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**DEVELOPMENT OF GLOBAL ASSESSMENT PROCEDURES FOR ENVIRONMENTAL ASPECTS AND IMPACTS**

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## **ABSTRACT**

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### **Development of global assessment procedures for environmental aspects and impacts**

Master's thesis

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157 pages, 17 figures, 3 tables, 2 appendices

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Environmental awareness has arisen globally and most leading companies have an environmental management system to manage environmental issues such as environmental aspects and impacts. This thesis based on global Management System's creation and has a foundation in the ISO 14001 standard. The aim is to develop a common global process that facilitates effectively aspect and impact assessment. It will comply with the ISO 14001 standard requirements and other international standards, requirements and agreements. There have been created assessment systems for the own operations, technologies and products as well as supply chains.

There are utilized nine of the ISO 14001 standard defined aspect categories in assessment of own operations. For technologies, products and services, general information about an assessment process has been collected. Ensuring efficient and sustainable technologies and products is a key business driver and focus for continuous research and development. The customers' using habits greatly affect the actual environmental impact of the products and services. Major global companies will focus on ensuring the ongoing sustainability management of the supply chain, due to the fact that there are common concerns about air quality, water scarcity and climate change through the supply chains and their impacts. The greatest problems are nearby the Equator.

The environmental aspect and impact assessment system needs clear steps to the goal and periodically reassessment ensuring that results of assessments are consistent and updated. Evaluation should be updated especially if the operation has changed or circumstances are different. It is necessary to consider that the environmental impact could be beneficial and adverse and the same aspect can have many impacts.

# TIIVISTELMÄ

Lappeenrannan teknillinen yliopisto  
LUT School of Energy  
Ympäristötekniikan koulutusohjelma

Eveliina Hakanpää

## **Gloaalien ympäristönäkökulmien ja -vaikutusten arviointitapojen kehittäminen**

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Ympäristötietoisuus on globaalisti lisääntynyt merkittävästi ja useat johtavat yritykset ovat ottaneet käyttöönsä ympäristöjohtamisjärjestelmiä ympäristöasioidensa, kuten ympäristönäkökulmien ja -vaikutusten hallitsemiseksi. Tämä diplomityö perustuu globaalien ympäristöjohtamisjärjestelmän luomiseen pohjautuen ISO 14001 -standardiin. Tavoitteena on kehittää yleinen ympäristönäkökulmien ja -vaikutusten arviointiprosessi, joka helpottaa ja yhtenäistää vaikutusten arviointia yrityksessä. Arviointityökalu pohjautuu ISO 14001 -standardin asettamiin vaatimuksiin sekä muihin kansainvälisiin standardeihin, määräyksiin ja sopimuksiin. Ympäristöarviointijärjestelmä on luotu globaalien yritysten omien toimintojen, teknologioiden ja tuotteiden sekä toimitusketjujen arviointiin.

Omien toimintojen arvioinnissa on hyödynnetty ISO 14001 -standardin määrittelemiä kategoriaita näkökulmien arvioimiseksi. Teknologioita, tuotteita ja palveluita varten on kerätty yleistä tietoa arviointiprosessin vaatimuksista. Tehokkaiden ja ympäristöllisesti kestävien teknologioiden ja tuotteiden varmistamiseksi yritykset ovat keskittyneet jatkuvaan tutkimukseen ja kehitykseen. Asiakkaiden käyttötavat vaikuttavat merkittävästi todellisiin tuotteiden ja palveluiden ympäristövaikutuksiin. Suurimmat globaalit yritykset ovat keskittyneet varmistamaan toimitusketjujensa jatkuvan kestävyuden hallinnan, koska yleisesti toimitusketjuihin ja vaikutuksiin liittyy huoli ilman laadusta, veden niukkuudesta ja ilmastonmuutoksesta. Merkittävimmät ongelmat sijoittuvat päiväntasaajan ympäristöön.

Ympäristönäkökulmien ja -vaikutusten arviointijärjestelmälle on asetettava selkeät tavoitteet ja tavoitteiden saavuttamiseksi uudelleenarvioitava toimintoja määrääjain sekä tarvittaessa päivitettävä. Uudelleenarviointia vaaditaan erityisesti, jos toiminto tai olosuhteet ovat muuttuneet. Arvioinnissa on hyvä ottaa huomioon, että ympäristövaikutukset voivat olla joko hyödyllisiä tai haitallisia. Yksi ympäristönäkökulma voi myös aiheuttaa useita ympäristövaikutuksia.

## FOREWORDS

Global companies try to balance with sustainable development and lower their costs. By achieving a relevant working habit and enterprise culture they can easily comply with principles of continuous and sustainable development. Competition is tough in the markets, and thus companies should have clear targets and action plans. This Master's thesis is a part of a global Environmental Management System's creation project in one global leading reference company.

This project has been an interesting and rewarding process which has developed my skills and knowledge about environmental aspects and impacts in global companies. It also gave me overview about different cultures and experience of working in a global work community. This project has been a productive ending to my studies.

Thank you to the whole team that has taken part in this project, especially to my supervisors. I would like to thank Professor Lassi Linnanen and Associate Professor Mirja Mikkilä who supported me through the whole process and gave me sophisticated tips for completing this project. Thank you also for my colleagues. You guided me to a world of global company's complicated businesses and encouraged me through this process. Special thanks to Tim Whale. You have been irreplaceable in this project. "Patience is a virtue" as you said and it is true.

This project has been a long journey which consists of happiness but also reversals. I have finished my thesis and degree with my family's, relatives' and friends' support. During the last years I have learnt that: "do not only try your best, do your best." Thanks to my boyfriend, you have spurred me to always achieve my best and supported me during my studies at university. Special thanks also to my parents who have always encouraged me forward both in my studies and through my life. This project will be a bridge to working life after 18 years of studies.

*"Education is not the learning of facts, but the training of the mind to think." Albert Einstein*

Rauma, 27.10.2017

Eveliina Hakanpää

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for certified location by the ISO 14001 standard

Appendix 2: Example of environmental aspect and impact assessment template  
for supply chains

## **LIST OF ABBREVIATIONS**

### **Abbreviations**

ATEX	The Explosive Atmospheres Directive (2014/34/EU)
BAT	Best available techniques
BOD	Biological oxygen demand
BREF	Best available techniques reference document
CDP	The Carbon Disclosure Project
CHP	Combined Heat and Power
COD	Chemical oxygen demand
EED	The Energy Efficiency Directive (2012/27/EU)
EIB	The European Investment Bank
ELV	End of life vehicles, The ELV Directive (2000/75/EC)
EMEA	Europe, Russia, Middle East, Africa area
EPR	Extended producer responsibility
GHG	Greenhouse gas
GRI	Global Reporting Initiative
HSE	Health, safety and environment
IED	The Industrial Emissions Directive (2010/75/EU)
ILO	International Labour Organization
IPPC	The European Integrated Pollution Prevention and Control
ISO	International Organization for Standardization
ISO 14001	Environmental management system standard
ISO 9001	Quality management systems – Requirements standard
KPI	Key Performance Indicator
LCA	Life cycle assessment
LCI	Life cycle inventory
LCIA	Life cycle impact assessment
NGO	Non-governmental organization
OECD	The Organization for Economic Co-operation and Development
OHSAS 18001	Occupational health and safety management systems standard
PM	Particulate Matter

REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals (N:o 1907/2006)
R&D	Research and development
RoHS	Restriction of Hazardous Substances (2011/65/EU)
TSS	Total suspended solids
UN	The United Nations
UNEP	The United Nations Environment Programme
WEEE	Waste Electrical and Electronic Equipment (2012/19/EU)

### **Chemical formulas and elements**

AOX	Absorbable organic halides
CFC	Chlorine-fluorine-carbon
CH <sub>4</sub>	Methane
CO	Carbon oxide
CO <sub>2</sub>	Carbon dioxide
HCl	Hydrochloric acid
HFC	Hydrofluorocarbons
N	Nitrogen
N <sub>2</sub> O	Nitrous oxide
P	Phosphorus
PAH	Polycyclic aromatic hydrocarbon
PFC	Perfluorocarbons
pH	Potential of hydrogen
PHC	Petroleum hydrocarbons
SF <sub>6</sub>	Sulfur hexafluoride
SO <sub>2</sub>	Sulfur dioxide
VOC	Volatile organic compounds

### **Units**

CO <sub>2, eq.</sub>	Carbon dioxide equivalent
MWh	Megawatt hour
m <sup>3</sup>	Cubic meter
mg	Milligram
TJ	Terajoule

## **1 INTRODUCTION**

Most leading companies have an environmental management system to manage environmental issues such as environmental aspects and impacts, as well as operations that cause environmental issues. A good level of environmental awareness assists companies in addressing environmental issues. The aim of this master's thesis project is to develop and design global implementation procedures which support environmental aspect identification and an impact assessment in global companies.

Most companies have separated own reporting systems that include monitored information about their environmental issues. In addition, most of them have an environment permit with strict reporting requirements. Nevertheless, there is a strong requirement for a common process that facilitates effective impact evaluation which will support the global management system of global companies. As well as there is a need for continuous improvement of the environmental performance of companies' processes. The operation of the evaluation system has to be acceptably simple to all employees ensuring global use.

### **1.1 Background of the study**

Commonly, global companies want to standardize their management system and follow international standards, such as the Environmental Management System of the International Organization for Standardization and certify ISO 14001 within their operations. There will be a need for a global management system that will generally assist global companies to manage their environmental issues. The aim of the global management creation process is to implement a systematic way of global working across the organization and certify it under one certificate in a company. The scope of one global environmental management issue tool is that ISO 14001 standard will incorporate all operations whilst maintaining full certification of global companies. (Manager of Global Management system 2016). The environmental management issue tool will cover the companies' all parts of organizations and business areas.

The outcome of this project will be a common management system to enable a specific way of working in the companies (Manager of Global Management system 2016). This thesis will also give common view of technologies' and products' environmental impacts and effects of the entire value chain to the environment. There will be a need to understand which

are global effects of the technologies and products, but also supply chains to the environment.

## **1.2 Scope of the study**

This study examines global companies' own operations, such as offices and workshops with the aid of common assessment procedures and documentation systems. It also includes technologies and products, environmental impacts, as well as environmental issues of global supply chains. The examination outcome will be a general summary of environmental aspects and impacts in global companies. They cause environmental impacts across the whole value chain. In many cases, the major part of impacts center on usage of products when considering environmental impacts of the entire life cycle of the processes. Global companies also have long supply chains which consist of a number of suppliers all around the world. Own operations impacts will be the smallest part of all the companies' environmental impact across the value chain. If companies concentrate on their own operations and try to understand their impacts, they will also aid in the continuous improvement process in the entire value chain.

This study will consider global companies and their separated business fields all around the world containing their different geographical and environmental aspects. These areas will have separate legislations and regulations. Geographical and environmental differences of areas define what kind of local circumstances cause significant environmental impacts, therefore the same environmental aspect could have a different effect and impacts will vary across the world. The environmental impact is caused by companies' operations that could be led from an operating model such as object washing. There will occur adverse or beneficial aspects by operations. Generally, companies have influence within some of their environmental aspects, and therefore they can transform or develop these aspects. There are also aspects with features where companies only have to accept them, due to the fact that companies cannot affect them. Often the aspects that are impossible for companies to enhance are caused by partners. There will exist a possibility to negotiate on adverse aspects with partners and try to change circumstances. An extreme way to improve any such circumstances is to change the partner. (Verbanac 2016.) Emissions to air, effluent discharges, waste, and energy usage are typical environmental aspects that are reported by companies at present.

