement of eco-efficiency is critical to finding cost-effective ways to reduce environmental pressures. In addition, policies targeted at efficiency improvements tend to be easier to adopt than policies that restrict the level of economic activity (Kuosmanen and Kortelainen, 2005), particularly in developing countries such as China[41].

The 2012 Energy Efficiency Directive (2012/27/EU) establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020. Under the directive, all EU

[36] Sundin E., Lee H.M. (2012) In what way is remanufacturing good for the environment?. In: Matsumoto M., Umeda Y., Masui K., Fukushige S. (eds) Design for Innovative Value Towards a Sustainable Society. Springer, Dordrecht. https://link.springer.com/chapter/10.1007/978-94-007-3010-6_106

[37] https://doi.org/10.1016/j.ecolind.2012.06.007

[38] Yadong, Y (2013). "Eco-efficiency trends in China, 1978-2010: Decoupling Environmental Pressure from Economic Growth". *Ecological Indicators*. **24**: 177–184. doi:10.1016/j.ecolind.2012.06.007

39 OECD Secretariat. (2002). Indicators to measure decoupling of environmental pressure from economic growth. Sustainable development, Retrieved from http://www.docstoc.com/docs/84838188/oecd_decoupling

[40] OECD Secretariat. (2002). Indicators to measure decoupling of environmental pressure from economic growth. Sustainable development, Retrieved from http://www.docstoc.com/docs/84838188/oecd_decoupling

[41] Yadong, Y (2013). "Eco-efficiency trends in China, 1978-2010: Decoupling Environmental Pressure from Economic Growth". Ecological Indicators. 24: 177–184. doi:10.1016/j.ecolind.2012.06.007

countries are required to use energy more efficiently at all stages of the energy chain[42]. Emissions of the main air pollutants in Europe (SO2; NOx; NH3; NMVOCs; PM2.5) have decreased and projections suggest that the EU as a whole is on target to meet its 2020 EU and international air pollutant emission reduction commitments for all but ammonia emissions[43] By 2050, he EU aims to cut its emissions substantially – by 80-95% compared to 1990 levels as part of the efforts required by developed countries as a group, turning Europe into a highly energy efficient and low-carbon economy[44].

This topic reveals eco-efficiency trends and decoupling of environmental pressure from economic growth. Policy implications can be drawn from the following 3 aspects:

- In the long run, improvement in resource efficiency should be given high priority; at the current stage, improvement in minerals efficiency should be prioritized. As increasing problems associated with waste generation and emissions are related to the scale of material input (Behrens et al., 2007), the use of resources is the basic cause of environmental pressure. An overall reduction of material use (i.e., dematerialization) by means of increased resource efficiency will be a key strategy to combat global environmental problems (Behrens et al., 2007, Kovanda and Hak, 2011). Effective policies for the improvement of minerals efficiency are badly needed[45].
- Relative decoupling targets should be set in big industrial countries especially for resource efficiency. Although absolute decoupling of resource use as measured by Domestic Extraction Used (DEU) occurred in several top Gross Domestic Product (GDP) countries on a global scale, absolute decoupling is rare, as resource consumption is steeply on the rise (UNEP, 2011). Absolute reduction of energy and resource consumption cannot yet be expected to be included in the policies of developing countries (UNEP, 2011)[46].
- Improvement in resource efficiency can be achieved by improving levels of technology in production sectors and shifting the economic structure from energy and resource-intensive industries to light industries. Because structure adjustment is difficult to achieve in the short term, the advancement of technology can be an effective way for the improvement of resource efficiency[47].

[42] https://ec.europa.eu/energy/en/topics/energy-efficiency/targets-directive-and-rules/energy-efficiency-directive
[43]https://www.eea.europa.eu/airs/2018/environment-and-health/air-pollutant-emissions
[44] https://ec.europa.eu/clima/policies/strategies/2050_en
[45] Yadong, Y (2013). "Eco-efficiency trends in China, 1978-2010:decoupling environmental pressure from economic growth". Ecological Indicators. 24: 177–184. doi:10.1016/j.ecolind.2012.06.007
[46] Yadong, Y (2013). "Eco-efficiency trends in China, 1978-2010: Decoupling Environmental Pressure from Economic Growth". Ecological Indicators. 24: 177–184. doi:10.1016/j.ecolind.2012.06.007
[47] Yadong, Y (2013). "Eco-efficiency trends in China, 1978-2010:decoupling environmental pressure from economic growth". *Ecological Indicators*. **24**: 177–184. doi:10.1016/j.ecolind.2012.06.007

The textile industry, in general, isn't considered an energyintensive industry. That being said, the textile industry comprises a large number of plants which all together expand a large amount of energy[48]. Figure 8 provides examples of industry-specific indicators for resource and energy consumption.

Benchmarks in textile production

CONSUMPTION OF RESOURCES AND ENERGY

PROCESS	ELECTRICAL ENERGY (KWH/KG TEXTILE SUBSTRATE)	THERMAL ENERGY (MJ/KG TEXTILE SUBSTRATE)	WATER CONSUMPTION (L/KG TEXTILE SUBSTRATE)
Wool scouring	0,3	3,5	2-6
Yarn finishing	-	-	70-120
Yarn dyeing	0,8-1,1	13-16	15-30 (dyeing) 30-50 (rinsing)
Dyeing loose fibres	0,1-0,4	4-14	4-15 (dyeing) 4-20 (rinsing)
Finishing knitted fabrics	1-6	10-60	70-120
Finishing woven fabric	0,5-1,5	30-70	50-100
Finishing dyed knitted fabrics	-	-	<200

Source: IFC-EHS Guidelines „Textile Manufacturing"

Figure 8 Benchmarks in textile production[49]

As an example of Eco – efficiency we can mention Daimler Chrysler, who is making car components using locally produced and manufactured sisal fibers. To implement the program new technology, plant design and technical advice were needed. Now 75 percent of the Mercedes Benz C Class rear shelf is composed of a sisal - cotton mixture[50.]

Topic 2.2.3.3 Textile and clothing industry environmental effects

According to Euratex, in 2017 the textile and clothing industry in the EU had a turnover of €181 billion and comprised 176.400 companies (mainly SMEs), employing over 1,7 million people. While between 1998 and 2009 the sector lost about half its workers and turnover declined by 28%, in 2015 it still accounted for a 5% share of employment and an over 2% share of value added in total manufacturing in Europe[51], see Figure 9.

[48] https://www.omicsonline.org/open-access/a-review-on-energy-management-in-textile-industry.php?aid=92916
[49] https://www.ifc.org/wps/wcm/connect/711c2479-baf7-461a-aa85-0e483625550a/Final%2B-%2BTextiles%2BManufacturing.pdf?MOD=AJPERES&CVID=jqeIcTk&id=1323162617789
[50] http://www.gdrc.org/sustdev/concepts/04-e-effi.html
[51] EPRS_BRI(2019)633143_EN.pdf EPRS | European Parliamentary Research Service, Author: Nikolina Šajn, Members' Research Service, PE 633.143 – January 2019, Environmental impact of the textile and clothing industry

Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E) [sbs_na_ind_r2]

Last update: 12-06-2019

Table Customization show

TIME | NACE_R2 | Geopolitical entity (reporting): European Union - 28 countries

Economical indicator for structural business statistics: Value added at factor cost - million euro

NACE_R2 \ TIME	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Manufacturing	:	:	:	1,660,000.0 (de)	1,630,000.0 (de)	1,630,000.0 (de)	1,710,000.0 (de)	1,850,000.0 (de)	1,912,370.9	:
Manufacture of textiles	:	:	:	22,000.0 (du)	21,000.0 (du)	21,000.0 (du)	22,000.0 (de)	23,000.0 (du)	: (c)	:
Manufacture of wearing appai	:	:	:	20,646.8	18,840.1	18,803.8	19,760.7	19,336.7	19,770.0	:

Figure 9 Manufacturing in Europe[52]

The amount of clothes bought in the EU per person has increased by 40% in just a few decades, driven by a fall in prices and the increased speed with which fashion is delivered to consumers. Clothing accounts for between 2% and 10% of the environmental impact of EU consumption[53].

This impact is often felt in third countries, as most production takes place abroad. The production of raw materials, spinning them into fibres, weaving fabrics and dyeing require enormous amounts of water and chemicals, including pesticides for growing raw materials such as cotton. Consumer use also has a large environmental footprint due to the water, energy and chemicals used in washing, tumble drying and ironing, as well as to microplastics shed into the environment. Less than half of used clothes are collected for reuse or recycling when they are no longer needed, and only 1% are recycled into new clothes, since technologies that would enable recycling clothes into virgin fibres are only starting to emerge[54].

Real case 1: Detox to Zero by OEKO-TEX.

Scope	#Environmental performance #Zero Hazardous Chemicals
Value added	**DETOX TO ZERO by by OEKO-TEX®** is a comprehensive verification and reporting system that uses the requirements stipulated by the Greenpeace Detox Campaign, which aims to eliminate all hazardous chemicals from the textile supply chain by 2020. DETOX TO ZERO is a program in continuous improvement by analysing the situation within a facility and creating a robust plan to reduce hazardous substances in the production processes while implementing environmental protection procedures. **Source of information: Web site of OEKO-TEX, guidelines Detox to Zero (visited on Dec 2019). Nov 2019**
More information	DETOX TO ZERO Guidelines - https://www.oeko-tex.com/importedmedia/downloadfiles/DETOX_TO_ZERO_by_OEKO-TEX_R_ - _Guideline.pdf

[52] https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sbs_na_2a_dfdn&lang=en
[53]http://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI%282019%29633143
[54] EPRS | European Parliamentary Research Service, Author: Nikolina Šajn, Members' Research Service, PE 633.143 – January 2019, Environmental impact of the textile and clothing industry

2.2.4 Suggested reading

- Binder K, EU flagship initiative on the garment sector, EPRS, European Parliament, April 2017.
- Binder K, Improving global value chains key for EU trade, EPRS, European Parliament, June 2016.
- Ellen MacArthur Foundation, A new textiles economy: redesigning fashion's future, 2017.
- European Clothing Action Plan, Mapping clothing impacts in Europe: The environmental cost, 2017.
- European Environment Agency, Environmental indicator report 2014: Environmental impacts of production-consumption systems in Europe, 2014.
- Global Fashion Agenda & The Boston Consulting Group, The Pulse of the Fashion Industry, 2017.
- https://ec.europa.eu/environment/waste/pdf/WASTE%20BROCHURE.pdf

2.2.5 Quiz

Self-evaluation Quiz

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1. Environmental performance for companies is contribution to sustainability. (select the most suitable option)
    a. <u>TRUE</u>
    b. FALSE
    c. I'm not quite sure, yet
2. How would you describe the concept of eco-efficiency? (select the most suitable option)
    a. <u>Reducing ecological damage to a minimum while at the same time maximizing efficiency</u>
    b. Careful measurement of environmental trends and progress
    c. The new era of data-driven environmental policymaking process
    d. The management philosophy geared towards sustainability

3. The textile manufacturing process is characterized by high consumption of resources such as water, fuel and a variety of chemicals in a long process sequence generating a significant load on the environment: (select the most suitable option)
    a. TRUE
    b. FALSE
    c. I'm not quite sure, yet
4. Which of the following stakeholders are interested in EPI? (select the most suitable option)
    a. Customers & communities
    b. Investors & special interest groups
    c. Employees
    d. Suppliers
    e. All of the above

Unit 2.3 Best Available Techniques (BAT) in the textile industry

2.3.1 Introduction

Negative impact of industrial enterprises on the environment determines the need to search for and adopt environmentally friendly techniques of production. The best available techniques (BAT) is aimed at improving the efficiency of environmental protection of the enterprises operation, with the economic feasibility of its use.

2.3.2 Short description

Knowledge	**Skills**	**Competencies**
At the end of this unit the in-company trainer will:	*At the end of this unit the in-company trainer will be able to:*	*At the end of this unit, the in-company trainer will have acquired the responsibility and autonomy to:*
• Knows the definition of Best Available Techniques (BAT). • Describes the concept of BAT. • Knows BAT assessment methodology.	• Ability to identify and analyse situations to solve environmental problems in a textile industry. • Evaluates and selects BAT in the textile sector for	• Understands the concept of BAT, applies BAT Reference Documents (BREFs). • Understands the benefits of BAT application in textiles sector.

	reducing negative environmental impacts.	