Most companies comply with the ISO 14001 standard hence this study will take into account conformity requirements of this standard. There are a few other standards in this standard family that will conduct the development of environmental aspects and impacts evaluation system. Standards of life cycle assessment are necessary in some cases when there are defining processes. There are also international agreements that should be taken into account by developing environmental assessment procedures. Best available techniques (BAT) and best available techniques reference documents (BREF) will create preconditions for processes when process development is designed. They support the continual improvement process in production.

### **1.3 Aims of the study**

The aim of the entire study is to develop global common procedures to assess environmental issues in global companies. The main focus is their own operations identifying environmental risks that can lead to environmental impacts. Existing operation data will be collected to the evaluation system that is achievable to use globally. Fragmentary information of products and their life cycles will be collected to the same assessment system for an estimation of environmental impacts. The supply chain data will also be noticed in the eventual system.

System development needs environmental aspect identification and understanding about environmental risks. The main aim is to achieve an outlook of own operations, which enable the development of mitigation procedures for adverse environment issues. Effective internal communications are needed that can support environmental targets in companies. Open communication about environmental issues helps with operation improvements. It is needed to understand the working of operations before the entire evaluation and improvement process. This requires a description of operations. The aim is to develop a simple and user friendly system for evaluation. Evaluation of environmental aspects and impacts are easier when groups are created for the same type of processes, such as production, foundry, services and office operations. It is necessary to confect a global overview about processes and local differences between separate companies. Local specific circumstances such as regulations or geographical differences define environmental impact mitigation procedures. These aspects will be taken into account when there exist designed follow-up actions for environmental impacts.

There are many environmental aspects that could be mentioned, but the target is to find globally the most important aspects. It will enable the proposal of the most important environmental aspects, in specific organizations, after the evaluation process. An operation field of this study is complicated, but the evaluation process and results should be simple. There should be considered what kinds of issues are important and what are unnecessary for the impact assessment system. A clear definition makes the assessment process easier and helps processing in a real operational environment.

The workable assessment system requires implementation before its continuous use. One aim of the study is to create an implementation manual for companies. This manual will help the companies to follow up their environmental aspects and evaluate their impacts and assists in reporting about them. The outcome will be an ideal evaluation system for environmental aspects and impacts in this study. The potential time to implement such an ideal model will be after a number of years, but it will seem the most effective alternative for the future. The model should contain parts that are suitable to introduce for current time. This assessment procedure needs explicit guidelines where results will be relevant and comparable. In addition, there will be a literary summary of environmental impacts per potential technologies and supply chains.

The evaluation system of impact assessment has to be planned. Therefore it will be kept with LEAN procedures. The aim of LEAN is to engage people to create more value with their job and improve their way to work. In environmental assessment, LEAN procedures secure that the information about environmental issues are important and relevant, the evaluation system is user-friendly without any special skills usage requirement in the system. In addition, there cannot be any wasted reporting time using this system which improves quality of operations. All in all, this evaluation system will support continual improvement procedures according to LEAN aims.

Therefore, this study will answer the following questions:

- What are the most remarkable environmental aspects in different processes?
- What kind of environmental impacts are caused by environmental aspects?
- How are environmental impacts defined in the assessment process?
- What are the main elements of environmental impact assessment?
- How is it possible to improve environmental issues in companies' own operations?

- What kind of requirements does the ISO 14001 standard create for impact assessment?

#### **1.4 Research method**

This study will be founded on research-based and practice-based materials. Research-based on qualitative and quantitative methods aiming to the logical argumentation and objectivity. Quantitative analysis will be determined as search of statistical regularity. It provides results, but it does not provide an explanation why results are as they are. (Alasuutari 1999, 38.) Quantitative analysis based on entire research data. All reliable data will be clarified in a way that the data will not contradict the presented interpretation. In qualitative research there are too many research units, hence data should be simplified and analyze results. (Alasuutari 1999, 39, 44.) Qualitative analysis demand that observations should be simplify before problem solving and results. There is a selected overview for the data and the analysis will be executed across relevant information. In the same analysis, research data will be analyzed within different overviews. Data will be simplified also by combining observations together. In that way is easy to find common characteristic for all observations. The results of qualitative analysis will be find by combining relevant observations that will answer the research problem. (Alasuutari 1999, 40.)

The results will be analyzed in different way depending on analysis method: is there used qualitative or quantitative method. In qualitative analysis there will not be any exceptions that will deviate from a determined research rule. In quantitative analysis based on empirical generalization and it will consists of exceptions. (Alasuutari 1999, 52.) The quantitative analysis needs fact overview due to the fact that it based on subjective answers. Despite on that the assessment has specific guidelines there will be as many interpretations as respondents. Hence a source criticism is essential part of analysis. There should be solved how reliable information are. (Alasuutari 1999, 95.)

In this study, there will be utilized reference material from global companies as well as from scientific research. In many cases, existing systems are a basis for the development process of a common environmental assessment procedure. It is necessary to establish issues that should be developed. A practical overview for the study is to explore reference studies such as other master's theses and scientific issues.

The research-based part of this thesis will be founded on environmental standards such as ISO 14001 and published research materials concerning environmental management systems and environmental impact assessment procedures. There will be also a need for general life cycle assessment after the environmental evaluation process. This will be executed following base requirements of the life cycle assessment standard. In addition, there will be used other international standards, scientific articles, reports and other publications in this study.

The research-based part of this thesis will be founded on environmental standards such as ISO 14001 and published research materials concerning environmental management systems and environmental impact assessment procedures. There will be also a need for general life cycle assessment after the environmental evaluation process. This will be executed following base requirements of the life cycle assessment standard. In addition, other International Standards, scientific articles, reports and other publications will be used in this study.

The aim of the study is to develop a global assessment system for environmental aspect and impacts. This system will be created for instance in Excel or another universal program that is simple for all employees. Impact evaluation system creation will need a flow chart or other basic analysis model for the basis of the assessment. The environmental aspect significance will be estimated with the aid of a risk matrix. It might still be required to compare different aspects and impacts with characteristic indicators, hence this will require conversion into comparable data. The evaluation of the supply chain will provide a base report for more specific systems to identify the most significant environmental aspects and impacts of companies supply chains in the future.

Regardless, this study will not require only an understanding of the principles of the ISO 14001 standard or other standards and management systems, but it also demands conception of local operating environments, environmental regulations and requirements of customers and other interest groups. This study will combine various operating models and habits in global companies as well as the demands of regulations and legislations. The simple procedure for environmental aspects and impacts must conform for a global complicated operational environment.

## 2 ENVIRONMENTAL ASPECTS AND IMPACTS

Environmental aspects and environmental impacts have a close relationship. Both are based on an activity or a service of a company. The environmental aspect that leads to the environmental impact is a significant part of that activity or service of an organization and has a near relation with the environment. The impact will be a positive or negative environment change and normally that is caused by the environmental aspect. (Verbanac 2016.) The relationship between environmental aspects and environmental impacts is one of cause and effect. (Stojanovic 2016.) Figure 1 below shows the flow between cause and effect.



**Figure 1.** Relationship between environmental aspects and impacts (Verbanac 2016).

### 2.1 Environmental aspects

The International Organization for Standardization defines, in standard ISO 14001, that environmental aspect is a part of activities, products or services of a company. This element interacts or can interact with the environment. (ISO 14001: 2015, 51.) Environmental aspects are points of view to an environment that are caused by activity, service or products. Activity can be defined to be a part of the core business of a company. It could mean the production process steps of a main product. Generally, service means an auxiliary service that supports core activities in the company. Concept of product means merchandise that the company offers for market. (Verbanac 2016.) Environmental aspects could include both direct aspects that arise from activities, products and services of a company and indirect aspects that can be affected by the activities of suppliers of a company and contractors that work on activities of a company. These indirect aspects can occur also from customer use of a product. (EPD 2017.) Aspects are considered as air, water and soil, but are also considered as from other sides. Emissions to air contain for instance smoke, dust, odors and fumes. Releases to water can be waste water discharges to water streams or soil. Contaminated water might contain chemicals or other hazardous ingredients that would contaminate a water system or the soil. Discharges to soil might be caused by chemical, waste or other spills, but also through land use. Waste discharges to soil are environmental aspects that have the potential to cause contamination to soil. Usually, contamination is caused by the generation of waste and/or by-

products. Use of raw materials, energy and natural resources are also environmental aspects, because all of them have a production process behind of them. In addition, energy emitted, heat, noise generations and vibration, as well as radiation and light are determined as environmental aspects. (ISO 14001 Requirements 2012.) Use of space is also thought to include a part of environmental aspects.

## **2.2 Environmental impacts**

Environmental impacts are defined as impact change to the environment according to the standard ISO 14001 of the International Organization for Standardization. The change could be harmful or positive for the environment and result in a benefit or adverse impact to the environment. An impact is caused entirely or partly from environmental aspects of a company. (ISO 14001: 2015, 51.)

Environmental impacts are direct results from environmental aspects. Emissions to air cause air pollution, releases to water cause water pollution while releases to soil cause soil pollution. Use of natural resources effect on the possibility to utilize them later, hence sustainable usage and benefit impacts demand responsible use. Also, noise pollution and global warming are environmental impacts. Ozone depletion is an environmental impact that has a close connection to global warming and climate change. (ISO 14001 Requirements 2012.) Environmental impacts are effects that need examination and improvement actions within a company.

## **2.3 The difference between environmental aspects and impacts and other impacts of business**

The most significant difference between environmental aspects and impacts is their relation between cause and effect. An environmental aspect may cause many environmental impacts. Typically, environmental aspects express type, size or frequency of activity. Instead of environmental impacts which are for instance scale, severity or duration exposure of activity. Relationship of aspects and impacts is possible to describe as cause and effect. Environmental aspects are causes and environmental impacts are effects. The impacts of aspects are significant, because one cause of aspect could have one or several effects that have an influence on the environment.

An entrepreneurship has a lot of background actions that do not relate to the core business. Every company works between three main pillars: economy, environment and society in a

business field. Sustainable development is a theme that is put together with all three aspects and considers impacts not only on the environment but also health and safety. Global responsible companies invest in corporate citizenship. They aim for transparent communication forward in the entire value chain and comply with laws and regulation. Responsible companies take into account not only the natural environment, but also the operational environment. There can be rules for sustainable business practices, which demand all employees in the organizations work with same responsible conditions.

The companies will have many policies that are not directly environmental protection policies, but support sustainable operations and the democratic treatment of all around the world. There will be an anti-bribery policy; health, safety and environment policy; sustainable chain policy and human rights statement in the companies. In addition, there will be also non-governmental, humanitarian organizations that work at local level. These organizations are working with youth activities, environmental protection, research and education. Through support, the companies can be responsible for society, improving education and knowledge and mitigate the impacts that result from unawareness.

The international standards, such as the ISO 9001, ISO 14001 and OHSAS 18001, aim to mitigate impacts of business. The ISO 9001 quality management system is the foundation for sustainable business practices and other ways of working principles. The OHSAS 18001 health and safety management system and the ISO 14001 environmental management system standard aim to this mitigate impacts to the health, safety and environment. These three standards are main categories in business fields that cause most of impacts of the businesses. There are also other standards that mitigate other impacts of the business and improve circumstances in this way. There are a lot of international principles and guidelines that the global companies will be committed to comply with. Due to the fact that processes are multicultural and operate in a global environment, most of the principles are set by the United Nations (UN). It has ten principles that are separated into four categories: *Human rights, labor, environment* and *anti-corruption*. Since companies have a major influence globally, there are many targets that companies have the possibility to improve upon. The ten principles of the UN Global Compact are:

- Human Rights

Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights

Principle 2: Make sure that they are not complicit in human rights abuses. (UN Global Compact 2017 a.)

- Labor

*Principle 3:* Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining

*Principle 4:* The elimination of all forms of forced and compulsory labor

*Principle 5:* The effective abolition of child labor

*Principle 6:* The elimination of discrimination in respect of employment and occupation. (UN Global Compact 2017 a.)

- Environment

*Principle 7:* Businesses should support a precautionary approach to environmental challenges

- This principle sets the requirements for systematic application of risk assessment, risk management and risk communication.
- This based on the Principle of the 1992 Rio Declaration that states guidelines for serious or irreversible damages and lack of full scientific certainty. In such cases, it shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.
- This principle requires also a decision on the acceptable level of risks. This should involve scientific-technological evaluation, economic cost-benefit analysis and political considerations such as acceptability to the public. All these topics take into account impacts that are widely caused by business. (UN Global Compact 2017 b.)

*Principle 8:* Undertake initiatives to promote greater environmental responsibility

- This principle defines the role of business and industry in the sustainable development agenda.

- There are requirements that business and industry should increase self-regulation, transparency and communication with employees and the public, as well as guide instructions for the way of working.
- There is a demand that business has the responsibility to ensure that activities within their own operations do not cause harm to the environment. (UN Global Compact 2017 c.)

*Principle 9:* Encourage the development and diffusion of environmentally friendly technologies

- This principle demands that environmental technologies should protect the environment. They should also pollute the environment less, use all resources more sustainably, recycle more of the waste and products and handle residual waste in an acceptable way, compared to previous technologies.
- This considers cleaner production processes and pollution technologies, as well as end-of-pipe and monitoring technologies that mitigate environmental impacts. (UN Global Compact 2017 d.)
- This principle is also the foundation for utilizing *best available techniques* (BAT) files. These are described in more detail, later in this thesis.

- Anti-Corruption

*Principle 10:* Businesses should work against corruption in all its forms, including extortion and bribery. (UN Global Compact 2017 a.)

The United Nations (UN) has also set Sustainable Development Goals in 17 categories. Collected in these goals are, for example, the most significant environmental impact categories. Climate change is seen as one of the most international effects of environmental impacts. Everyone suffers from effects of climate change, thus the need for real mitigating actions. Some of these are themes that apply straight to global companies and some of them have only an indirect relationship. The principles of Sustainable Development Goals are separated to 17 categories are:

- 1) No poverty
- 2) Zero hunger

- 3) Good health and well-being
- 4) Quality education
- 5) Gender equality
- 6) Clean water and sanitation
- 7) Affordable and clean energy
- 8) Decent work and economic growth
- 9) Industry, innovation and infrastructure
- 10) Reduced inequalities
- 11) Sustainable cities and communities
- 12) Responsible consumption and production
- 13) Climate action
- 14) Life below water
- 15) Life on land
- 16) Peace, justice and strong institution
- 17) Partnership for the goals

Each category in the list has targets that aim to achieve a more sustainable world. There are many countries that accepted these UN's targets around the world on September 25<sup>th</sup> 2015. The aim is to end poverty, protect the planet and ensure prosperity for all. These goals will be achieved over the next 15 years. Companies around the world have own part to play in the new sustainable development agenda. Without companies, it is more difficult to achieve these targets, because these goals are possible to be reached by governments, the private sector and civil society. (UN 2017 a.)

When thinking about, for example typical impacts of heavy production operations, it creates impacts relating to air, water and soil and the use of raw materials, energy and space. The UN's targets have the same themes in their goals. There are many categories among these 17 goals that are near to the global engineering businesses. In the major picture, all these goals are significant, but a few of them have specific information for developing companies' operations. The UN's targets are set for 2020 and 2030. Some of them need more effort to execute, but some are already considered and some requirements are already met by the companies.

Water is one of the common used resources in every company. The United Nations have target 6 for water scarcity, poor water quality and inadequate sanitation, because these have

negative impacts on food security, livelihood and educational opportunities for poor families across the world. The aims are access to safe and affordable drinking water for all. Improvement of water quality by reducing pollution is made possible by decreasing hazardous chemical and material releases and minimizing the amount of untreated wastewater. Also, increasing water recycling and safe reuse improves water quality. Use of fresh water is not the self-evident truth across the world, therefore there is a need to increase water-use efficiency by developing more efficient products and production processes. Water-use means integrated water resources management at all levels. There exists a need for transboundary cooperation that protects and restores water-related ecosystems. Water-use in industry effects to mountains, forests, wetlands, rivers, aquifers and lakes, therefore co-operation with separate parties is necessary. Companies have a good chance to expand international co-operation, to support countries water and sanitation-related activities for example water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies. (UN 2017 b.)

Energy use is one of the most significant parts of production operations during the whole life cycle. As the United Nations defines in sustainable development goals, energy is a major part of every huge challenge and opportunity in the world such as jobs, security, climate change, and food production. The UN's goal number 7 is access to modern energy services, improve energy efficiency and increase the use of renewable energy sources. Companies can approve affordable, reliable and modern energy services and increase the share of renewable energy in the global energy mix through its own actions. The UN set a target to double the global rate of improvement in energy efficiency. Companies can take part in this target through performing, for instance improvements on machines and buildings. The UN's targets will be considered also in investments. Companies can enhance clean energy research and technology in their projects. This means investment supports renewable energy, energy efficiency, advanced and cleaner fossil-fuel technology. Supplying modern and sustainable energy services for all in developing countries enables the decreasing of impacts of energy and supporting environmental protection. (UN 2017 c.)

Business is not business without infrastructure. Transportation, energy and information and communication technology are important parts of business. Investments in infrastructure are preconditions for growth in productivity, incomes, improvements in health, and education outcomes. Technological solutions can protect the environment from industrialization. They

can also decrease the impact on the environment through increasing resource and energy-efficiency. It is a circle where every part involved needs to play its part so that improvements can occur in industry: without technology and innovation, industrialization will not happen and without industrialization development will not happen. Target 9 for industrialization is to promote sustainable industrialization and increase the access of small-scale industrial and other enterprises, especially in developing countries. Companies can upgrade infrastructure and processes making them sustainable at their mill sites. They can increase resource-use efficiency and enhance clean and environmental friendly technologies and processes. According to the UN's targets, scientific research and upgraded technology capabilities will be increased in the industrial sector by 2030. The aim is also to support domestic technology development, research and innovation in developing countries. (UN 2017 d.)

Sustainability is one important outlook for resource consumption and production in industry business fields. The sustainability way of thinking supports resource and energy efficiency and sustainable infrastructure. These also encourage quality of life for all in the major picture. Sustainable consumption and production have links also to environmental and social costs and economic competitiveness. The main idea of sustainable consumption and production is "doing more and better with less". This means reduced resources using, degradation and pollution during the whole life cycle. In order to achieve the tasks set by the United Nations, it is necessary to include awareness, education on sustainable consumption, lifestyles and information through standards and labels. Target 12 set by the UN is possible to take into account in many ways. One way is to achieve sustainable management and efficient use of natural resources. The aim by 2020 is to achieve management of chemicals and all waste, throughout their life cycle, and further reduce causes to air, water and soil. Emission minimizing reduces negative impacts on the environment and also on human health. Waste comes also under scrutiny. The aim is to reduce significantly waste generation by reduction, recycling and reusing. The United Nations want to encourage global companies to adopt sustainable practices. They have a good possibility to influence, for instance, a way of working, such as in public procurement practices. Global companies, especially those that are operating in developing countries, have also the chance to support those countries to strength their scientific and technological capacity. This support helps countries to move towards more sustainable ways in consumption and production. One of the UN's main targets is to reduce the use of fossil fuels and their subsidies, because they encourage wasteful consumption and cause a lot of impacts on the environment and human health. (UN 2017 e.)

Climate change is a huge scourge for human beings nowadays. It affects every country and continent. Its effects are possible to see in many issues from national economies to the life of people. These effects are deepened all the time and are visible by changing weather patterns, rising sea level and more extreme weather events. Human activities that cause greenhouse gas emissions drive these changes. It is disquieting that the emissions of carbon dioxide are at the highest levels in history and the world's average surface temperature is rising. The poorest and most vulnerable people are suffering these changes the most. Major industry affects the emissions to a great degree. Hence, especially global companies have a chance to effect on these aspects, for example by reducing energy consumption and turning to renewable energy. Due to climate change a global challenge exists which requires international solutions. Consequently, there is the Paris Agreement that has been adopted by all countries party to the agreement. They have agreed to work towards limiting the global temperature but also in achieving Sustainable Development Goals. In addition, these countries will reduce emissions and build climate resilience through a roadmap for climate actions as was said in UN target 13. (UN 2017 f.)

Companies will comply with other principles of the United Nations defined below, that mitigate the effects of business on the environment and also on society and economy. These international principles and guidelines will be the United Nations Universal Declaration of Human Rights, the United Nations Guiding Principles on Business and Human Rights, the Declaration on Fundamental Principles and Rights at Work of the International Labour Organization (ILO), as well as the OECD's Guidelines for Multinational Enterprises.

## **2.4 Principles of environmental aspect identification and impact assessment**

An important point of environmental aspect identification is that the identification supports the environmental management system. Aspect identification leads to evaluation of environmental aspects that will affect aims, operational controls and other elements of the environmental management system. An organization has a lot of issues that will cause environmental aspects such as activities, products and services. An environmental aspect will turn up in any time of a life cycle of any activity, product or service. An example of such a phase that will affect the environment can for instance be in purchasing or disposal. (Strojanovic 2016.)

A main principle of environmental aspect evaluation is to understand environmental aspects at first by organization. After this an organization can identify these aspects that have or can have a significant impact on the environment. The environmental aspect determining process has several factors that must be considered. These factors set the significance of the aspects, such as condition of the environment, information about proper legal requirements and other. Expectations of interested parties are also meaningful. The identification of significant environmental aspects helps control of them and enables continual improvements of environmental aspects. Evaluation of aspect significance is not separated from actions of the organization. This includes criteria that help an organization in the use of technical analysis and judgment application. The same evaluation system is usable in the impact identifying process. (Strojanovic 2016.)

There are some criteria that should be considered when the significance criteria of aspects and impacts are determined. These criteria could be related either to aspects or impacts. The first criterion considers environmental protection. It identifies type, size and frequency of environmental aspects and defines scale, severity and duration of impacts. The second criterion considers legal and other requirements such as limitation of emissions, every license for emissions and all kinds of requirements. There will also be more of the same kind of criteria such as requirements of emission training. The third criterion relates to needs and expectations of interested parties that identify the values of the organization and reputation. These interested parties also evaluate noise, smell and visual degradations that are caused by the organization. Successful evaluation needs clear steps to the goal. Individual assessments are the first step to go forward. The next is the requirement to have discussions about arguments and make a joint assessment with people that have different expertise. These people can help to acquire the correct results for the evaluation and implementation processes regarding aspects and impacts. The aim is to achieve continuous success. The process needs as many relevant people as possible. They will conduct reassessment periodically and ensure that results of assessments are consistent and updated. It is notable to remember that the evaluation must be updated. Hence, if there is some case of changes in an operation, it becomes necessary to reassess that operation. (Strojanovic 2016.)

As, in this study, it is fact that it is impossible to create an evaluation system for environmental aspects and impacts that are irreproachable the first time. It is needed to develop the system and update it many times during its lifetime. This is why there exists a requirement

for periodic reassessments to be conducted. These will help to incorporate new information and knowledge to update the list of significant environmental aspects. These processes also help to focus on the issues that are important.