2.3.3 Content unit

Topic 2.3.3.1 Concept of Best Available Techniques

The BAT (Best Available Techniques) concept was introduced as a key principle in the IPPC Directive, 96/61/EC. The term best available technique is defined in Directive as "the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole[55]:

- **techniques** include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;
- **available** techniques are those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;
- **best** means most effective in achieving a high general level of protection of the environment as a whole." [56]

In the Directive 2010/75 / EU it is stated that the requirement for the application of BAT applies only to those sectors of economy, where the operation of the largest enterprises is associated with a significant impact on the environment[57].

In the process of classifying a technique as BAT in accordance with Annex III to Directive 2010/75/ EU, the following aspects should be taken into account:

- the use of low-waste technology;
- the use of less hazardous substances;
- the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;
- comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;

[55] https://ec.europa.eu/environment/archives/enlarg/news4.htm
[56] *Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control.* https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31996L0061:en:HTML
[57] https://ec.europa.eu/environment/industry/stationary/ied/legislation.htm

- technological advances and changes in scientific knowledge and understanding;
- the nature, effects and volume of the emissions concerned;
- the commissioning dates for new or existing installations;
- the length of time needed to introduce the best available technique;
- the consumption and nature of raw materials (including water) used in the process and energy efficiency;
- the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
- the need to prevent accidents and to minimize the consequences for the environment;
- information published by public international organisations[58].

The term “Best available techniques” is used primarily in the context of regulatory acts, standards, rules, regulations on limitation of emissions and discharges of pollutants into the environment, taking into account strategies on pollution prevention and control. The term has been subject of change in dependence with the changing goals of practical activities, as well as social values: “reasonably achievable”, “best practicable”, “best available”. The following terms have been used with similar meaning: available techniques, best practicable means, best practicable environmental option.

Initially, the “best available techniques” meant the best achievable one among up-to-date techniques without considering the traditional economic cost-benefit analysis. At present, when classifying techniques as “best available” economic factors are also taken into consideration.

Topic 2.3.3.2 BAT selection

BAT in the European Union are defined and reviewed within the official framework of the Seville Process in cooperation with member states, industrial enterprises and other interested parties. This work is coordinated by the European Bureau for Integrated Pollution Prevention and Control of the Advanced Technological Research Institute at the EU Joint Research Center in Seville (Spain). The work of an IPPC technical working group is led by the European Commission’s in-house science service, the Joint Research Centre’s European IPPC Bureau (EIPPCB) and as results produce reference documents on Best Available Techniques REFerence documents, called BREF.

The technical working groups (TWG) represent the main stakeholders (i.e. EU Member States, industry concerned, environmental NGOs and services of the EU Commission) is established for each industrial sector which, in the process of technical and economic information exchange supported by expert analysis and recommendations, defines the BAT for a particular

[58] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:334:0017:0119:en:PDF

industrial sector. The elaboration process of reference documents on BAT (BREF documents) is schematically shown in the figure 10. The preparation of BAT Reference documents is not a one-time job; it includes periodic review, updating, renewal and expansion of the data submitted.

Procedures for creating and converting BAT Reference Documents, as well as requirements for their content, are set out in the Information Exchange Guidelines IEF 22-4-1 BAT information exchange guidance document[59].

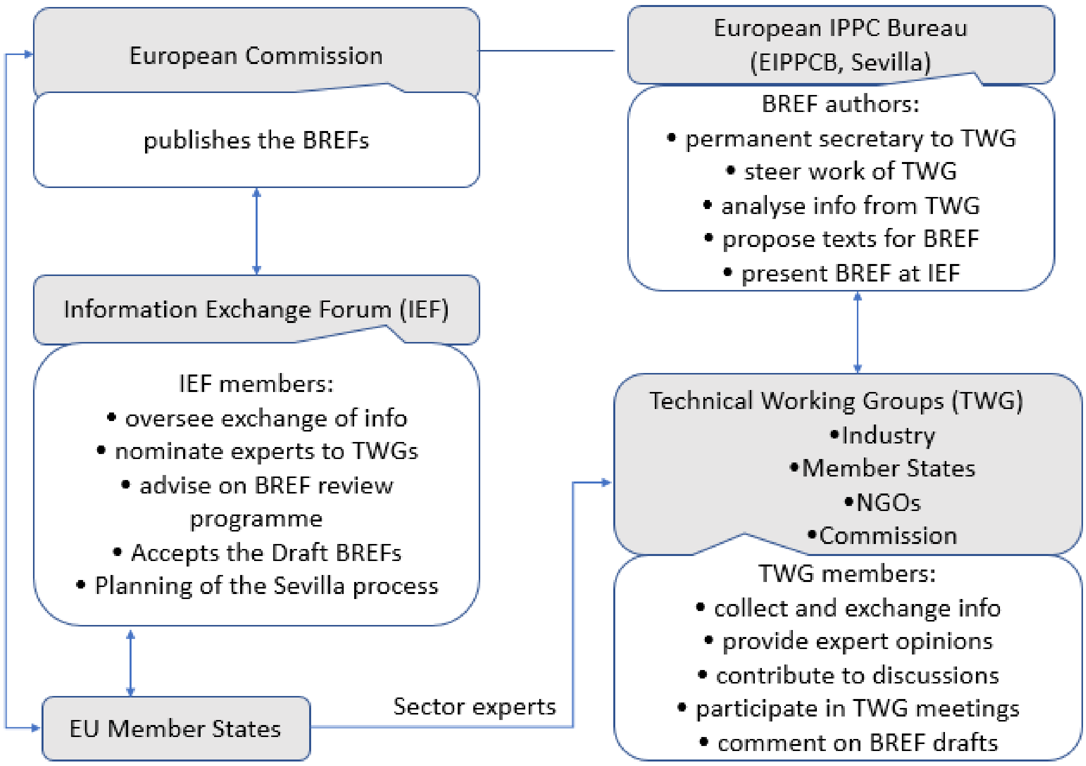


Figure 10 The elaboration of BAT reference documents[60]

In the process of determining the best techniques in industrialized countries, the main thing is that the use of the term BAT extends to those technological processes and techniques that have already been commercialized and their environmental effectiveness has been already confirmed by the conclusion of independent experts. It is especially emphasized that the transition to the use of BAT should not reduce the economic efficiency of the enterprise. So, the main criteria in procedure to evaluate candidate BAT are as follows[61]:

- the technical feasibility

[59] http://www.oree.org/_script/ntsp-document-file_download.php?document_id=997&document_file_id=1001
[60] http://www.provincia.torino.gov.it/ambiente/file-storage/download/ippc/pdf/meeting_europeo/roudier_europeanbureau.pdf
[61]https://pdfs.semanticscholar.org/0d14/e3c786efb4d546e1f902b36030b8f444d095.pdf

- the overall environmental benefit
- the economic feasibility

Technical feasibility is evaluated by looking for experiences with the techniques in practical situations. Is the technique already applied in the sector? Is it applied on conditions that are considered relevant for the sector as a whole? Does the technique affect the quality of the products of the sector? Does the technique affect workers' safety?[62]

A technique will be the best only if its application ensures the protection of the environment as a whole, and not the protection of separate components of the environment. In practice, for example, this means that a high degree of purification of wastewater discharged into a water body should not be achieved due to an increase in emissions of pollutants into the air or an increase in the production of wastes[63].

The overall economic benefit of candidate-BAT is determined by an expert assessment of the impact on different environmental media (air, water, waste, soil, energy, use of natural resources, noise/vibrations and odour).

Ecological criteria of the best available techniques are its capabilities to ensure comprehensive prevention (where possible) and / or reduction of emissions (discharges) of pollutants (or other types of negative impact) into the atmospheric air, water bodies, other environmental components, as well as reduction (exclusion) of the formation of waste production and consumption, reduction of energy and resource intensity of production processes[64].

Candidate-BAT is considered economically acceptable if the cost / environmental benefit ratio is not unreasonable, that is, the environmental benefits exceed the economic costs of purchase, implementation and use of BAT. The assessment of the economic feasibility of a technique for a particular industry takes into account the requirement of the Directive regarding guarantees that, in determining any technique as a BAT, there should not be undermined the economic sustainability of the industrial sector, where this techniques is being implemented[65].

Most of the remaining BAT-options are not mutually exclusive, i.e. implementation of one candidate BAT does not exclude the use of another. However, often several techniques have similar environmental benefits[66].

Only with the combined consideration of environmental, economic and social factors, as well as its practical accessibility, the technique can be recognized as the best available.

[62] https://pdfs.semanticscholar.org/0d14/e3c786efb4d546e1f902b36030b8f444d095.pdf
[63] http://forum.europa.eu.int/Public/irc/env/ippc_brefs/library.
[64] http://forum.europa.eu.int/Public/irc/env/ippc_brefs/library.
[65] https://eippcb.jrc.ec.europa.eu/reference/BREF/ecm_bref_0706.pdf
[66] https://pdfs.semanticscholar.org/0d14/e3c786efb4d546e1f902b36030b8f444d095.pdf

The methodologies presented in the Reference Document (REF) Economics and Cross - Media Effects consistently describe the structure of the decision-making process, and also provide a clear and transparent scheme for the elaboration of a final decision in which ecological and economic interests should be balanced[67]. The following figure presents a methodology to evaluate a candidate BAT.

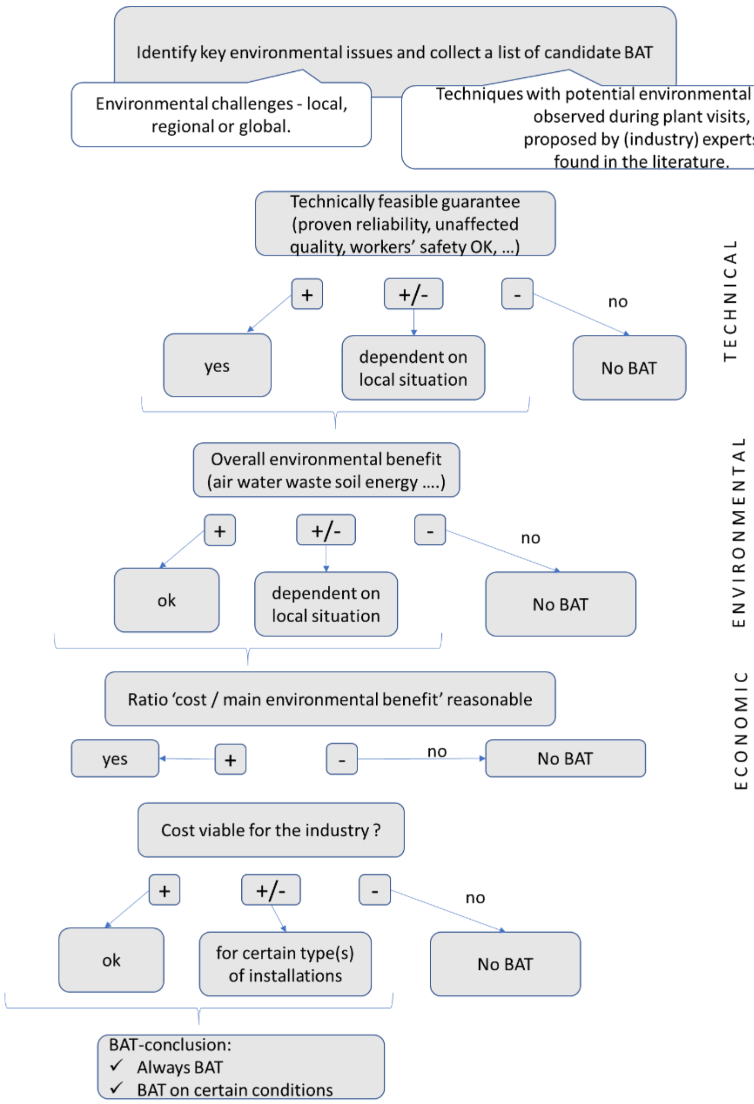


Figure 11 BAT selection procedure at the industry level[68]

As a result of BAT identification are used the following designations: "+" – BAT, category "+/-" – is conditional BAT, "-" – is not BAT.