#### **2.4.1 Environmental aspect identification**

There are many guidelines on how to identify environmental aspects. Generally, there are steps that follow directions of the standard ISO 14001. A successful evaluation process needs a person with the responsibility to attend this developing process. The organization should concentrate on examining the entire life cycle and identifying environmental aspects. This does not mean that it should be turned into a detailed life cycle assessment. The core of the assessment is to find phases of the life cycle that can be controlled or influenced by the organization. It does not already define which phases are the most significant parts of the life cycle. Typical phases of a life cycle of products or service are raw material acquisition, design, production, transportation or delivery, use, end-of-life treatment and final disposal. It depends on the activity, product or service, what kinds of phases are relevant to be considered in the assessment. The organization must identify environmental aspects that are included in the environmental system. All inputs and outputs are considered that relate to activity, products and services, both intended and unintended. This evaluation should take into consideration normal and abnormal operating conditions, shut-downs and start-up conditions. There is also a place for any reasonably foreseeable emergency situations. If there are prior occurrences of emergency situations they should receive further attention. (ISO 14001: 2015, 72.) It is not needed to consider each activity, product, component or raw material individually. It is sufficient to group or categorize the activities, products and services if they have common characteristics. In this way, the main environmental aspects will be determined. (ISO 14001: 2015, 73.) In this study, the evaluation is determined in separate locations and operations are categorized according to common characteristics.

The following issues are considered determining environmental aspects:

- Emissions to air
- Releases to water
- Releases to soil
- Use of raw materials and natural resources
- Use of energy
- Energy emitted (e.g. heat, radiation, vibration, noise and light)

- Generation of waste and/or by-products
- Use of space.

The environmental aspects mentioned, in the above list, can be controlled directly by an organization. There are also aspects that the organization can only influence. Often, they can be related to services or products that are produced by others. (ISO 14001: 2015, 73.)

There is a list of issues that should be considered when the evaluation of environmental aspects is being made. These issues relate to the organization's activities, products and services. The organization can have control or influence on these aspects that relate to the whole life cycle of operations of the organization. Below is a list of life cycle phases that can have environmental aspects:

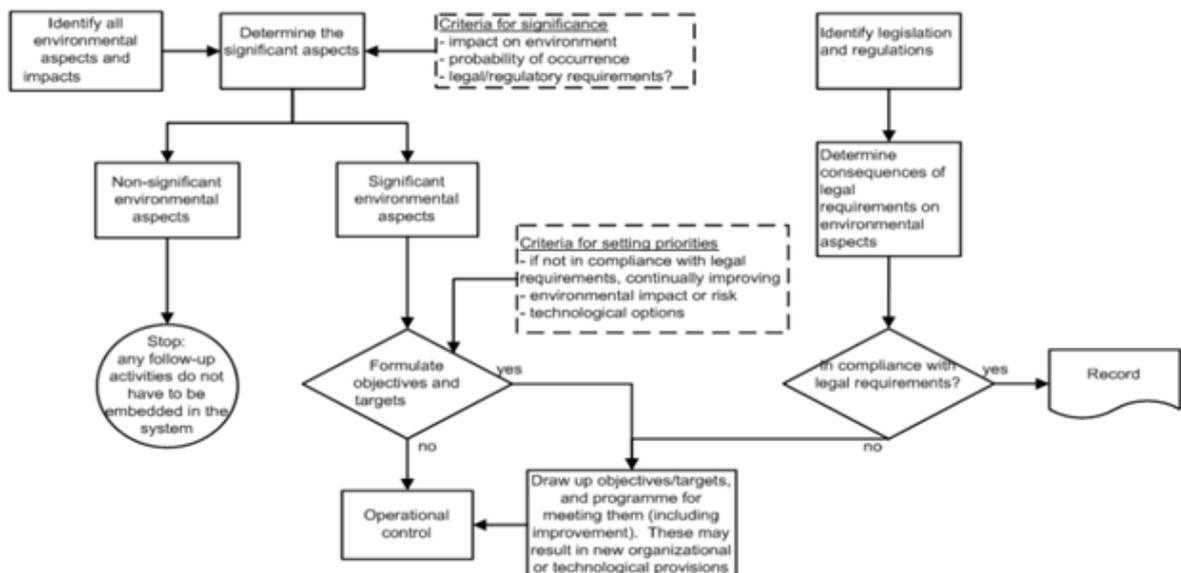
- Design and development that relate to an organization's facilities, processes, products and services.
- Procurement of raw materials and natural resources. This section also includes extraction of materials.
- Operational and production processes that are one of the most significant phases in hard engineering. Warehousing of materials and products are also considered.
- Operation and maintenance of facilities, organizational assets and infrastructure need attention.
- Researching environmental aspects of a supply chain must also consider the environmental performance and practices of external providers.
- Product transportation and service delivery that includes packaging is part of logistics and part of the supply chain. In any case, it is important to pay attention to these in the evaluation process.
- Life cycle of products is a part of the evaluation. Hence, storage, use and end-of-life treatment of products are of significance.
- Waste management that includes reuse, refurbishing, recycling and disposal are the last phases of the life cycle of products and the evaluation. (ISO 14001 2015, 73.)

The environmental aspect identifying process has four main phases. These steps are used when the evaluation system is developed. All examined aspects relate to one operation, product or service. Hence, the first step is to choose what kind of operation, product or service is

evaluated. The second step, after selection of the evaluation target, is to identify the environmental aspects of operation, product or service. The main advice is to identify as many aspects as possible. These aspects are reported, in order that control of the development process is possible. Notices of normal circumstances are taken into account and also abnormal conditions and unusual circumstances, because they also cause environmental aspects. The third step is to identify environmental impacts that will be positive or negative and are caused by real and possible aspects. In the identification process environmental issues are considered that were earlier listed in this section, such as emissions to air, water and releases to soil. Attention should also be paid to abnormal circumstances. Following on from the environmental impact identification process, the fourth step is to evaluate the significance of impacts. There is some commercial factor that usually leads the evaluation process.

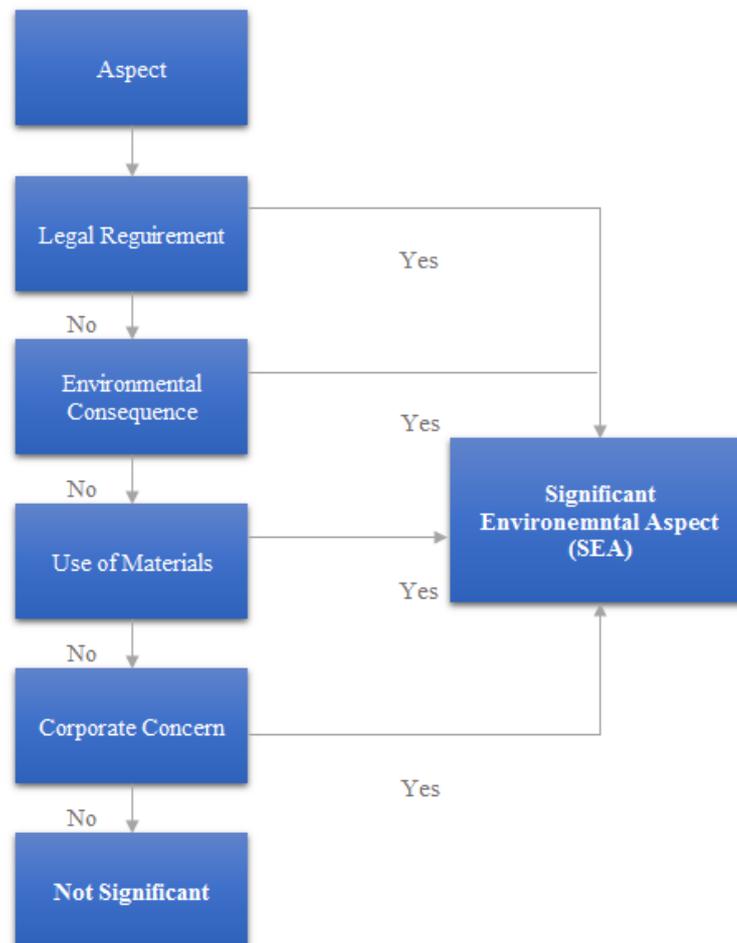
- Compliance obligations;
- Duration and severity of effect;
- Probability of incident;
- Image of the company, operation or product;
- Difficulty to change effects. (SCCM 2014, 6.)

The following figure 2 depicts the identification and evaluation process of environmental aspects and impacts. Adherence to this will result in the process succeeding.



**Figure 2.** Identifying and evaluating environmental aspects and impacts (SCCM 2014, 7).

It might be difficult to establish the difference between significant and non-significant environmental aspects that must be identified before the aspect evaluation process. The aspect identification and evaluation process can be represented by a simple workflow shown in the following figure 3. At the top this figure is the aspect that is estimated and downwards in the figure are significant and non-significant aspect alternatives. Between these factors are simple questions that lead to a correct conclusion. (The Government of Hong Kong 2014.)



**Figure 3.** Workflow of aspect identification and evaluation (The Government of Hong Kong 2014, 6).

#### 2.4.2 Environmental impact assessment

Environmental impacts, which related to environmental aspects, need identification before assessment. Hence, all identified aspects should be investigated and environmental impacts of each aspect shall be identified according to the following factors that are the same type as

with defined factors of environmental aspects. Next, there is a list of environmental impacts and examples of evaluation factors

- Air emissions e.g. volatile organic compounds (VOC) or carbon dioxide (CO<sub>2</sub>)
- Water pollutions e.g. nitrogen (N) or phosphorus (P)
- Soil contamination e.g. heavy metals and petroleum hydrocarbons (PHCs)
- Resources utilization that including use of raw materials, energy etc.
- Waste management e.g. total amount of waste or utilization rate
- Noise, radiation, vibration nuisance etc.
- The impact can be aimed also at flora and fauna, nuisance or site security. In addition, that can be visual, community or transportation related impact
- Assessment considers also indirect impacts that are caused by suppliers, contractors or customers (The Government of Hong Kong 2014.)

Impact assessment has five steps. These steps have also environmental aspect identifications. At first, it is necessary to list all activities of the selected part of an organization. As stated earlier, this can include operations, products and services of organization. The second step is to name the aspects of each activity. The figures earlier shown in this study (figure 2 and 3) can be used. After this, the third step is to describe the impact of each aspect. The fourth step should define the potential impact and what environmental harm the impact causes. (ISO 14001: 2015, 73.) This will have a high, medium or low potential. Both environmental factors and commercial factors should be considered when there is an evaluation of the significance of the environmental impacts. Typical environmental factors are scale and severity of impact, duration and exposure of impact. There is also probability of incident. The most significant commercial factor is compliance requirements. Customers have significant opinions and requirements. The environmental aspect might be the common aspect, but demands of the customer might change this and then the impacts of aspect might be significant. (Teknologiategollisuus Ry 2011 a.) The fifth and the last step, is to make suggestions for improvement. Typical improvements concern energy consumption, raw materials and waste decreasing, life cycles, product design and lower emissions. The most significance part of impacts relate to energy and materials. Hence, attention concentrates on consumption of energy and materials. The main aim is to decrease consumption substantially. In addition, decreasing of emissions is an important theme. The energy producing effect is a major part of indirect emissions, when there is considered, for instance a single product. The other part is

material use. Acquiring of raw material causes indirect energy consumption and emissions to the single product. (Teknologiateollisuus Ry 2011 b.) The other noteworthy phase of material use is product manufacturing. If a process is inefficient it will accrue a lot of waste material, waste energy and unnecessary costs. The idea is to handle impacts before they occur, hence the design is very important part of the life cycle of products. (Verbanac 2016.) If it is not possible to affect impacts before they occur, such as waste, it is important to find a beneficial way to handle them after a process, which will be innovative to reuse and recycle in the same process or a different operation. (Teknologiateollisuus Ry 2011 b.)