[67] https://eippcb.jrc.ec.europa.eu/reference/BREF/ecm_bref_0706.pdf
[68] Adapted from https://pdfs.semanticscholar.org/0d14/e3c786efb4d546e1f902b36030b8f444d095.pdf

Topic 2.3.3.3 BAT reference document (BREF)

'BAT reference document' means a document, resulting from the exchange of information organised pursuant to Article 13, drawn up for defined activities and describing, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques, giving special consideration to the criteria listed in Annex III[69]. BREF document can be downloaded at the European Commission EIPPCB webpage[70]. Currently the EU has developed 33 BAT Reference Documents, which relate to various industries:

- 28 of them are "vertical" - for all the industrial sectors from ANNEX I (including BREF for textiles Industry). "Vertical" reference documents are prepared for the use in one industrial sector;
- 3 "horizontal" reference documents are applicable to most industries;
- 2 Reference Documents (REFs) - (Economics and Cross - Media Effects, Monitoring of Emissions to air and water);
- 1 BREF for a 'non-IPPC' activity - Management of Tailings and Waste-Rock in Mining Activities

BAT Reference Documents are neither standards nor technical regulations. The BAT Reference Documents do not prescribe the use of any of the technologies, but offer a range of emission levels (discharges) that can be achieved by applying various best technologies available on the market and having the least environmental impact, taking into account technical characteristics of the installation, its geographical location and local environmental conditions. BREFs are the main reference documents used by:

- industrial facilities to select the most appropriate technology among their vast numbers;
- competent authorities in 27 Member States to provide integrated permits/licences for allowable environmental impact for the installations that represent a significant pollution potential in Europe[71].

Permit conditions, including emission limit values (ELVs), must be based on the Best Available Techniques (BAT). Until the adoption of such new BAT conclusions, the old BAT reference documents are to apply as BAT conclusions for the purposes of the IED[72].

In addition, BAT Reference Documents describe promising technologies, thereby defining a vector (direction) for the industry development, since the active introduction of promising technologies redirects them into the category of BAT. Using Best Available Techniques (BAT)

[69] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:334:0017:0119:en:PDF
[70] http://eippcb.jrc.ec.europa.eu/reference/
[71]http://www.hrdpnetwork.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e52068/e52963/08_BAReferenceDocumentTextileSector_LalitSharma_GIZ.pdf
[72]https://www.era-comm.eu/EU_Law_on_Industrial_Emissions/module_2/bat.html

to combat harm caused by pollution in the textiles sector[73]. BREFs typically contain the following information:

- Executive summary, Preface, Scope
- 1. General information about the sector concerned
- 2. Applied processes and techniques
- 3. Emission and consumption levels
- 4. Techniques to consider in the determination of BAT
- 5. Best available techniques
- 6. Emerging techniques
- 7. Concluding remarks
- References, Glossary of terms and abbreviations
- Annexes

For the textile industry a BREF has been developed in 2003. The reviewing process of the BREF for the textile industry started in 2017 and it is expected that the new BREF will be published in 2021. BAT form the basis of legally binding emission limit values in integrated environmental permits for the textiles industry in a wide range of countries. Using Best Available Techniques (BAT) to combat harm caused by pollution in the textiles sector[74]. The Textile BREF is a valuable source:

- of information on available techniques, their applicability and their associated consumption and emission levels for plants of different size and structure (small plants as well as large plants)[75].
- for ideas on how to improve the production processes in regard of its environmental impact. The measures e.g. aim at:
    - reducing losses and increasing efficiency in the use of raw materials, chemicals etc.
    - increasing product quality and reliability
    - reducing the amount of energy need
    - reducing the amount of water need
    - avoiding or reducing pollution of air and water

[73] https://mneguidelines.oecd.org/OECD-Garment-Forum-2019-session-note-Using-best-available-techniques-to-combat-harm-caused-by-pollution.pdf
[74] https://mneguidelines.oecd.org/OECD-Garment-Forum-2019-session-note-Using-best-available-techniques-to-combat-harm-caused-by-pollution.pdf
[75]http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e52068/e52963/08_BATReferenceDocumentTextileSector_LalitSharma_GIZ.pdf

- avoiding or reducing the amount of hazardous substances in the products[76].

BREF Textile industry includes description of 130 techniques in the chapter - 4 “Techniques to consider in the determination of BAT”:

- Generic BAT for whole textile industry
- Process-integrated BAT
- End of pipe techniques
- All main textile fibre types are included additional information on auxiliaries, dyes and pigments, textile machinery and typical recipes[77]

BREF Textiles Industry scope covers three sectors:

- Wool scouring;
- Textile finishing operations where the treatment capacity exceeds 10 tonnes per day (excluding floor covering);
- The carpet sector.

Particular attention is given to the following processes (see Figure 12):

- fibre preparation;
- pre treatment;
- dyeing;
- printing;
- finishing.

[76] https://www.global-chemicals-waste-platform.net/fileadmin/files/Summer_School_2015/UBA_Checklist_BAT_Textile_Industry.pdf

[77] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e52068/e52963/08_BATReferenceDocumentTextileSector_LalitSharma_GIZ.pdf

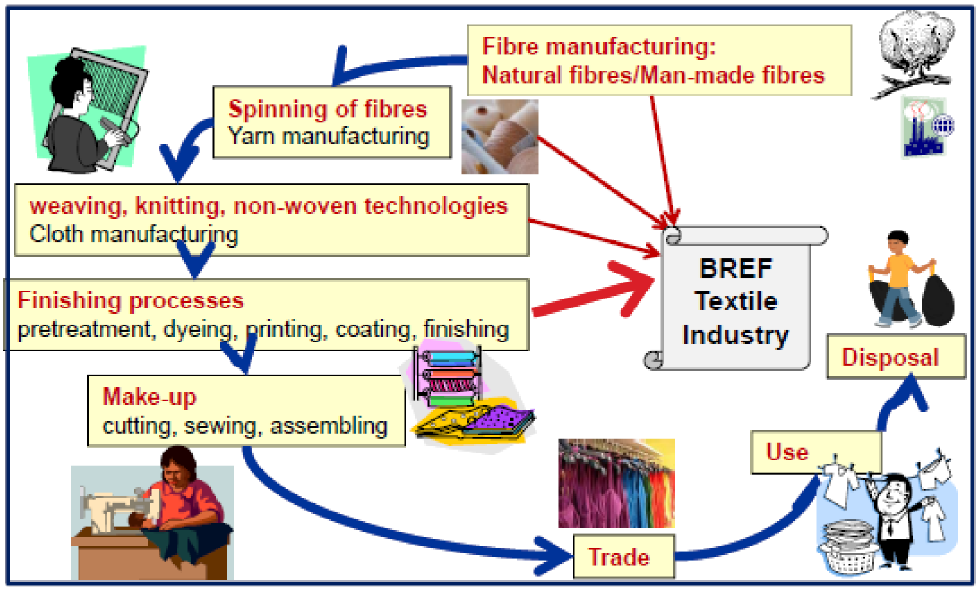


Figure 12. Status and scope of the BREF Textile Industry[78]

The purpose of adoption of BAT at the enterprise is to increase the efficiency of environmental and economic production figures, boost in productivity, increase in the innovative potential of the enterprise, new markets development, improvement of confidence, stability, search for new sources of financing, etc., which allow to ensure a stable economic growth and to improve the overall competitiveness in the industry[79].

Enterprises can use a checklist to identify the potential for improving environmental impact in the textile industry. The checklist is based on the 2003 version of the BREF for the textiles industries. In the checklist all best available techniques compiled in the BREF are taken into account and dealt with in individual tables (see Figure 13).

[78] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

[79] http://www.revistaespacios.com/a17v38n33/a17v38n33p32.pdf

1.6 Water and energy management	
See BREF chapters 4…as mentioned below, and 5.1	**Follow**
BAT is a variety of measures/techniques to minimize water and energy consumption in the production process. The following is a summary of the selected BAT for water and energy saving.	
BENEFITS: Water and energy savings are often related in the textile industry because the main use of energy is to heat up the process baths. Resource-conserving techniques result almost in cost savings.	

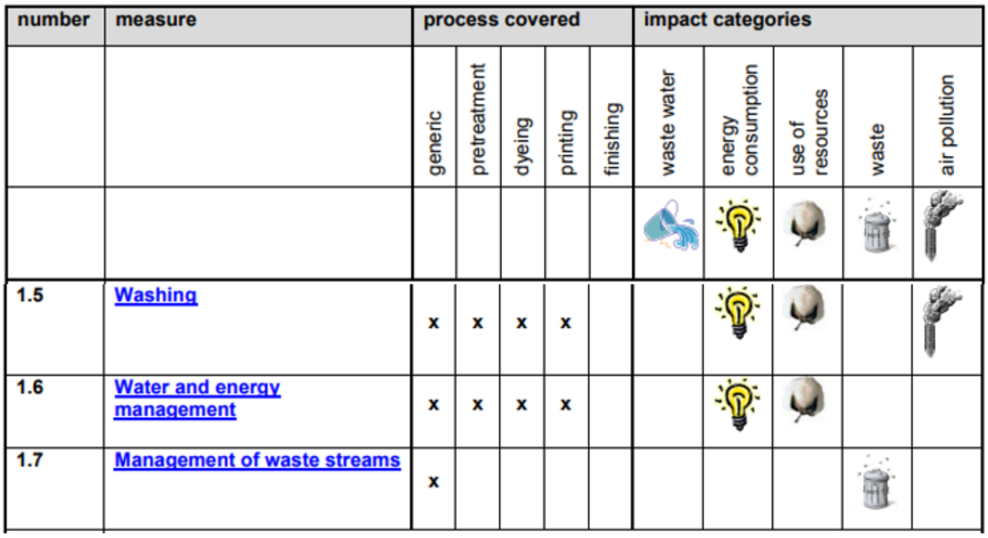
Details	**Status**				**Remarks**	**Follow**	
	yes	no	partly	not appl.		yes	no
Do you monitor water and energy consumption in the various processes, as mentioned earlier and described in 1.1.1 (see BREF chapter 4.1.2)?							
Have you installed flow control devices and automatic stop valves on continuous machinery (see chapters 4.1.4 and 4.9.2)?							

Figure 13. Detailed checklist (fragment)[80]

The table (see Figure 14) helps to identify relevant BATs and sorts the BATs in regard of the impact categories waste water, energy consumption, use of resources (including fresh water), waste and air pollution. Priorities need to be set site specific, taking into account the particular situation of the factory under consideration[81].

[80] https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4294.pdf

[81] https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4294.pdf



number	measure	process covered					impact categories				
		generic	pretreatment	dyeing	printing	finishing	waste water	energy consumption	use of resources	waste	air pollution
1.5	Washing	x	x	x	x						
1.6	Water and energy management	x	x	x	x						
1.7	Management of waste streams	x									

Figure 14. Topics covered in the checklist with indication of process covered and impact categories addressed[82]

Topic 2.3.3.4 Environmental benefits of textile BAT – examples

The following table presents an example of the environmental benefits of three types of BAT (BAT for good housekeeping, for dyeing and for printing), considering the level of environmental benefit: X – High environmental benefit/high savings potential, and x - Environmental benefit/savings potential:

Area of application	Best Available Techniques (BAT)	Water demand/ wastewater pollution	Energy demand	Resource	Waste volume	Air pollution
BAT FOR „GOOD HOUSEKEEPING“						
Use of water and energy	Employ efficient washing processes, for example (Chapter 4.9.1; 4.9.2): - Replacement of overflow rinsing with interval rinsing, - Counter current principle.	X	x			
		50-75 % less water consumption				
		X	x	X		

[82] https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4294.pdf

Area of application	Best Available Techniques (BAT)	Water demand/ wastewater pollution	Energy demand	Resource	Waste volume	Air pollution
	Reuse water, for example (Chapter 4.6.22; 4.1.1; 4.5.8): - reuse the last rinsing baths, - reuse dye baths, - use the water from the pre-wash for the re-washing (carpet finishing), - use counter current for continuous wash, - use cooling water as process water.	Reduces specific water consumption from 60 to 25 l/kg				
	Use machines with low liquor ratio (short bath). Use airflow-jet dyeing machines instead of conventional jet dyeing. Modern tanning tanks save water. (Chapter 4.1.4)	X	X	X		
		Savings potential for water, chemicals and heating energy of up to 50%				
BATS FOR DYEING						
General BATs for batch dyeing	Use of dyeing machines with (Chapter 4.6.19–4.6.21): - automatic controls for filling volume, temperature and other relevant parameters, - indirectly heated heating and cooling systems - hoods and doors to minimise vapour loss in enclosed dyeing machines.	X	X	X		
		The optimisation of machine equipment for winch beck dyeing machines saves up to 50% of fresh water and up to 30% of energy in the total dyeing process				
Batch dyeing with reactive dyes	Exhaustion dyeing of cellulose fibres with low salt reactive dyes. (Chapter 4.6.11)	X				
		Lowers neutral salt consumption by a third. Important in arid climate zones with negative water balance.				
BATS FOR PRINTING						
General	Reduction in water consumption for washing processes (Chapter 4.7.7): - start/ stop control for the cleaning of the printing belt - of the cleanest portion of the rinsing water from the cleaning of the squeezers and screens,	X				
		Lowers water consumption by up to 55 %				

Area of application	Best Available Techniques (BAT)	Water demand/ wastewater pollution	Energy demand	Resource	Waste volume	Air pollution
	- of the rinsing water from the cleaning of the printing belt.					

Figure 15. Environmental benefits of *BATS for good housekeeping, dyeing and printing*[83]

In Chapter 4.1.3 of the BREF Textile Industry, process improvements for dyeing, one of the techniques referred is the automated preparation and dispensing of chemicals[84], which includes:

- Microprocessor-controlled dosing systems meter chemicals automatically.
- Usually the frequently used colorants (highest consumption) are selected for automation.
- commonly applied in many companies in the textile industry (Examples of plants with production capacity ranging from 70 t/day to 5 t/day)

The main benefits of this BAT are:

- improved right-first-time performance
- minimising corrective measures (e.g. reworks, re-dyeing)
- significant reduction of waste water pollution and wasted chemicals thanks to the minimisation/ avoidance of liquor residues

The Chapter 4.5.7 of the BREF Textile Industry identifies the BAT of recover and re-use alkali from mercerizing, in the cotton processing:

[83] https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4289.pdf

[84] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

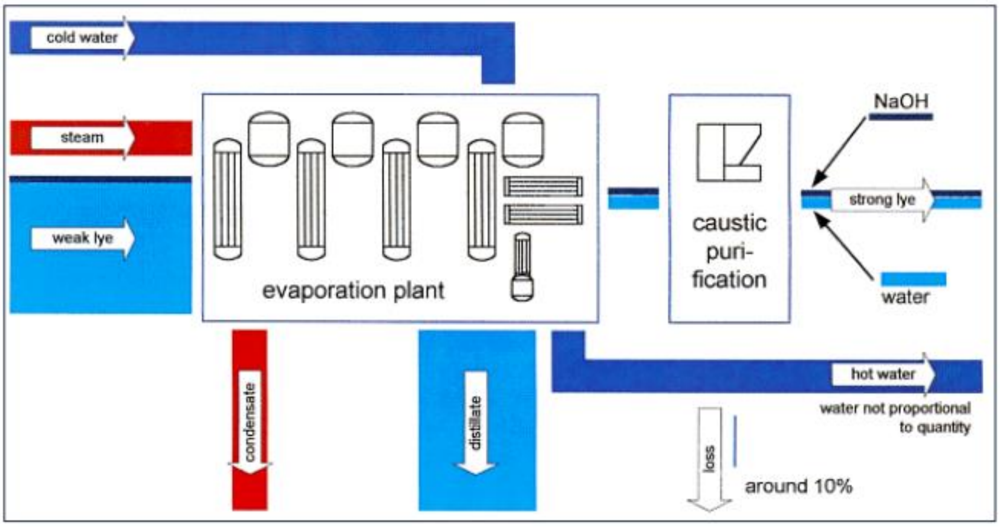


Figure 16. Scheme of the caustic soda recovery process[85]

The Mercerising process is one of the main source of alkaline load of wastewater. In this process the rinsing water from mercerising (weak lye: 40 - 50 g NaOH/l) is concentrated by evaporation for re-use in mercerisation. The recycling degree is up to 80% and the alkaline load of wastewater is reduced drastically. Usually this BAT has a pay-off time of less than 1 year.

The chapters 4.9.1 and 4.9.2 of Textile Industry BREF refer measures for reduction of water consumption (Efficient washing processes)[86]. Following figure presents some of the techniques and the benefits achieved in terms of water consumption:

[85] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

[86] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

- Replacement of overflow rinsing with "drain and fill rinsing" or "smart rinsing".
- Use of "Drain and fill" in combination with low liquor ratio machines equipped with time-saving devices (power draining and filling, combined cooling and rinsing, full volume heated tanks)

→ **50 – 75 % less water consumption**

- Water conservation in continuous washing and rinsing:
  - Water flow control
  - countercurrent washing
  - Use of squeeze rollers or vacuum extractors for the reduction of carry-over

	Water consumption (l/kg)
Pretreatment process	
Washing for desizing	3 - 4
Washing after bleaching	4 - 5
Washing to remove NaOH after mercerisation	4 - 5
Washing after dyeing	
Reactive dyestuffs	10 - 15
Vat dyestuffs	8 - 12
Washing after printing	
Reactive dyestuffs	15 - 20
Vat dyestuffs	12 - 16

Figure 17. Achievable specific water consumption levels for continuous washing processes[87]

The Chapter 4.6.22 of the BREF Textile Industry related with the water re-use/recycling in batch dyeing processes refers:

- Exhausted hot dye baths are analysed for residual colourant and auxiliary concentration, replenished and re-used to dye further batches
- easiest systems for re-use are dye classes with high affinity (exhaustion) and minimum changes during the dyeing process (e.g. acid dyes for nylon and wool, basic dyes for acrylic, direct dyes for cotton and disperse dyes for synthetic fibres)
- on average four cycles of the same shade are possible, obtaining a reduction of overall water consumption of 33 % and cost savings (depending on water price and effluent disposal costs) [88].

The general principles for wastewater management and treatment[89] includes:

- Start with the characterization of the different streams of wastewater generated in company processes and segregate them according to their contaminants type and load. With this information, decide on the destination for each type of wastewater generated, including the ones that can be recycled or reused and the ones that have to be treated.

[87] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

[88]http://www.hrdpnetwork.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

[89]http://www.hrdpnetwork.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

Figure 18 Life cycle stages and system boundaries[90]

- Do not send any wastewater into the biological treatment facility that could cause malfunctions there.
- Employ alternative cleaning techniques for wastewater with relevant volumes of no biodegradable substances:
    - Chemical oxidation for highly-polluted, selected, non-biodegradable waste water partial flows (e.g. desizing baths);
    - Precipitation and flocculation for partial flows containing heavy metals
    - Membrane process for heavily coloured wastewater partial flows and wastewater with a high volume of dissolved substances;
- If waste water with non-biodegradable compounds is not treated separately, then additional physical-chemical treatment of the waste water as a whole is required;
- Specific process residue (e.g. printing paste residue, padding liquor residue) should not enter the wastewater but be disposed of in a more appropriate manner[91].

One case example presented as a BAT is the de-colouring using membrane technology[92].

[90] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf
[91]http://www.hrdpnetwork.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf
[92] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

1. step: nanofiltration

2. step: electrochemical de-colouration

Figure 19. Case example: De-colouring using membrane technology [93]

This example presents the following conditions and benefits:

- Company characterization: company finishes knitted fabric. Pre-treatment of wastewater from pad batch dyeing and from continuous washers.
- BAT process: 1º step: nanofiltration, with an efficiency of de-colouration: 80->99% and 2º step: electrochemical de-colouration, with an efficiency of de-colouration: 35 – 78%. After treatment in municipal waste water treatment plant.

The Anaerobic pre-treatment of desizing effluents[94] is also presented as a BAT. With the following conditions and benefits:

- Company characterization: company finishes woven, knitted and non-woven fabric
- ✓ BAT process: buffering/pre-acidification and anaerobic treatment in fixed bed reactor. COD-removal efficiency: 60 – 70 %. After treatment in municipal waste water treatment plant.

[93] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf
[94] http://www.hrdp-network.com/live/hrdpmp/hrdpmaster/igep/content/e48745/e49028/e58164/e58169/BAT_Textile_Vortrag_GPCB_.pdf

2.3.4 Suggested readings

- http://www.revistaespacios.com/a17v38n33/a17v38n33p32.pdf
- http://www.eeaa.gov.eg/portals/0/eeaaReports/BAT4MED/BAT4MED%20Project%20Brochure/Textile%20Egypt_EN_CORR.pdf
- Brigitte Zietlow BAT in textile manufacturing. Workshop Textile Industry 18-21/04/2015 – http://seip.urban-industrial.in/live/hrdpmp/hrdpmaster/igep/content/e62771/e63552/e65250/e65251/e65474/Annex22_BATintextilemanufacturing.pdf
- Harald Schönberger, Thomas Schäfer Best Available Techniques in Textile Industry https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/2274.pdf
- Margherita Secci, Giorgio Grimaldi Best Available Techniques (BAT) BREFs on Textile and Weaving Industries http://www.isprambiente.gov.it/contentfiles/00001800/1807-breftextile.pdf
- Miray Emreol Gönlügür Sustainable Production Methods in Textile Industry https://api.intechopen.com/chapter/pdf-preview/65473
- https://www.researchgate.net/publication/238658170_Promotion_of_Best_Available_Techniques_BAT_in_the_Textile_and_Leather_Industry_in_Developing_Countries_and_Emerging_Market_Economies
- http://asiapacific.recpnet.org/uploads/resource/5dc73954aa0ca1086e074affc2089512.pdf
- Choudri, B. S. & Baawain, Mahad. (2016). Textiles Waste Management. Water Environment Research. 88. 1433-1445(13). Doi:10.2175/106143016X14696400495172.

2.3.5 Quiz

Self-evaluation Quiz

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1. Which techniques to consider in the determination of BAT? (select the most suitable option)
   a. Generic
   b. Wool scouring
   c. Textile finishing
   d. All of the above

2. What is a BREF? select the most suitable option)
    a. Results of an information exchange on best available techniques
    b. Provides competent authorities, companies, public, Commission etc. with information for their decision- making, including BAT-associated emission levels
    c. Tool to drive environmental performance IPPC
    d. All of the above

3. What are the main criteria in procedure to evaluate candidate BAT? (select the most suitable option)
    a. Technical feasibility
    b. Overall environmental benefit
    c. Economic feasibility
    d. All of the above

Unit 2.4 Textile products environmental performance

2.4.1 Introduction

Clothing has a long and complicated life-cycle (i.e. the supply chain and 'downstream' processes after manufacturing) consisting of many phases including resource production and extraction, fibre and yarn manufacturing, textile manufacturing, clothing assembly, packaging, transportation and distribution, consumer use, recycling and ultimate disposal. The environmental impacts associated with the production and use of clothing throughout its lifespan include wastewater emissions, solid waste production and significant depletion of resources from consumption of water, minerals, fossil fuels and energy.[95].

2.4.2 Short description

Knowledge	Skills	Competencies

[95] Environmental Impacts in the Fashion Industry. A Life-cycle and Stakeholder Framework. Anika Kozlowski, Michal Bardecki, Cory Searcy, JCC 45 Spring 2012 © Greenleaf Publishing 2012, 17-36pp.

At the end of this unit the in-company trainer will:	*At the end of this unit the in-company trainer will be able to:*	*At the end of this unit, the in-company trainer will have acquired the responsibility and autonomy to:*
• Knows Life Cycle Assessment (LCA) definition • Knows the concepts, framework and application of Life Cycle Assessment method for carbon footprint and water footprint assessing	• Evaluates the Environmental Performance of products and systems by using Life Cycle Assessment method	• Applies water footprinting and carbon footprinting analysis for decision-making in production company by using the Life Cycle Assessment method

2.4.3 Content unit

Topic 2.4.3.1 Life Cycle Assessment (LCA) definition

Based on the ISO standards, in the textile industry, there are five phases in a product's life cycle to be considered for environmental sustainability[96]: (a) material phase, (b) manufacturing phases, (c) retail phases, (d) consumption phases, and (e) disposal phases.