Impacts of organization's operations and productions can be classified into separate groups. Minor impacts need nothing but identification. If there are possibilities to develop them they should be carried out, however, it is sufficient to follow them up when compliance obligations or commercial situations develop. There is a need to intervene in impacts immediately. It is important that employees are educated to an operating mode of the organization so that they know how to manage environmental impacts. The environmental positive practice should be a day-to-day routine in organizations. (Teknologiateollisuus Ry 2011 b.)

An environmental conscious company can affect its business positively, if it attends to its environmental impacts well. The first step to manage environmental impacts well is to record current ways of environmental actions. After this it is easier to identify issues that need improving. The environmental management system might help with the environmental impact improving and updating processes. It should be checked from an environmental impact point of operations perspective and identify operations with the most significant impacts potential to the environment. Following this, all impacts can be examined with a potential benefit for the business such as cost savings, image or benefits that are a cause from anticipation of fulfillment of compliance obligations. Every significant environmental impact needs specific attention. There should be nominated a person who is in charge of implementing the development processes, identifying the implementation schedule and what kind of follow-up inspections are needed. Indicators that evaluate the process are necessary to be used for development follow-up. Follow-up factors could be amount of waste, emissions or economical savings. Follow-up inspections also assist in continuous development. (Teknologiateollisuus Ry 2011 b.)

There are a few steps on how to manage environmental issues in the organization. It is necessary to remember that environmental impacts can affect positively or negatively to business. The organizations that are aware of environmental issues can have a competitive edge over their rivals in the markets. Conversely, organizations that fail to take care of environmental impacts might be exposed to extra costs, poor company image and they have the potential to lose market share. Management of environmental issues should be a part of business and strategy. It depends on an organization how they include environmental management into the strategy. Major competitive edge is possible to achieve if the organization wants to be a trail blazer. This kind of organization foresees changes in the markets and requirements of compliance obligations. They make sure that they have resources sufficiently that they can foresee development in a line of business. (Teknologiaeollisuus Ry 2011 c.)

Environmental impacts are classified, because they are required to assess the damage level of processes. Indicators in a scale are defined through the requirements and classification criteria of environmental impacts. Environmental impacts of materials and processes are possible to classify through four score categories that result in a single final impact score. Research group of Brazilian archives of biology and technology developed an EI scale that helps evaluation of environmental impacts. In research it was agreed that the EI scale should be cheap, available and a user-friendly tool for environmental impact controlling. The same tool helps to reduce impacts allowing planning and material specification to minimize negative effects to the environment. (Morales et.al 2010, 1511.) Example of classification can be shown by material. This could be classified into five categories in evaluation: non-renewable resource, difficult renewable resources, normally renewable resources, easy renewable resource, and non-scarce resource. (Morales et.al 2010, 1512.)

The EI scale has divided an environmental impact evaluation scale into five phases, in research. These phases are: identification of environmental impact aspects, establishment of indicators, variables definition to determine the scale interval and qualifying the intervals. Significant aspects of environmental impacts means, that among the environmental aspects, environmental impact analysis is focused, which also includes materials and processes. It is possible to evaluate impacts of materials and processes using the following factors: recyclability, components recovery and access, repairability, biodegradability, durability, incorporation of recycled material, material resource, contaminants lacking and material availability

in nature. Evaluation factors in the research also include a thought about reduction in resource use. This part is divided into a smaller part: energy reduction during its extraction, production, recycling and transportation. There is also a thought about waste incineration and reuse that has its own smaller evaluation parts: certification, separation of components of facility, waste generation, simple and practical design considering energy use during production, distribution and transportation. The last one in its entirety is use of renewable energy resources that includes: use of multifunctional, recycled and renewable materials, durable products, packages recycling, use of hazardous and water based substances and labor accident control. (Morales et.al 2010, 1515.)

The selection of indicators is a major part of the evaluation process. There are 16 different indicators in the EI scale research. These indicators were divided into specific parts that describe evaluated impact, such as the example below that describes renewable material into five categories. Impact evaluation may include the following indicators:

- Material natural resource
- Material natural reserves
- Extraction process
- Industrial process of material production
- Toxic products emission during product life cycle
- Waste presence
- Waste recyclability
- Selective collection
- Biodegradability
- Calorific capacity
- Combustibility
- Mass balance (kg/m<sup>3</sup>)
- Energetic balance
- Sonorous environmental impact
- Durability
- Maintenance requirements (Morales et.al 2010, 1515 – 1516.)

After the selection of indicators a scale should be established. Environmental impacts are evaluated by four steps in an estimation scale. All indicators have a defined score from 1 to

4. The relation of issues for scoring is represented by-separated production phases and the most important materials used in production. The scoring includes the following phases: material resource, renewability conditions, environmental damages caused by its extinction, toxicity of the material production process, contaminants generation and incorporation, toxic products emission during production, packing, transportation, handling, application and use. (Morales et.al 2010, 1516.)

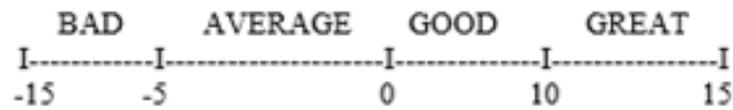
The nine most evident aspects in the research are chosen. These aspects were analyzed and there were selected into five positive and four negative aspects that effect the environment. Positive effect will be:

- Material waste recyclability
- Facility on setting storage and selective collecting
- Durability
- Resource reserves
- Waste incorporation in the material production.

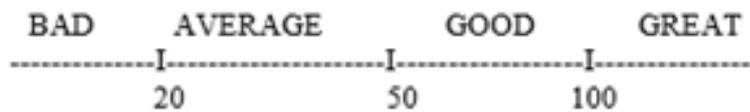
All aspects receive positive points from categories that are scored from 0 to 4. After evaluation, an aspect has a numerical value. The larger the value is as positive the aspect is towards the environment. After this, negative aspects are evaluated that give negative values for items. Conversely, the lower the value is the minor the effect towards the environment is. Negative aspect can be shown by the following factors:

- Material acquiring process
- Losses during material handling
- Carbon dioxide emissions during material production
- Waste generation

Positive and negative values are added up to provide an effect value of environmental impact. It is possible to set in a line as shown in figure 4. (Morales et.al 2010, 1517.)



Performance material scale considering the environmental impact.

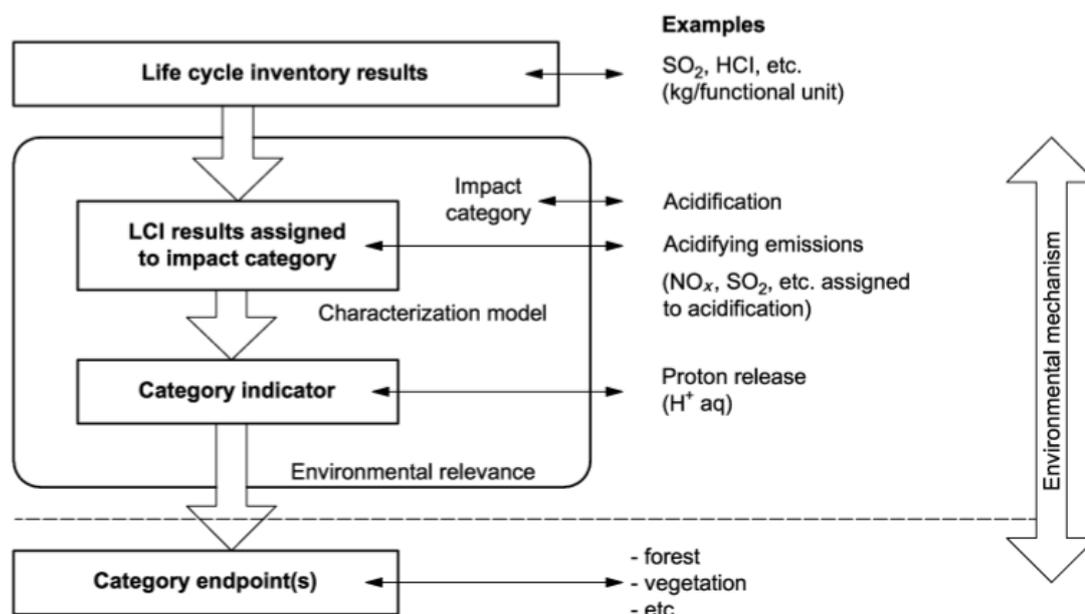


Scale used to global impact determination

**Figure 4.** Scale of environmental impact assessment (Morales et.al 2010, 1518).

For the evaluation process the EI scale was created to be utilized through a computer program that helps the management of environmental impacts. The system also helps in conformity of evaluation that refers to activities such as production process. This also allows that product quality, guaranteeing losses reduction and waste generation are assured in an environmentally correct execution. (Morales et.al 2010, 1518.)

It is possible to use elements of life cycle impact assessment (LCIA) when environmental impact assessment is carried out. Life cycle impact assessment consists of impact categories, category indicators and characterization models. There are results of life cycle impacts that have a direct connection to life cycle assessment, such as mass and energy flows. Also there are results that do not have a direct connection to life cycle assessment, such as land use. These indirect results should be identified and their relationship to the category indicator that correspond with mass or energy flows should be determined. Usually, existing impact categories, category indicators or characterization models for the evaluation will be selected. Sometimes it is necessary to define new ones. There is also an environmental mechanism that is used in evaluation. This mechanism is shown in figure 5 below. The figure illustrates also categories of impact assessment and the necessary components of the LCIA. (ISO 14044: 2006, 43.)



**Figure 5.** Concept of category indicators. (ISO 14044: 2006, 45).

A category indicator can be chosen anywhere along the environmental mechanism between the LCI results and the category endpoints. (ISO 14044: 2006, 45.) These category indicators will help in environmental impact assessment. In the figure, lines of environmental relevance can be seen that are a qualitative assessment of degree of linkage. This is between category indicator result and category endpoints and could be of high, moderate or low linkage. (ISO 14044: 2006, 45.) In the ISO 14044 standard, there exist requirements for impact categories, category indicators and characterization models that help the evaluation. Using these categories in all evaluations could have comparable results. Anyway, there is the following environmental data in the characterization model:

- the condition of the category endpoints;
- the relative magnitude of the assessed change in the category endpoints;
- the spatial aspects, such as area and scale;
- the temporal aspects, such as duration, residence time, persistence, timing, etc.;
- the reversibility of the environmental mechanism, and
- the uncertainty of the linkages between the category indicators and the category endpoints. (ISO 14044: 2006, 47–49.)

## **2.5 Identification and assessment of environmental aspects and impacts**

Identification and assessment of environmental aspects and impacts are a part of the environmental management system. The purpose of identification is defining the methodology for identifying and evaluating environmental aspects. After identification aspects and impacts can be controlled. The scope of the assessment includes all activities, products and services of the company. For a better understanding of the meaning of the activities of the company, there should be procedures for identifying significant aspects and impacts. This needs information gathering, analyzing and reviewing of data. (Stojanovic 2017.)