[96] Kyung Eun Lee, Springer Nature Singapore Pte Ltd. 2017 S.S. Muthu (ed.), Sustainability in the Textile Industry, Textile Science and Clothing Technology, DOI 10.1007/978-981-10-2639-3_3

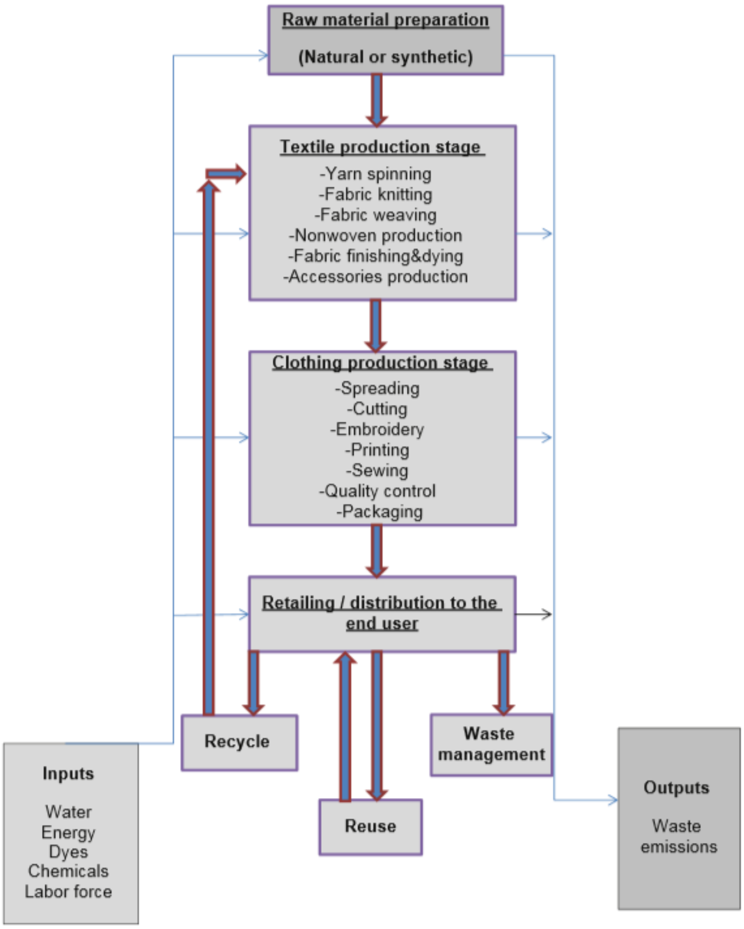

Figure 20 Textile and clothing production life cycle. [97]

Life Cycle Assessment (LCA), as defined by the ISO 14040 and ISO 14044 is the compiling and evaluation of the inputs and outputs and the potential environmental impacts of a product system during a product's lifetime. LCA addresses the environmental aspects and potential environmental impacts (e.g. use of resources and the environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave)[98].

LCA can be defined as a systems-based, quantitative method for evaluating the environmental impact of a product. It is a tool used to assess the stages and impact of a product's entire life,

[97] *Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing*. Subramanian Senthilkannan Muthu (Editor). Woodhead Publishing Series in Textiles, 2015, ISBN-13: 978-0081001691
[98] https://www.iso.org/obp/ui/#iso:std:iso:14040:ed-2:v1:en

from raw material extraction (cradle) to waste treatment (grave). Besides that, LCA typically does not include social impacts nor economic impacts[99].

Real case example: Life Cycle Assessment (LCA) of Organic Cotton Fiber

Scope	#LCA #OrganicCotton #Raw materials
Value added	In this case you can learn how to build an up-to-date and well-documented Life Cycle Inventory (LCI) for organic cotton fiber (ginned and baled), representative of worldwide global production. This Life Cycle Assessment (LCA) of Organic Cotton Fiber was commissioned by Textile Exchange. **Source of information: Web site of Textile Exchange. Nov 2019** The life cycle assessment of organic cotton fiber – A Global Average. Textile Exchange 2014.
More information	https://textileexchange.org/wp-content/uploads/2017/06/TE-LCA_of_Organic_Cotton-Fiber-Summary_of-Findings.pdf

LCA quantifications can be carried out in many forms, which are labelled as variants of LCA. The most popular of these variants are:

- Cradle to grave – full life-cycle assessment which includes all the stages of a life cycle.

Real case example: Life Cycle assessment of a jean

Scope	#LCA #global production footprint #supplychain #consumer #end of life #brand
Value added	Understanding the environmental impact of a pair of Levi's® 501® *jeans.* LEVI STRAUSS & CO. © 2015. The life cycle of a jean. This study show carbon and water footprint in different aspects: cotton production, fabric production, garment manufacturing, packaging, sundries, transportation & distribution, consumer care and the end of life. **Source of information and image: Web site of Pepe Jeans. Nov2019.** The life cycle of a Jean. Understanding the environmental impact of a pair of Levi's 501 jeans 2007.
More information	http://www.levistrauss.com/wp-content/uploads/2015/03/Full-LCA-Results-Deck-FINAL.pdf

[99] *The life cycle of a jean. Understanding the environmental impact of a pair of Levi's® 501® jeans.* LEVI STRAUSS & CO. © 2015 http://www.levistrauss.com/wp-content/uploads/2015/03/Full-LCA-Results-Deck-FINAL.pdf

- Cradle to gate – life cycle assessment deals only with the raw material extraction, production, manufacturing, packing and transportation processes. It assesses only activities which occur within the factory. It will not include the distribution, consumer use and disposal phases.[100]

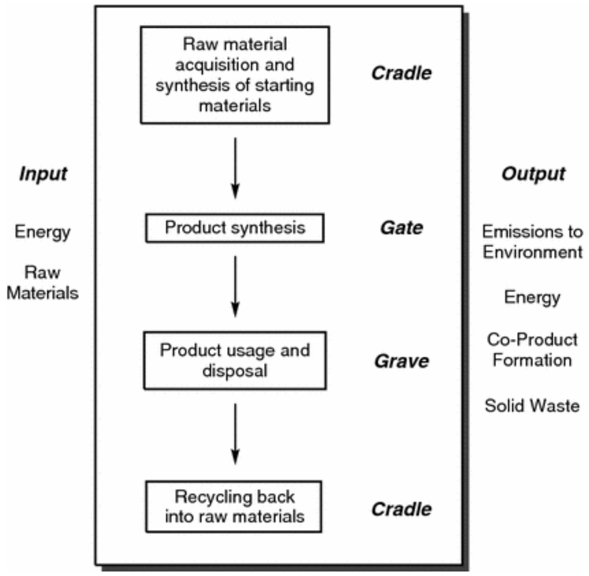

Figure 21 Life cycle stages and system boundaries[101]

Topic 2.4.3.2 Life Cycle Assessment (LCA) phases

There are four phases in an LCA study[102]: the goal and scope definition phase, the inventory analysis phase (LCI phase), the impact assessment phase (LCIA) and the interpretation phase.

[100] Subramanian Senthilkannan Muthu. Assessing the Environmental Impact of Textiles and the Clothing Supply Chain. Woodhead Publishing, 2014, ISBN9781782421047
[101] Dicks A.P., Hent A. (2015) An Introduction to Life Cycle Assessment. In: Green Chemistry Metrics. SpringerBriefs in Molecular Science. Springer, Cham.
[102] ISO 14040:2006

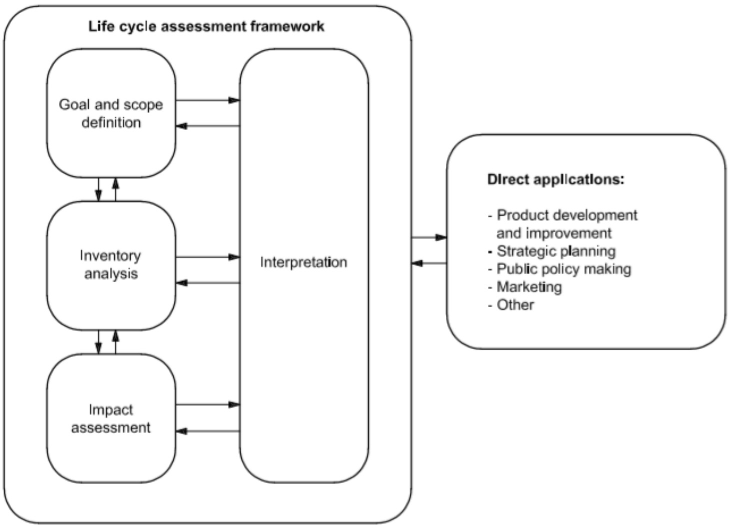

Figure 22 Stages of LCA[97]

The scope, including the system boundary and level of detail, of an LCA depends on the subject and the way study will be used. How deeply and widely LCA will be carried out depends on the goal of a particular LCA[103].

Goal and scope definition phase

According to the ISO 14040 standard the first phase of an LCA is to define goal and scope, both of these need to be defined clearly and consistently with the intended application. The Goal and scope is where all general decisions for setting up the LCA system are made. Points that need to be determined in the goal definition are[104]:

- The intended application of an LCA study - An LCA can be used for many different applications such as marketing, product development or improvement, strategic planning, etc.
- The purpose of an LCA study – There are many different purposes for LCA and the chosen one will dictate the scope of the study. If the study is intended to be published, the scope will be more comprehensive and include a greater data collection effort and the review process must be formalized. No critical review is necessary, if the LCA will be used internally, the scope will be dictated by the company's objective and their access to data.
- The intended audience of an LCA report – The audience can be the shareholders, executives, engineers, scientists, customers, etc., depending on the client's objectives.

[103] https://web.stanford.edu/class/cee214/Readings/ISOLCA.pdf
[104] http://lab.fs.uni-lj.si/kes/erasmus/LCA-Introduction.pdf

- Usage for comparative analysis – reasons must be determined if the LCA results are intended to be used for comparative. Critical review is obligatory if the results are going to be published.

During the scope definition the product or process system under study is characterized. These are the factors that require definition before the LCA is done[105]:

- Function of the product: products functions has to be defined in order to describe the product. To do that the demands of the product also needs to be defined. If there are different products to be compared, the different functionalities of each of the products should be documented exactly.
- Functional unit - the functional unit is the quantified definition of the function of a product. In case of comparing two products, their functional units must be equivalent.
- Reference flow – is a part of functional unit defining. The reference flow shows the product components and materials needed to fulfil the function, as defined by the functional unit. All data used in the LCA must be calculated or scaled in accordance with this reference flow.
- System boundaries - the system boundary defines which processes will be included in, or excluded from, the system; i.e. the LCA.

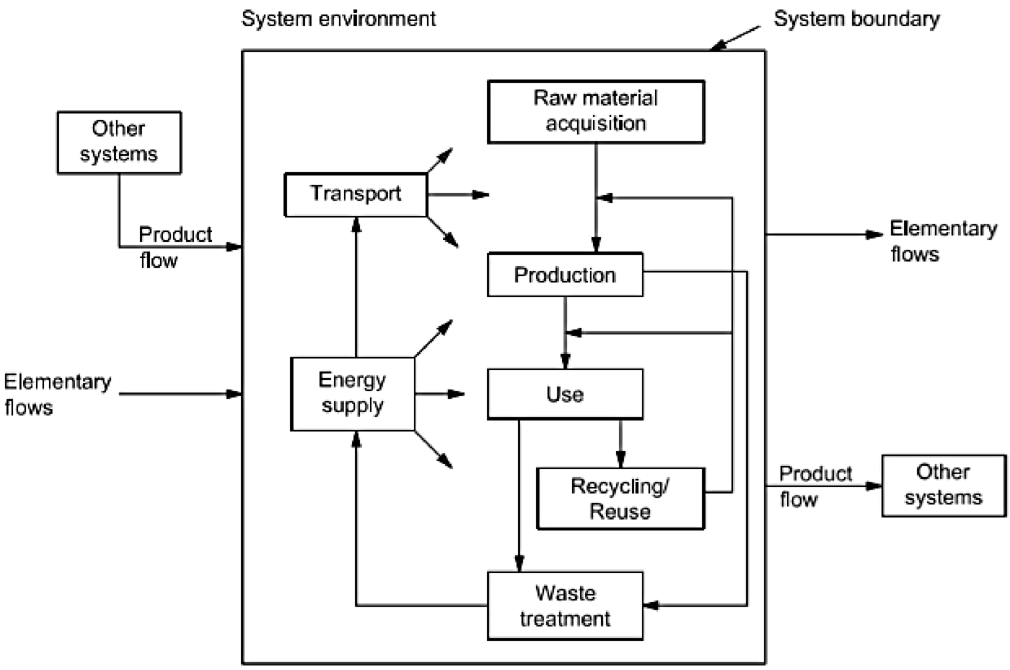

Figure 23 Example of a product system for LCA[106]

[105] http://lab.fs.uni-lj.si/kes/erasmus/LCA-Introduction.pdf
[106] ISO 14040:2006

The system can be described using a process flow diagram that shows the processes and their relationships. Figure 23 shows product system or generic process flow diagram with all processes included in the LCA shown inside the box marked as the System Boundary[107].