### **2.5.1 Principles for identification and assessment**

There are some topics that are relevant and should be taken into account when the assessment is being carried out. Often there are legal and regulatory requirements that make an aspect automatically significant. There are also expectations and requirements of interested parties regarding the environment. These are not mandatory to consider, but usually they are important for the business, hence they are relevant in evaluation of the assessment. If there are technical and project related documentation of products and facilities, such as monitoring and measurement reports of emissions and report of analysis, surveys, audits etc., they are a good base for assessment. Each time there are changes in activities, processes, products and services or in environment, then the assessment should be updated. The same rule applies if there are some improvement proposals or HSE committees. The issues described above or experience, as well as feedback from interested groups, could be a starting shot for new environmental investigations or changes in processes. These need updated assessment also. (Stojanovic 2017.)

It is also necessary to evaluate abnormal conditions, emergency situations and accidents. Unforeseeable situations should be provided for in advance, but also check possibilities to mitigate potential risks for abnormal conditions. There could be reports on environmental impacts and ecological incidents, as well as potential emergency situations that could be a good base for assessment of other than normal situations of activities. (Stojanovic 2017.)

As earlier stated, environmental impacts could be a positive or negative effect towards the environment. Positive impacts are opportunities and negative impacts are risks to the environment. The person in charge of identification procedures should identify and evaluate impacts regarding environmental aspects. These aspects and their impacts should be evaluated by using the principles of a risk matrix that is described in the next section. Assessment of

aspects and impacts has criteria that vary between different models of assessment. Usually there are two criteria: probability of occurrence and severity of consequences. Other criteria are bonuses and could be for example time of recovery, reach of impact, compliance obligations, and requirements of interest groups or difficulties to change impacts. There is a summary that illustrates the significance of aspects and impacts at the end of evaluation. It is important to notice that there could be some scales that have criteria when the aspect is significant regardless of other criteria, such as severity of consequence and compliance obligations. (Stojanovic 2017.)

### **2.5.2 Environmental impact assessment matrix as an evaluation tool**

Environmental aspects and impacts have their own evaluation system – *environmental impact assessment matrix* – that can identify and evaluate the significance of impacts. This tool is influenced from health and safety matrixes that are generally used. This impact assessment matrix will identify environmental impacts before they happen by focusing on quantities and quality that affect contamination of the environment.

Risks that create environmental impacts are necessary to analyze. The first area is limited and subdivided after analysis. The second step is to decide what issues the analysis refers to. Physical and activity limits are taken notice of for instance at a mill site that is separated by a fence and a mill site where there may be working different companies. It is a shared work place. All resources should be considered that are needed in the process, because they can cause risk to the balance of the environment, regardless if a substance is harmful or not. Risk analysis supports the environmental management system and continuous improvement. (Wessberg et.al. 2007, 1.) Risk analysis needs a description of operations that refer to all the organization. It is also necessary to describe the environment around the operation. There may be a sensitive biodiversity, groundwater area or a place where are a lot of young people are such as a school or a day care center around the mill site. These kinds of targets are called industry disturbed. There may also be targets that distribute or might cause a risk of damage to the mill site and the environment, such as other industry, routes and phenomena of nature. These should be considered also in the analysis. Before starting an analysis the correct way is to check all interference reports that show precious damage situations. This way it is easier to prepare for unexpected situations. (Wessberg et.al. 2007, 2.)

There are many factors that can impact the environment. All of them should be identified. A possibility of interference might be caused by chemicals, process instruments, operations,

people inside and outside and factors that are outside of the mill site, which can further increase interference situations. (Wessberg et.al. 2007, 2.) The environmental impact assessment matrix is used a lot in evaluation of environmental and other risks. This tool considers impacts to the environment. Implementation needs some factors that describe the impact such as frequency and significance of the interference. These factors are added to the matrix that is used as a tool for evaluation. Different operations are also added that cause impacts. (Wessberg et.al. 2007, 3.) Before, it is possible to use the risk matrix it is necessary to describe the processes. There should also be a description of devices, raw materials and auxiliary substances that are relevant for the assessment. As earlier stated, it is a good maintenance habit to write down methods of operations for assessment. In abnormal conditions, it is necessary to show method descriptions and analysis of failure emissions as well as methods of risk maintenance. The first step to identifying of risks and other impacts is to describe possibilities of impacts. Through aspect analysis it is possible to find possible impact sources such as used raw materials, activities of operations and abnormal operating conditions. It is an important part of evaluation to notice past, present and future time. (Wessberg et.al. 2007, 3.)

The significance of the impact is evaluated by using the environmental impact assessment matrix. After selection of significant impacts, significant aspects should be selected. These are the aspects that have or can have significant impacts towards the environment. They must also at least be addressed as a priority and in the environmental management system. These objectives for improvement may be formulated. (SCCM 2014, 11.) A 5x5 risk matrix is used that consists of probability of occurrence and severity of consequences. The value of significance of an impact is the result of multiplication. This value describes the class of the impact. Five risk classifications are defined with this matrix. These classifications are *insignificant*, *low*, *medium*, *high* and *extreme*, that are described in table 1 below. After identification of aspects and risks it is possible to estimate the significance of impacts. Which is an acceptable risk or impact should be decided. This identification is possible to be carried out not only by the company but also authorities, non-governmental organizations (NGO's), neighbors and other interest groups. (Wessberg et.al. 2007, 3–4.) One of the most important requirements for an assessment matrix is that should be reproducible in order to make comparing of results possible. It is also possible to set priorities for which aspect is a part of formulating the objectives by using a matrix. (SCCM 2014, 11.)

**Table 1.** Environmental impact assessment matrix (Hakanpää, HSE Manager, QHSE Manager 2017).

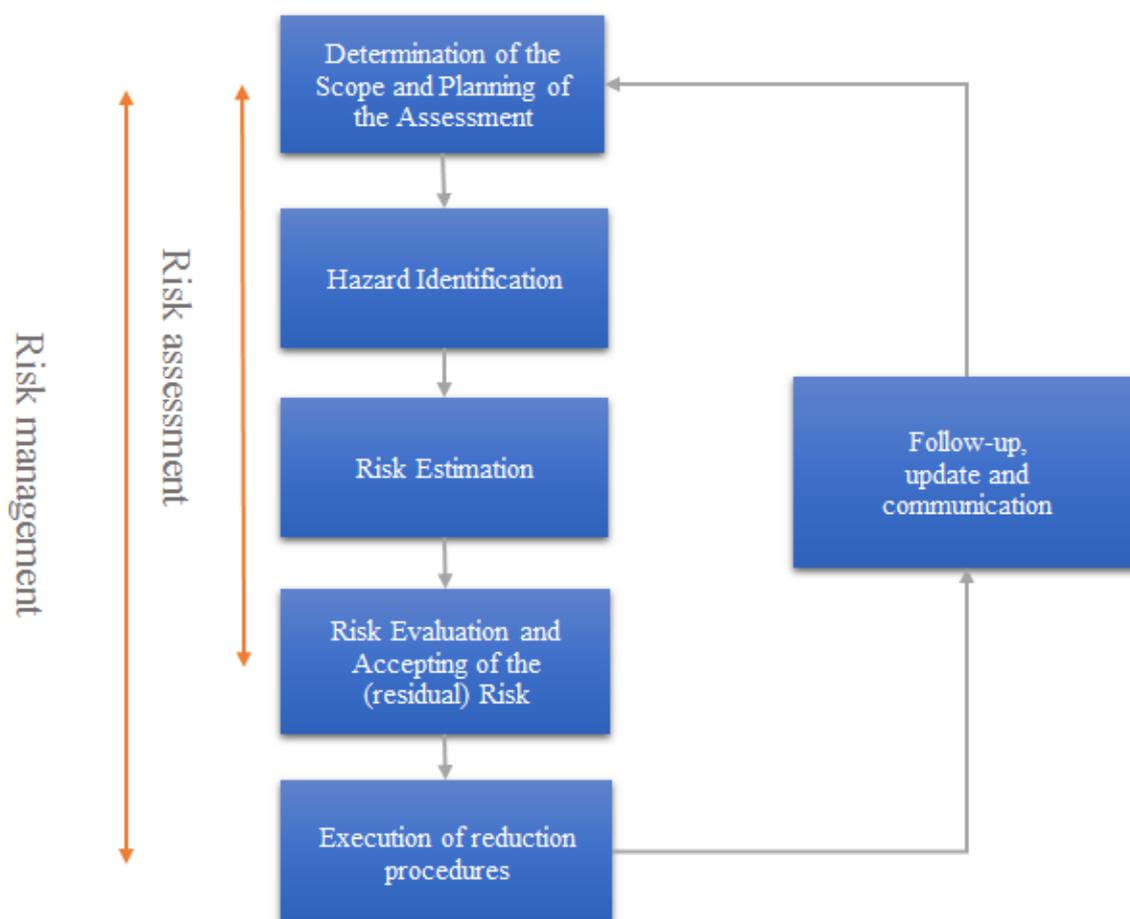
Environmental impact assessment matrix				Consequence				
				1	2	3	4	5
				Minor	Slight	Substantial	Severe	Very Severe
				Minor impact onsite or no impact	Some local impact on the environment, but not exceeding reportable limit	Significant local impact on the environment, exceeding reportable limit	Significant off-site impact, some remediation required	Serious off-site impact, significant remediation required
Probability	5	Very likely	Daily / Every time the activity is executed	Low	Medium	High	Extreme	Extreme
	4	Quite likely	Weekly	Low	Medium	High	High	Extreme
	3	Slightly likely	Monthly	Low	Medium	Medium	High	High
	2	Unlikely	Annually	Insignificant	Low	Medium	Medium	Medium
	1	Highly unlikely	<1 Incidence/year	Insignificant	Insignificant	Low	Low	Low

Table 2 below presents the idea of the risk matrix.

**Table 2.** Risk classifications and definitions as well as required actions of impact mitigations (Hakanpää, HSE Manager, and QHSE Manager 2017).

Risk classification		Required actions
1 to 2	Insignificant	<b>Acceptable aspect or impact.</b> No immediate actions required.
3 to 5	Low	<b>Activities can be continued.</b> The factor should be monitored and actions to reduce the risk must be implemented.
6 to 10	Medium	<b>Preventative actions are required.</b> Activities can be continued, but the risk shall be systematically monitored to ensure that the risk stays under control. More specific risk assessment methods can be used, if needed, to focus on certain risk factor(s) to ensure proper risk monitoring methods.
11 to 19	High	<b>Actions shall be started as quickly as reasonably possible.</b> Risk mitigation actions are mandatory and an action plan must be created immediately. This risk needs regular monitoring and reporting.
20 to 25	Extreme	<b>The activities must be stopped immediately.</b> Risk mitigation actions are mandatory and there have to conduct immediate actions to change and improve process. Measures must be taken before the activity can start again, and the works shall not continue or start before the risk has been mitigated in acceptable level. If the reduction of the risk is not possible the work in question must be permanently prohibited.

The main principles of common risk management have been used, as well as health and safety assessments. The main process of risk assessment is described below in figure 6. The same procedure is used also in health and safety risks in many companies. The first step is risk or impact analysis that consists of three parts: determination of the scope and limits of the assessment, hazard identification and risk estimation. In determining the scope, activities will be found that will cause aspects. The next step is hazard identification. It will observe environmental aspects and try to determine the most significant aspects of that activity. Risk estimation means identification of environmental impacts. After this it is possible to go to the next phase: risk assessment. There is an impact assessment that follows the matrix that is presented above. After assessment, it can be said how significant an impact is and is it acceptable. There are two options. The impact is acceptable and could go to the last step or that is not acceptable and the risk needs reduction actions. This consists of planning and implementation actions of the impact. The last phase is a sustenance step that consists of internal and external communication, follow-up procedures and updating of impact assessments. The entire procedure is called risk or impact management. (TTK 2016, 23)



**Figure 6.** Risk assessment process flow chart that is used impact assessment (TTK 2016, 23).

After assessment procedures, results should be analyzed and then action plans to mitigate significant impacts are created. With the action plan, consequences of impacts would be prepared, also reduction of the impacts before they affect the environment. With assessment it is also possible to meddle with impacts before they are real risks. Assessment should be updated regularly and every time if the process is changed. (Wessberg et.al. 2007, 4.)