A system's boundaries are defined by cut-off criteria. Cut-off criteria are used to define the parts and materials that are included or excluded from the product system. There are four main options to define the system boundaries: Cradle to Grave; Cradle to Gate; Gate to Grave and Gate to Gate (see figure 23. Life cycle stages and system boundaries).

Allocation procedures

Allocation is the partitioning and relating of inflows and outflows of a function to the relevant products and by products. The allocation to different products can be done according to one of the rules[108]:

- Allocation by Mass: The inflows and outflows of the function are given to all of its products proportionally to their mass.
- Allocation by Heating Value: The inflows and outflows of the function are given to all of its products according to their heating value. This allocation method is often used for production processes of fuels.
- Allocation by Market Value: The inflows and outflows of the function are given to all of its products according to their market value.
- Allocation by Other Rules: This can include energy, substance content, etc.

Data quality requirements

To define the required properties of the data for the study data quality requirements have to be documented. Data quality has a significant influence on the results of the LCA study, so descriptions of data quality are of big importance, where requirements of them have to be determined at the beginning of the study. Mostly, data quality is a trade-off between feasibility and completeness. The only way to evaluate the quality of a dataset is if the characteristics of the data are sufficiently documented. Data quality does, therefore, correspond to the documentation quality. The following issues should be considered for data quality[109] :

- Data acquisition: Is data measured, calculated or estimated? How much of the data required is primary data (in %) and how much data is taken from literature and databases (secondary data)?
- Time-reference: When was this data obtained and have there been any major changes since the data collection that might affect the results?

[107] http://lab.fs.uni-lj.si/kes/erasmus/LCA-Introduction.pdf
[108] http://www.gabi-software.com/fileadmin/GaBi_Manual/GaBi_Paperclip_tutorial_Part1.pdf
[109] http://lab.fs.uni-lj.si/kes/erasmus/LCA-Introduction.pdf

- Geographical reference: For what country or region is this data relevant?
- Technologies (Best Available techniques) – Is the secondary data from literature or databases representative for state-of-the-art- technology or for older technology?
- Precision: Is the data a precise representation of the system?
- Completeness: Are any data missing? How are data gaps filled?
- Representivity, consistency, reproducibility: Is the data representative, consistent and can it be reproduced?

Inventory analysis phase

The life cycle inventory analysis phase (LCI phase) is an inventory of input/output data with regard to the system being studied. In order to meet the goals that are defined in the study LCI phase involves collection of the data necessary. The Inventory Analysis is the LCA phase that involves the compilation and quantification of inputs and outputs for a given product system throughout its life cycle or for single processes[110].

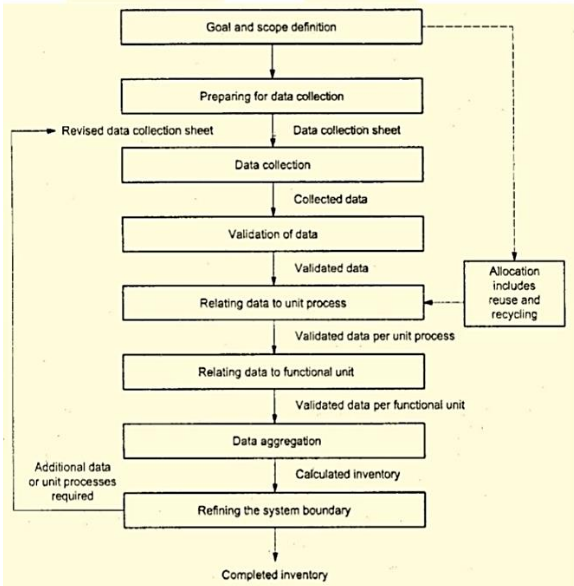

Figure 24 Simplified procedures for inventory analysis [111]

As data is collected and more is learned about the system, data requirements or limitations may be redefined or a change in the data collection procedures in order to meet the goal of the study may be required. Sometimes, when running into issues, goal or scope definition of the study requires revisions. An LCI table for the whole product system is created, after all the data has been gathered. The LCI is often presented as a table listing of all the material and

[110] https://www.iso.org/obp/ui/#iso:std:iso:14040:en
[111] ISO14044

energy inputs and outputs for the system. Input-output analysis has historically been used at the regional or national level[112].

Data collection and classifications phase is the most work intensive and time consuming of all the phases in an LCA. It includes gathering quantitative and qualitative data for every unit process in the system. The data for each unit process can be classified as follows: energy inputs; raw material inputs; ancillary inputs; other physical inputs; products; co-products; wastes; emissions to air, water and soil; other environmental aspects.

Before calculating the life cycle inventory, the following three steps should be completed:

- Data Validation - verifying the collected information may be a continuous process. This can be done with mass or energy balances as well as with a comparison to similar data.
- Relating Data to Unit Processes - the data has to be related to unit processes
- Relating Data to Functional Unit - the data has to be associated with the functional unit.

These steps are necessary to come up with the LCI for each unit process and for the overall product system. The LCI of the complete product system is the sum of all LCIs of all involved processes.

The purpose of life cycle impact assessment phase (LCIA) is to provide extra data to help assess a product system's LCI results so as to better understand their environmental significance[113]. The LCIA in turn is performed in several steps[114]:

1. Choosing impact categories, indicators and models.
2. Classification. A qualitative step where the 'interventions' (inflows and outflows) contributing to every of the impact categories are described.
3. Characterisation. Here the models chosen are used to quantify the contribution of the different interventions to the various impact categories.
4. Normalisation. Here the results of the characterisation are compared against a number of reference values, for example the total contribution to the impact category for a country.
5. Grouping/ranking. A qualitative evaluation.
6. Weighting. Here the results of the characterisation or standardization are at eventually weighed against each other with quantitative coefficient factors.
7. Data quality analysis.

[112] http://www.gabi-software.com/fileadmin/gabi/tutorials/tutorial1/GaBi_Education_Handbook.pdf
[113] ISO 14040
[114] Weighting and valuation in selected environmental systems analysis tools e suggestions for further developments. Sofia Ahlroth a,*, Måns Nilsson, Göran Finnveden, Olof Hjelm , Elisabeth Hochschorner, Journal of Cleaner Production 19 (2011) p.145-156.

According to the ISO standard for LCA, steps 1-3 are required in a Life Cycle Impact Assessment (although it is not required to carry out such an assessment). Steps 4-7 are voluntary with certain exceptions. Step 7 is compulsory in applications where options are being compared and the results publicised. Step 6 (weighting) is not permissible in such applications. A variety of generic weighting methods have been developed.

Impact categories and the impact assessment method

It shall be determined which impact categories, category indicators and characterization models are included within the LCA study. The selection of impact categories, category indicators and characterization models used in the LCIA methodology shall be consistent with the goal and scope of the study. Examples of impact categories are described in ISO/TR 14047[115].

The selection of impact categories shall reflect a comprehensive set of environmental issues associated with the product system being studied, taking the goal and scope into consideration. The selected impact categories should cover the environmental effects of the analysed product system. The choice of impact categories and the therefore the impact assessment method should be documented within the goal and scope definition[116].

The results of the Life Cycle Inventory phase include many various emissions. After the relevant impact categories are selected, the LCI results are assigned to at least one impact categories. If substances contribute to more than one impact category, they must be classified as contributors to all relevant categories. For example, CO_2 and CH_4 are both assigned to the impact category “global warming potential” [117].

Normalization, evaluation, grouping and weighting are all optional elements that are performed to facilitate the interpretation of the LCIA results. It is essential that these actions are transparently documented since other individuals, organizations and societies may have different preferences for displaying the results and might want to normalize, evaluate, group or weight them differently[118].

Normalization involves displaying the magnitude of impact indicator results relative to a reference amount. For example, this can be done for comparison with a reference system. The impact potentials quantify the potential for specific ecological impacts. In the normalization step the impact category results are compared to references in order to distinguish what is normal or not. For the normalization, reference quantities for a reference region or country during a time period are used[119].

[115] https://www.researchgate.net/publication/308568645_Selection_of_Impact_Categories_Category_Indicators_and_Characterization_Models_in_Goal_and_Scope_Definition
[116] https://ec.europa.eu/environment/eussd/pdf/footprint/PEF%20methodology%20final%20draft.pdf
[117] https://www.sciencedirect.com/topics/engineering/life-cycle-impact-assessment
[118] https://www.sciencedirect.com/topics/engineering/life-cycle-impact-assessment
[119] https://www2.mst.dk/udgiv/publications/2005/87-7614-574-3/pdf/87-7614-575-1.pdf

Interpretation phase.

The goal of the life cycle interpretation phase is to draw conclusions, identify limitations and make recommendations for the intended audience of the LCA. The roles and responsibilities of the various interested parties should be described and brought under consideration. Results of critical review, if one has been conducted, should also be described. Interpretation phase is where the results are checked and evaluated to make sure that they are consistent with the goal and scope definition and that the study is complete. This phase includes two primary steps[120]:

- identification of significant issues;
- evaluation.

In step one of the life cycle interpretation phase results from the LCI and LCIA have to be structured and "significant issues" or data elements that contribute most significantly to the results of both the LCI and LCIA for each product, process or service have to be identified. Significant issues can include[121]:

- Inventory elements such as energy consumption, major material flows, wastes and emissions etc.
- Impact category indicators that are of special interest or whose amount is of concern.
- Essential contributions of life cycle stages to LCI or LCIA results such as individual unit processes or groups of processes (e.g., transportation, energy production).

The aim of the evaluation increase the accuracy of the study. Methods that should be used for evaluation are: completeness check, sensitivity check, consistency check.

The results of the Life Cycle Assessment need to be clear, transparent and structured; being assembled in a comprehensive report. The report should present the results of the LCI and LCIA and also all of the data, methods, assumptions and limitations in sufficient detail. The reference document should consist of all elements indicated in ISO 14044[122].

The ISO standards require critical reviews to be performed on all Life Cycle Assessments supporting a comparative assertion. The type and scope (purpose, level of detail, persons to be involved in the process etc.) of the critical review is described in the LCA report. The review should ensure the quality of the study as follows: LCA methods are consistent with the ISO standards; Data are appropriate and reasonable in relation to the goal of the study; Limitations are set and explained; Assumptions are explained; and Report is transparent and consistent and the type and style are oriented to the intended audience. The critical review can be done by an external or internal expert, or by a panel of interested parties[123].

[120] https://web.stanford.edu/class/cee214/Readings/ISOLCA.pdf
[121] https://www.sciencedirect.com/topics/engineering/life-cycle-interpretation
[122] http://lab.fs.uni-lj.si/kes/erasmus/LCA-Introduction.pdf
[123]Introduction to Life Cycle Assessment. http://lab.fs.uni-lj.si/kes/erasmus/LCA-Introduction.pdf

Real case example: life cycle assessment of wool textiles

Scope	#LCA #Wool #Guidelines #Raw materials
Value added	Guidelines for conducting a life cycle assessment of the environmental performance of wool textiles. This document has general guidance on life cycle assessment based on several sources that provide background information, to persons wishing to conduct a life cycle assessment of wool products. **Source of information: Web site of Iwto. Nov 2019**
More information	https://www.iwto.org/sites/default/files/files/iwto_resource/file/IWTO%20Guidelines%20for%20Wool%20LCA.pdf

Topic 2.4.3.3 Carbon footprint

Carbon footprinting is the central method for the assessing of textiles and other products with respect to their contributions to climate change, and it takes into account the relative importance of different greenhouse gases. Carbon footprinting is a simplified form of product environmental footprint (PEF) calculation. That is based on the described standard ISO 14040. Carbon footprinting is simplified in the sense that only one impact category (climate change) is considered, while a PEF or LCA will typically consider other resource, environmental and human health categories, like energy consumption, impacts on habitat and the emission of carcinogens. Carbon footprint studies typically assume a 100-year time perspective, abbreviated "GWP100". Carbon footprinting is a four-step process also, as shown in figure 22. Stages of LCA[124].

- A key element of this first step in carbon footprinting is the definition of the 'functional unit' - a quantitative description of the benefit a product is expected to provide.
- Second step - inventory analysis is the most time-consuming step in carbon footprinting. Typically, this involves the foreground product system defined in the previous step, carefully examining each life cycle element (Materials, Manufacture, Transport, Use, Disposal) and identifying what greenhouse gases may be expected to pass out of the product system.
- The third step of carbon footprinting, impact assessment, is when the differences between the greenhouse gases are considered. Carbon footprinting typically considers all the greenhouse gases identified by the Intergovernmental Panel on Climate Change: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. In the atmosphere, a kilogram of each of these gases causes a different degree of insulation, and each has a different residence time.

[124] https://ec.europa.eu/environment/archives/eussd/pdf/Deliverable.pdf

- Forth step - the interpretation phase of a carbon footprint study is a time to formally reflect on the meaning of outcomes of the preceding three steps, and probably to do parts of them again. This iterativeness is the symbolic intent of the double arrows (← →) in LCA Framework, Figure 22 - in fact at any step in the overall process the analyst will frequently learn about the effect of decisions made in the other steps, which may point out inconsistencies that need to be removed or opportunities for product improvement that deserve consideration in additional scenarios[125].

Calculations of the carbon footprint of textile manufacturing plants are generally made within the context of an EMS, an organisational carbon footprint or for the purpose of a product LCA. If it is the first or second of these, the functional unit can be simply defined as one year of operation of the textile plant, regardless of which processes are present. If the goal is a product LCA, allocation procedures are required, and the extent to which different processes are applied to the specific product under investigation needs to be considered. Throughout the production processes for textiles, material is wasted, which means that the carbon footprint of the product has to be adjusted to consider the material losses from previous steps[126].

Topic 2.4.3.4 Water footprint

The water footprint of a product is defined as the total volume of fresh water that is used directly or indirectly to produce the product. It is determined by quantifying water consumption and pollution in all steps of the production chain. The water footprint includes three components[127]:

- **Green water footprint** is water from precipitation that is stored in the root zone of the soil and evaporated, transpired or incorporated by plants. It is particularly relevant for agricultural and forestry products;
- **Blue water footprint** is water that has been sourced from surface or groundwater resources and is either evaporated, incorporated into a product or taken from one body of water and returned to another, or returned at a different time; and
- **Grey water footprint** is the amount of fresh water required to assimilate pollutants to meet specific water quality standards. To calculate the water footprint of a product, it is necessary to understand the way the product is produced, i.e. identify the

[125] *Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing*. Subramanian Senthilkannan Muthu (Editor). Woodhead Publishing Series in Textiles, 2015, ISBN-13: 978-0081001691
[126] Collins, M., Aumonier, S., 2002. Streamlined Life Cycle Assessment of Two Marks & Spencer plc Apparel Products. Environmental Resources Management Ltd, Oxford, UK.
[127] Assessment of polyester and viscose and comparison to cotton. Water Footprint Network Supported by C&A Foundation, March 2017.

production system. The water footprint is then quantified for each of the sequential process steps of the production system.

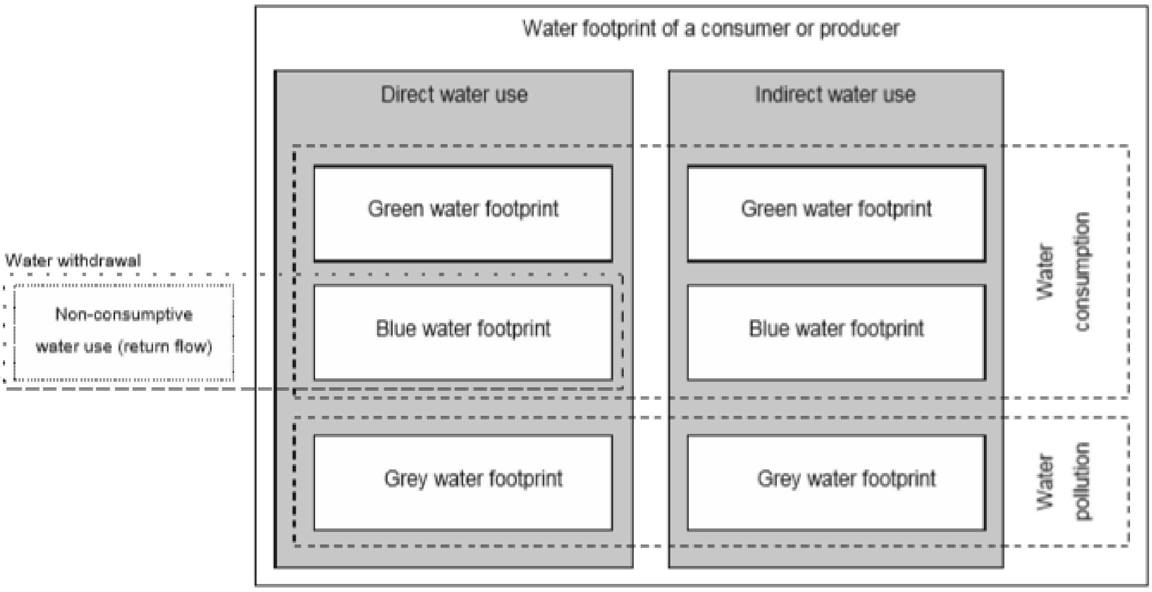

Figure 25 Schematic representation of the components of a water footprint[105]

It shows that the non-consumptive part of water withdrawals (the return flow) is not part of the water footprint. It also shows that, contrary to the measure of 'water withdrawal', the 'water footprint' includes green and grey water and the indirect water-use component.

1. It does not include blue water use insofar as this water is returned to where it came from.
2. It is not restricted to blue water use, but also includes green and grey water.
3. It is not restricted to direct water use, but also includes indirect water use.

A full water footprint assessment consists of four distinct phases:[128]

1. Setting goals and scope.
2. Water footprint accounting.
3. Water footprint sustainability assessment.
4. Water footprint response formulation.

Real case example: Assessment of polyester and viscose and comparison to cotton

Scope	#LCA #Raw materials #Water Foot Print

[128] The Water Footprint Assessment Manual. Setting the Global Standard. Arjen Y. Hoekstra, Ashok K. Chapagain, Maite M. Aldaya and Mesfin M. Mekonnen, London • Washington, DC, Copyright © Water Footprint Network 2011, ISBN: 978-1-84971-279-8 hardback

Value added	Document of reference for assessment of polyester and viscose and comparison to cotton. This study show an approach about the water footprint in the three most consumed raw materials in texile sector polyester, viscose and cotton. **Source of information: Web site of Water Footprint. Nov 2019**
More information	https://waterfootprint.org/media/downloads/WFA_Polyester_and_Viscose_2017.pdf

2.4.4 Suggested reading

- Handbook of Sustainable Textile Production (Woodhead Publishing Series in Textiles) by Marion I. Tobler-Rohr, 2011.
- Handbook of Sustainable Textile Production by Abdulkerim Macar, 2016.
- The Sustainable Fashion Handbook 1st Edition by Sandy Black, Thames & Hudson, 2013.
- EU green public procurement criteria for textiles products and services. COMMISSION STAFF WORKING DOCUMENT, SWD (2017) 231 final, Brussels, 6.6.2017
- https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1528981579179&uri=CELEX:32018L0850
- Revision of the EU Green Public Procurement (GPP) Criteria for Textile Products and Services, Nicholas Dodd, Miguel Gama Caldas (JRC), June 2017. http://ec.europa.eu/environment/gpp/pdf/criteria/textiles_gpp_technical_report.pdf
- http://sustainability-ed.org.uk/pages/example4-3.htm
- http://www.gabi-software.com/support/gabi-learning-center/gabi-learning-center/part-1-lca-and-introduction-to-gabi/
- Assessment of polyester and viscose and comparison to cotton. Water Footprint Network Supported by C&A Foundation, March 2017; https://waterfootprint.org/media/downloads/WFA_Polyester_and__Viscose_2017.pdf

2.4.5 Quiz

Self-evaluation Quiz

1. Which steps are included in the Life Cycle Assessment method (LCA)? (select the most suitable option)
    a. Goal and Scope Definition
    b. Inventory Analysis
    c. Impact Assessment
    d. Interpretation
    e. <u>All of the above</u>
2. A carbon footprint is: (select the most suitable option)
    a. the measurement of the amount of carbon dioxide gas emitted as a result, either directly or indirectly, of human activity.
    b. <u>the measurement of the amount of greenhouse gases emitted as a result, either directly or indirectly, of human activity.</u>
    c. the measurement of the amount of greenhouse gases emitted as a result of human activity.
3. Which component the water footprint includes? (select the most suitable option)
    a. Yellow water footprint
    b. Purple water footprint
    c. <u>Green water footprint</u>

Unit 2.5 Environmental legislation for the textile sector

2.5.1 Introduction

This Unit focuses on Environmental legislation for the textile sector, has explanations of directives, standards and regulations surrounding it, paying the most attention to REACH.

2.5.2 Short description

Knowledge	**Skills**	**Competencies**
At the end of this unit the in-company trainer will:	*At the end of this unit the in-company trainer will be able to:*	*At the end of this unit, the in-company trainer will have acquired the responsibility and autonomy to:*
• Knows directives, standards and regulations surrounding textile industry.	• Finds and applies the information about directives, standards and regulations surrounding textile industry.	• Understands how to use standards and how to get companied certified for REACH.

• Knows what REACH stands for and how companies can obtain it.		

2.5.3 Content unit

Topic 2.5.3.1 European and National Environmental legislation

Environmental laws in the European Union (EU) are considered to be the widest of any international organization. It addresses issues such as noise pollution, waste and water pollution, sustainable energy, quality of air, acid rain and ozone layer. There are more than 500 Directives, Regulations and Decisions under EU environmental law. One of the main tasks for EU in to improve the quality of the environment for European citizens.

In EU, more than 25% of municipal waste is still landfilled and less than 50% are recycled or composted, numbers that vary a lot between different Member States. Improving the numbers would lead to positive changes for the climate, environment, human health and the economy. Four legislative proposals have been made by European Commission to shift towards a circular economy, regarding re-use, recycling and landfilling, strengthening provisions on waste prevention and extended producer responsibility, and streamlining definitions, reporting obligations and calculation methods for targets. Final acts were signed on 30 May 2018. Directives into national law have to be transposed by 5 July 2020[129]. EU environmental regulations have a huge impact on national policy, for example[130]:

- The EU has an agreement to reduce emissions of greenhouse gases in 2020 by 20 % on 1990 levels.
- Implementing Action Plan to stimulate sustainable production and consumption in key economic sectors such as food, transport, and energy. This is a vital to make the economies of the EU Member States sustainable and resource efficient.

Waste management directive (Directive 2018/851/EU)

Waste management should be arranged in a way to conduce sustainability, environmental protection and preservation, protection of human health, rational utilization of natural resources, circular economy, and renewable energy usage, independence on imported resources, new economic opportunities and focus of product cycle in order to preserve resources.