## 2.6 Abnormal conditions and emergency situations

Occasionally something abnormal may occur and unexpected damages that cause impacts on the environment. It is required that these situations are provided for at a company. In addition, there should be action plans that have steps to increase effects of the impacts. Determining of aspects in abnormal situations requires taking into account the inputs and outputs that arise from the company's activities, intended or unintended. As with normal activities, abnormal conditions could be associated with the company's current and relevant past

activities, products and services; planned or new developments; and new or modified activities, products and services. For this reason it is important to analyze abnormal conditions with an extensive outlook. (ISO 14001: 2015, 72.)

The assessment that is used should take into account abnormal operating conditions, shut-down and start-up conditions, as well as the reasonably foreseeable emergency situations (ISO 14001: 2015, 72). Accidental emissions are exceptional by quantity and quality. Normally, these emissions are caused by an unexpected situation and gives rise to the possibility of contaminating the environment. Accidental emissions are emissions that can go through a protection system the organization has in place. Generally, these emissions are released to the environment in an uncontrolled way. If the environmental impacts are possible to prevent, or are restricted outline to only the industrial site, they are then near miss situations.

## **2.7 Environment policy and other global principles**

The ISO 14004:2016 standard on Environmental Management Systems defines the general guidelines on the implementation of environmental policy with its intentions and direction of the organization, relating to environmental performance, as formally expressed by its top management. (ISO 14004: 2016, 9.) As defined by the ISO 14004 standard on Environmental Management Systems, the environmental policy instructs the strategic direction of a company with regard to the environment. In addition, it has a scope definition of the environmental management system. The policy creates environmental targets and sets the level of environmental responsibility and performance required of the company. The environmental policy will be a framework of environmental action for the organization and has a purpose and the context in which the company operates. It includes the nature and scale of the environmental impacts that result from the company's activities, products and services. The policy also has requirements of actions that are needed to fulfill compliance obligations and commitments related to protection of the environment, prevention of pollution and continuous improvement. (ISO 14004: 2016, 88–89.)

The environmental policy should have the principles of environment protection and prevention of pollution. The company should be aware of the environment in which they operate. There should be an awareness of availability of resources, air and water quality, as well as the effects and impacts with climate change. The protection of the environment, that is connected to the company's activities, products and services as well as its locations, supply chain management, product use or disposal, and prevention of pollution support, that can be

incorporated throughout the life cycle of products or services, including design and development, manufacture, distribution, use and end of life, both of which will affect the sustainability of company's business and society. An Environmental Policy will not only reduce resources and decrease the amount of waste and emissions but also reduce cost and develop more competitive products and services. (ISO 14004: 2016, 89.)

Adhering to the principles of the environmental policy will help the company to define the scope of their commitment to the environment as one of the three pillars of sustainability and provide common set of values. There will be other commitments that also define environmental policy. These will be sustainable development and associated guiding principles, for example The UN agenda or Global Compact or minimization of significant adverse environmental impacts of new developments through the use of integrated environmental management processes and planning. Commitments will also include design of products taking into consideration environmental aspects and the principles of sustainable development. (ISO 14004: 2016, 90.)

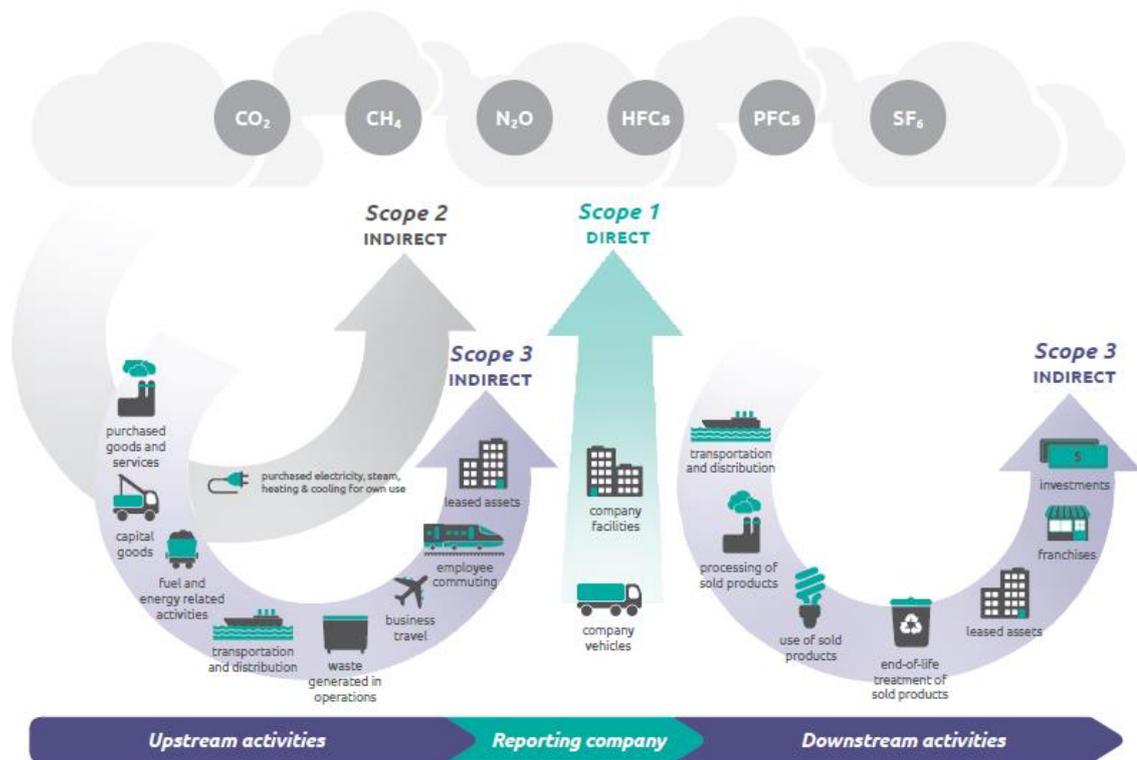
The companies will comply also with Extended Producer Responsibility (EPR) that was published in the OECD issue Paper in 2014: Promoting Sustainable Materials Management through extended Producer Responsibility. This document, based on a concept from 1990, sets the principles for producers and sustainable products. This supports a transformation of responsibility from governments or municipalities to producers in considering environmental aspects during the design and manufacture phases of product development. The target is also to reduce the environmental impacts of products throughout their lifespan and product's end-of-life treatment. Producer responsibility is thought very important, hence in the European Union it is mandatory within the context of WEEE, batteries and ELV directives that concentrate on the financing of collection, recycling and responsible end-of-life disposal of WEEE, batteries, accumulators and vehicles on producers. These are set in the Packaging Directive that demands member states secure that they have necessary measures to evaluate the collection and recycling of packing waste. The aim of the European Union is to increase recycling in areas where market factors do not encourage companies financially to collect and recycle. In 2011 the European Union planned a Roadmap to Resource an Efficient Europe that extends producer responsibility to cover the entity product life cycle. (HSE Manager 2016 b.)

The Extended Producer Responsibility (EPR) has four main categories for disposal management. This will affect also product developing and is responsible for the product life cycle. The first category is *product take-back requirements* that require the producer or retailer to take-back the used product from the consumers after use. The aim is to achieve the target of the recycling stage. The second one is *Economic and market-based instruments* that aim to get producers to comply with EPR, for example they relate to hazardous and more difficult recyclable products and substances. These instruments can be disadvantageous for companies if they do not comply with EPR, such as material taxes and disposal fees. The third category is *Regulations and Performance Standards* that, for example set the minimum recycled content. These could be also mandatory and voluntary programmes. The fourth and last category is *Accompanying Information-Based Instruments*, which the target is to indirectly support EPR programmes by increasing public awareness. This could consist of information requirements such as reporting by the producer, product and component labeling as well as informing customers about the responsibility of the producer. There could also be information on waste separation and recyclable materials that were used in products. (HSE Manager 2016 b.) These categories are the most important for engineering of products and cooperation with customers that have set many demands for suppliers.

The companies can also comply with European Community law regarding the supply of new products. There exist many various directives concerning new products. This law harmonizes technical rules as well as affects the health and safety of new products by design and construction. The aim has been to remove barriers to trade products with minimum health and safety objectives. This needs standards at product level and must be mandatory for all European Union member states that are required to implement European product supply into national law. The key European directives relate to the design, construction and supply of products when they are placed in the European Economic Area. For instance, there exists relevant guidance for machinery, electrical equipment, equipment for use in explosive atmospheres (ATEX), pressure equipment and vessels, gas appliances, cableways, explosives and pyrotechnic articles, noise emissions by equipment for use outdoors, emission of gaseous and particulate pollutants by non-road mobile machinery, restriction of the use of certain hazardous substances in electrical and electronic equipment, as well as eco-design for energy related products. (HSE Manager 2016 b.)

## 2.8 Value chain

Increased awareness of environmental issues was changed the business. Competitive companies should look beyond their own operations but also consider the entire value chain that will consist of three parts: supply chain and own operations, as well as services and technologies. Environmental impacts are caused during the value chain. There are direct and indirect emissions through the value chain (GHG Protocol 2011, 5). The value chain will be a traditional linear system, but it will also be modern part of circular economy that is described later in this chapter. The Greenhouse Gas Protocol utilize traditional value chain chart in emission calculation. The aim is to help companies to understand their full value chain emissions impact and standardize step-by-step approach them through the entire value chain. (GHG Protocol 2011, 4–5.) A linear value chain is presented in figure 7. The GHG Protocol’s calculations helps companies to understand their full impacts across the value chain and the calculations will reveal the greatest impact in that. (GHG Protocol 2011, 5–6.) It is important that the value chain is transparent and that traceability of its entire value chain from sourcing of raw materials to recycling of products is in order.



**Figure 7.** Emission scopes and emissions across the value chain by the Greenhouse Gas Protocol (GHG Protocol, 2011).

The own operations will be a minor part of impact cause in the value chain. The companies should be work closely with value chain partners and other key stakeholders, such as retailers, authorities and customers. Collaboration trough the value chain will lead greater efficiency, cost reduction, better product quality, better packaging performance and increased competitive advantage. Traditional value chain has upstream suppliers before the production. They will provide components for products, raw materials and other needed resources. Production consists of the company's own operations, and downstream provides product distribution and customer's use. In many case, the value chain is a complex relationship between the company, partners and stakeholders. Considering all operators in the company's value chain, it ensures that together all operators can ensure sustainability in the value chain. (Hermes 2012.)