[129]http://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI(2018)625108
[130] https://www.government.nl/topics/environment/roles-and-responsibilities-of-central-government/eu-legislation

Sustainable manufacturing and waste recycling will reduce the Union's dependence on raw materials import and facilitate transition to circular economy model, which create opportunities for local economy growth, still keeping synergies between smart and efficiency resources usage and economical benefit. The directive introduces targets for general municipal waste re-use and recycling of 55 % by 2025, 60 % by 2030 and 65 % by 2035[131].

All Member States that takes minimum requirements for extended producer responsibility shall[132]:

- Clearly define all involved parties' role and responsibilities;
- Organize waste management to attain quantitative targets relevant for extended producer responsibility scheme as laid down in this Directive, Directive 94/62/EC, Directive 2000/53/EC, Directive 2006/66/EC and Directive 2012/19/EU of the European Parliament and of the Council;
- Provide reporting system on aggregate data of products released in marked by producers who are members of extended producer responsibility scheme;
- Provide equality between producers regardless of their origins and size, also without disproportional regulations for small and medium-size producers that provides smaller quantities.

All Member States that takes measures to prevent waste generation, to at least[133]:

- Promote and support sustainability in production and consumption;
- Support resource-efficient reusable design, manufacturing and product usage;
- Target products that contain raw materials which prevent to become waste;
- Facilitate product re-usage and promoting system of products repair and further use, especially for electrical and electronic devices, textile and furniture and packaging and construction materials and products.

Regulation of textile fibre names and related labelling (Regulation EU 1007/2011)

Regulation has rules about use of textile fibre names, labelling and marking of fibre composition on textile products and rules concerning determination of the fibre composition of textile products by quantitative analysis of binary and ternary textile fibre mixtures, so only accurate information would be provided to consumers[134]. The regulation aims to make135:

- an origin labelling scheme aimed at providing consumers with accurate information on the country of origin and additional information ensuring full traceability of textile

[131] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1528981579179&uri=CELEX:32018L0851
[132] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1528981579179&uri=CELEX:32018L0851
[133] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1528981579179&uri=CELEX:32018L0851
[134]https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02011R1007-20130701
[135]https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02011R1007-20130701

products, taking into account the results of developments on potential horizontal country-of-origin rules;
- a harmonized care labelling system;
- a Union-wide uniform size labelling system for relevant textile products;
- an indication of allergenic substances;
- electronic labelling and other new technologies, and the use of language-independent symbols or codes for the identification of fibres.

Industrial emission directive (Directive 2010/75/EU)

Directive 2010/75/EU of the European Parliament and the council is on industrial emissions (integrated pollution prevention and control). It lays down rules about prevention and control of pollution coming from industrial activities. It includes emissions into air, water and land. A general framework has to be established for the control of the main industrial activities, taking into account factors, like economic situation and specific local characteristics of the place where industrial activity is happening[136].

Member States shall take the necessary measures to provide that installations are operated in accordance with the following principles[137]:

- All the appropriate preventive measures are taken against pollution;
- the best available techniques are applied;
- no significant pollution is caused;
- the generation of waste is prevented in accordance with Directive 2008/98/EC;
- where waste is generated, it is, in order of priority and in accordance with Directive 2008/98/EC, prepared for re-use, recycled, recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment;
- energy is used efficiently;
- the necessary measures are taken to prevent accidents and limit their consequences;
- the necessary measures are taken upon definitive cessation of activities to avoid any risk of pollution and return the site of operation to the satisfactory state defined in accordance with Article22.

REACH (Regulation EC 1907/2006)

REACH is an EU regulation, aiming to improve the environment and human health from the risk of chemical contamination, and at the same time improving the EU chemical industry

[136] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075
[137] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

competitiveness. It also assesses hazards related to the substances with the aim of reduce animal testing[138].

REACH stands for the Registration, Evaluation, Authorization and Restriction of Chemicals. REACH applies to all chemical substances, both those needed for industrial processes and those we use in our everyday lives, in paints, cleaning products, clothes, furniture, etc.[139]. It has been in force in all EU Member States since June 1, 2007. It also applies in Iceland, Lichtenstein and Norway[140]. In REACH, the companies bear the burden of proof, and must risk assess any substance which is manufactured in or is launched in the EU single market. A demonstration of safe use to ECHA must therefore be provided, and state the risks to the consumers. Authorities can restrict the product in several ways if it fails to comply with REACH, where the aim is to switch hazardous chemicals with compliant ones[141]. REACH Regulation include the following issues:

- **Registration** – registration is required if more than 1 ton per year of chemical substances are manufactured or imported into the EU. Requirement applies per substance and per manufacturer or importer. Registration applies to chemical substances as such, in preparations and, under certain conditions, to finished products incorporating those substances[142]. As the process is hard and pricy, the EU exempted a number of substances from the registration requirement. Those are seven:
    - Chemical substances imported into the EU or manufactured in quantities below 1 ton;
    - chemical substances used for research and development;
    - waste;
    - chemical substances whose uses are covered by other EU legislation such as medicine and food products;
    - pesticides and biocides;
    - polymers;
    - companies that had notified chemical substances under previous EU legislation (Directive 67/548/EEC).
- **Evaluation** process includes two aspects: file and substance evaluation. File evaluation puts a focus on completeness and quality of information. For substance evaluation European Chemicals Agency (ECHA) and the EU member states choose 30 chemical substances to be placed in "Community Rolling Action Plan" for further evaluation. Focus is on those chemical substances that are manufactured/imported in large

[138] https://echa.europa.eu/regulations/reach/understanding-reach
[139] https://europa.eu/youreurope/business/product-requirements/chemicals/registering-chemicals-reach/index_en.htm
[140] https://2016.export.gov/europeanunion/reachclp/index.asp
[141] https://echa.europa.eu/regulations/reach/understanding-reach
[142] https://2016.export.gov/europeanunion/reachclp/index.asp

quantities and are persistent and prone to bioaccumulation[143]. If the hazardous substances are deemed too dangerous, they may be banned. Alternatively it can be demanded further authorization[144].

- **Authorization** The authorisation process aims to ensure that substances of very high concern (SVHCs) are progressively replaced by less dangerous substances or technologies where technically and economically feasible alternatives are available[145]. The Candidate List of substances of very high concern for Authorisation are available in REACH website (https://echa.europa.eu/candidate-list-table) and the substance subject to authorization van be found in Annex XIV of REACH.
- **Restriction** allows to control the use of dangerous chemical substances that are in the common market. Chemical substances subject to restrictions can be found in REACH Annex XVII[146]. In this annex exist several restriction that are related with textile and clothing articles[147]. For instance, certain substances classified as carcinogenic, mutagenic or toxic for reproduction. The affected textile articles include[148]: clothing or related accessories, textiles other than clothing which, under normal or reasonably foreseeable conditions of use, come into contact with human skin to an extent similar to clothing, [excluding disposable textiles] and footwear

Real case example: Safety Gate for consumers: alert for dangerous non-food products from EU

Scope	REACH #Safe to wear
Value added	This website and its Safety Gate rapid alert system enables quick exchange of information between EU/EEA member states and the European Commission about dangerous non-food products posing a risk to health and safety of consumers, including textile products. In this web you can search non-compliance of textile products and recommendations to buy safety products. **Source of information: Web site of Safety Gate: the rapid alert system for dangerous non-food product. Nov 2019**
More information	https://ec.europa.eu/consumers/consumers_safety/safety_products/rapex/alerts/repository/content/pages/rapex/index_en.htm

143 https://2016.export.gov/europeanunion/reachclp/index.asp
144 https://echa.europa.eu/regulations/reach/understanding-reach
145 https://echa.europa.eu/substances-of-very-high-concern-identification-explained
146 https://2016.export.gov/europeanunion/reachclp/index.asp
147 https://echa.europa.eu/substances-restricted-under-reach
148 https://www.chemsafetypro.com/Topics/Restriction/REACH_Annex_XVII_REACH_Restriction_CMR_substances_clothing_textile.html

Topic 2.5.3.2 European environmental initiatives - examples

EU Ecolabel

EU Ecolabel was established in 1992. The functioning of the EU Ecolabel is set through the Regulation EC 66/2010. It is voluntary system and aims at promoting products and services whose environmental impact has reduced. As of March 2019, 1.575 licenses have been awarded for 72.797 of products and services available on the market[149]. Products that meet the criteria of EU Ecolabel textiles guarantee[150]:

- Limited use of substances;
- A less polluting production process;
- A durable product.

The EU Ecolabel covers a wide range of product groups, from major areas of manufacturing to tourist accommodation[151], including personal care products, cleaning, electronic equipment, furniture and bed mattresses, paper products, etc. One of those products groups is for Clothing and Textile products, being the criteria established in the Decision 2014/350/EU[152]. The criteria for awarding the EU Ecolabel to textile products, and the sub-categories under which they are grouped include: textile fibres, components and accessories, chemicals and processes, fitness for use and corporate social responsibility[153].

Green Public Procurement (GPP)

Green Public Procurement also known as GPP or green purchasing, is a voluntary instrument that helps EU to become more resource-efficient economy, by making a contribution to sustainable production and consumption. "Green Public Procurement is 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"[154].

Textile and textile product standard (CEN/TC 248)

Standard CEN/TC 248 about textiles and textile products is a standardization of different aspects of textiles, its products and components. It has information about[155]:

- Test methods;

[149] https://ec.europa.eu/environment/ecolabel/facts-and-figures.html
[150]https://ec.europa.eu/environment/ecolabel/documents/textile_factsheet.pdf
[151] https://ec.europa.eu/environment/ecolabel/products-groups-and-criteria.html
[152] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1403869165475&uri=OJ:JOL_2014_174_R_0015
[153]https://ec.europa.eu/environment/ecolabel/documents/textile_factsheet.pdf
[154] https://www.switchtogreen.eu/?p=1527
[155]https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6229&cs=1CD56AD35AEB8C1A2E7CEE2BB715CAB9F

- Terms and definitions;
- Specifications;
- Classifications;
- Equipment relevant for testing and use of textiles.

2.5.4 Suggested reading

- Jordan, A.J. and C. Adelle (ed.) (2012) Environmental Policy in the European Union: Contexts, Actors and Policy Dynamics. Earthscan: London and Sterling, VA.
- An outline of the European Union Strategy for Sustainable Development, proposed in Helsinki in 1999 can be found in European Commission (2001): A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development
- .https://europa.eu/youreurope/business/product-requirements/chemicals/registering-chemicals-reach/index_en.htm
- https://eur-lex.europa.eu/eli/reg/2006/1907/2014-04-10
- https://www.chem-map.com/chemical_news/new-chemical-restrictions-in-textiles-are-you-ready/
- https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1528981579179&uri=CELEX:32018L085
- https://2016.export.gov/europeanunion/reachclp/index.asp
- https://www.gov.uk/guidance/how-to-comply-with-reach-chemical-regulations
- https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075
- https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010R0066
- https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0400:FIN:EN:PDF

2.5.5 Quiz

Self-evaluation Quiz

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1. What does REACH stand for? (select the most suitable option)
   a. Research, Authorisation and Restriction of Chemical Substances
   b. Research and Authorisation of Chemical Substances

   c. Registration, Evaluation, Authorisation and Restriction of Mixtures
   d. Registration, Authorisation and Restriction of Chemicals

2. What is the minimum chemical quantity to the registration for REACH be mandatory? (select the most suitable option)
   a. if more than 1 ton per year of chemical substances are manufactured or imported into the EU
   b. if more than 10 tons per year of chemical substances are manufactured or imported into the EU
   c. if more than 100 tons per year of chemical substances are manufactured or imported into the EU

3. What does GPP stand for? (select the most suitable option)
   a. Green Public Product
   b. Green Public Procurement
   c. Green Public Plan
   d. General Public Plan

4. Products that meet the criteria of EU Ecolabel textiles guarantee: (select the most suitable option)
   a. A durable product
   b. Limited use of substances
   c. A less polluting production process
   d. All of the above

5. Industrial emission directive aims at: (select the most suitable option)
   a. prevention and control of pollution coming from industrial activities
   b. promoting products and services whose environmental impact has reduced
   c. making a contribution to sustainable production and consumption

6. Textile and textile product standard (CEN/TC 248) has information about textile and textile product: (select the most suitable option)
   a. Test methods;
   b. Terms and definitions;
   c. Specifications;
   d. Classifications;
   e. All of the above