Sustainability connects to the whole value chain, hence all phases of the value chain are important through that. Design of products and packaging consider material and energy use in production operations, but also in use of product. It also ensures sustainable end products and packaging reducing environmental impacts. In addition, light-weight packages and compact packaged products affect efficiency of transportation and distribution as well as reduce impacts to the environment. As larger the company is as better possibilities it has to affect for instance to new standards of purchasing such as demanding for certified wood fiber to paperboard production or having other requirements for material, water and energy purchasing. In own operations the company can affect to its carbon footprint reducing emissions, minimizing use of natural resources and using renewable energy resources. The companies can affect to its value chain by auditing its suppliers regularly. Having common codes to work across the value chain is possible to ensure sustainable operations for the customer. The company can have many separate ways to offer best possible equipment and support for its customer by ensuring resource efficiency, waste reduction, minimized emissions, and achieve environmental targets along entire value chain. One alternative is to comply with best available techniques (BAT) end their requirements across the value chain. Close relationship with customers creates more efficient value chains. There will be offered innovative tools to measure customers' impacts, anticipate their needs for the future and delivering solutions to improve companies. With better communication and cooperation across the value chain partners will improve social, economic and environmental performances. It will lead to companies be better positioned to manage risk, engage customers through a new strategic

agenda, establish more competitive long-term supplier base and build accountability, credibility and trust. (Hermes 2012.)

There are many specialties in the value chain that will affect total impacts of this. The entire product life-cycle will be something for example between 1 and 100 years. The time frame affects to the amount of impacts. The company's own operations, such as production will take only one per cent of entire life-cycle meaning one year in a 100 years' time frame. The hugest amount of emissions will occur from the customer use phase in the life-cycle by using technologies and products.

Global supply chains will be extensive. The supply chain network can span around hundreds countries and can consist of around thousands active suppliers in the same time. It demands for the company well supplier management that it can ensure sustainability across the value chain. Sustainability of the supply chain is an important theme for globally whereupon companies support their own and their partners' sustainability efforts. Ensuring that the companies operates responsibly throughout the value chain is one of sustainability. The aim also is that materials and components that companies procure adhere to all relevant local and global regulations and standards.

## **2.9 Life cycle perspective for the value chain**

The increased awareness of the importance of environmental protection has increased the need of assessment of the entire value chain. There are the possible impacts associated with manufactured and consumed products. Many tools have been developed to understand and address the impacts of the value chain. One of them is life cycle assessment (LCA), which addresses the environmental aspects and related environmental impacts, such as use of resources across the value chain. It considers impacts throughout the entire life cycle from raw material acquisition through production, use, end-of life treatment, recycling and final disposal. It could be said that LCA considers a product's life cycle from cradle to grave. The LCA can assist the company in identifying opportunities to improve the environmental performance of products at various point in their life cycle. It also informs decision-makers in industry, government and NGOs to planning its strategy, priorities and design of products and processes. It also gives relevant indicators to evaluate environmental performance for example with measurement techniques. In addition LCA will be a part of the company's marketing, for example implementing an eco-labeling, environmental claims and environmental product declarations. (ISO 14044: 2006, 9)

The real life cycle assessment of processes and products are outside of this study, but there are still good perspectives to form a life cycle assessment that could be utilized from this study across the value chain. In the latest version of the ISO 14001 standard there are requirements for the organization and obligates it to take into account the life cycle perspective of products, manufacturing processes and other operations. A life cycle concept usually means the entire product or service from cradle to a grave. If only own operations are considered in the company, the life cycle could mean all activities by starting from the beginning of a process and ending up when the product or service is at the customer. Hence, the organization could control how its products or services are designed, manufactured, planned to consume, distributed and disposed of. In this way it is possible to control processes and eliminate environmental impacts that are ignored or unintentionally moved forward in the life cycle. This leads to the fact that the organization should be fully aware that all possible environmental impacts in each processing stage of operation have been examined. The ISO 14001 standard identifies the organization should take responsibility for ensuring that the impacts of each stage of operations are as minor as possible. (Nolan 2017 c.)

The phases of operations in an organization are divided into smaller parts according to the ISO 14001 standard. Everything starts from design and development. Design of procurement is an important part of manufacturing. If it is ensured that all components are safe to use and do not contain any substances of very high concern when they are being sourced, the company is one step nearer to negative impact in free manufacturing and product use. Contents of material or compliance are obligatory are not only aspects that might affect impacts. Origin of raw materials, components and other parts in the process are also important. If raw materials were mined in a conflict area that could have huge local impacts. Mining could affect water systems, pollutions and land use in the areas. Although they are not taken into account in the whole life cycle of products or services, there are long-term effects of the design, procurement and production decisions. The idea is that the manufacturer must notice all environmental aspects during the whole life cycle. This consists also of products' end-of-life phase. (Nolan 2017c.)

Manufacturing is a substantial part of business, which is visible and its impacts towards the environment are easy to understand. Depending on the business field the environmental impacts of manufacturing could have a large scale and they could be global problems. These kinds of impacts not only cause environmental problems, but also generate costs for the

organization and weaken the image of the company. Environmental management is a competitive advantage in the markets and if a company creates significant impacts on the environment business can be seriously hindered. There are possibilities to support the business in streamlining manufacturing processes, reducing energy consumption and ensuring that the supply chain has the same habits than the target company. Positive environmental impacts can have massive benefits in environmental influence. (Nolan 2017c.)

Nevertheless, manufacturing will be the most significant part of operations the impact of components must also be considered, that are produced, for instance, by sub-contractors. Environmental impacts are considered in supply chain evaluation as the recyclability of the products is considered in product impact assessment. If these are noticed in design, there may be minor impacts to the environment. The part that usually is perceived as part of the supply chain is packing. This is part of the manufacturing process occurs before delivery and transportation. Packing protection of new products facilitates transportation difficult. This could also cause significant impacts. If the packaging is recyclable after product delivery or reusable then impacts are diminished. If the size and form of the packaging is practical it can also minimize impacts, because delivery space is better utilized. (Nolan 2017 c.)

If life cycles of products or extended concept of the manufacturing are considered, then the post-manufacturing part should be examined also. This could relate also to design since it has functional fields that are planned in the design section. The post-manufacturing phase means the situation where the customer purchases a product and takes it on site. The producer must provide appropriate information to the customer so that necessary recycling for packaging could be designed and ensured. The producer should also manufacture a product that is primarily possible to be used in an efficient way. The more options available then as better it is to upgrade the product and create a longer life. End-of-life cannot be forgotten. It is also an important part of the life cycle. At the end-of-life, customers must have knowledge how to recycle the product in the best way or if it possible to reuse wholly or in parts. (Nolan 2017 c.)

Life cycle perspective can prevent a shift of a potential environmental aspects and impacts between life cycle stages. It also addresses the environmental aspects and impacts of a product system, but leaves economic and social aspects and impacts outside the scope. Therefore, there should be combined other assessment tools that all environmental aspects can be con-

sidered in the assessment. The ISO 14040 demand that LCA based decisions found preferably on natural sciences. If this is not possible to execute, there will be used other scientific approaches, international agreements or the assessment should be based on value choices. (ISO 14040: 2006, 23.)

## **2.10 Circular economy**

Traditional linear value chain can be captured within three words: *take, make and dispose*. Circular economy aims to minimize adverse environmental impacts. Present economic model based on large quantities of cheap easily accessible materials and energy. It is not sustainable model and it is reaching its physical limits. A circular economy is restorative and regenerative by design. The aim of this model is to keep materials, products, and components constantly available at their highest utility and value. At present there are separated cycles for biological and technical process. The circular economy tries to find the method to connect them to one continuous, positive development cycle. It optimizes resource consumption, minimize system risks and support renewable flows. (Ellen MacArthur foundation 2017 a.)

The circular economy has three main principles. In a true circular economy, the consumption is based on only effective bio-cycles. There are resources regenerated in the bio-cycle or recovered and restored in the technical cycle. Three circular economy phases addressing several of the resource and system challenges that industrial economies faces. The first is preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows. This first principle tries to achieve dematerializing. The idea is that there should be utilize virtual delivering whenever possible. If there is the demand to utilize resources the circular system selects them wisely and chooses technologies and processes that use renewable or better-performing resources. It also encourages nutrient flows within the system and creates the conditions for regeneration. The second principle of circular economy is to optimize resource utilizing by circulating materials, product, and components with highest performance in technical and biological cycles. The idea is to keep materials and components in circulation by designing for remanufacturing, refurbishing, and recycling. The circular systems use tighter inner loops, keep product loop speed lower and increasing product utilization. They also maximize use of end-of-use bio-based materials, extracting valuable bio-chemical feedstock and leads them into different, increasingly low-grade applications. The third principle is to promote system effectiveness by revealing and designing out negative externalities. This means reduction of damages to land use, air, water and noise

pollution, release of toxic substances and climate change. It also includes damages to human utility, such as food, mobility and health. (Ellen MacArthur foundation 2017 b.)

The circular economy has some characteristics. The aim is to design out waste. It does not exist when the products biological and technical components are designed by intention to fit it within a biological and technical materials cycle. Using biological materials within material circles, there are not toxic compounds and they are possible to compost. Materials from a technical cycle, such as polymers and other man-made compounds are possible to use again with minimal energy and highest quality retention. There should be also built resiliency through diversity. It needs balancing between efficiency and resiliency on circulate. The systems should be run on used renewable energy. Fossil fuels that are used, for example, in fertilizers, machinery, processing and through the supply chain, such as transportation and delivery, should be replaced. There will be used biological materials that value will be extracted to additional value from products and materials by moving them through other applications. (Ellen MacArthur foundation 2017 c.)

A circular economy will be illustrated by the system diagram that contains principles 1–3. There is also a continuous flow of technical and biological materials through the value chain. The circular economy seeks to rebuild all capital types: financial, manufactured, human, social and natural.

### OUTLINE OF A CIRCULAR ECONOMY

#### PRINCIPLE

## 1

Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows  
ReSOLVE levers: regenerate, virtualise, exchange



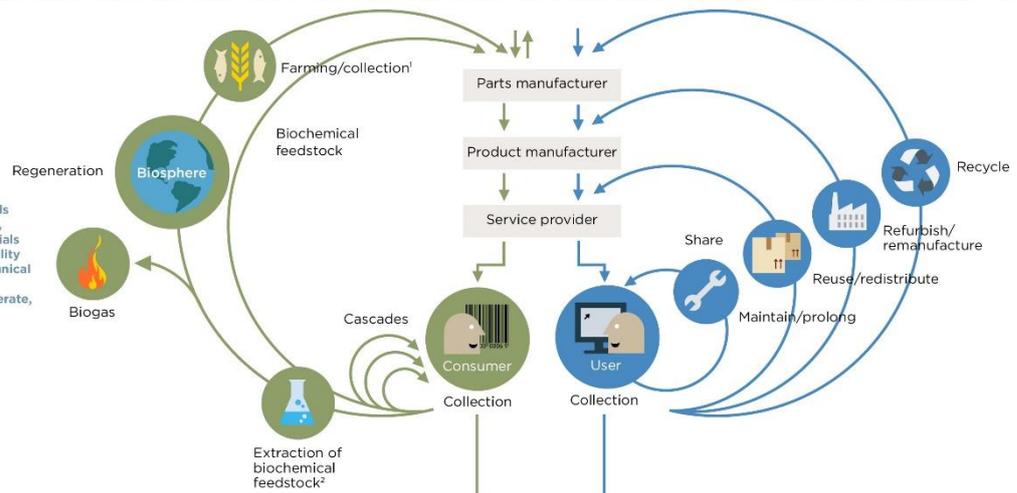
Renewables flow management

Stock management

#### PRINCIPLE

## 2

Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles  
ReSOLVE levers: regenerate, share, optimise, loop



#### PRINCIPLE

## 3

Foster system effectiveness by revealing and designing out negative externalities  
All ReSOLVE levers

Minimise systematic leakage and negative externalities

1. Hunting and fishing  
2. Can take both post-harvest and post-consumer waste as an input  
Source: Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braungart & McDonough, Cradle to Cradle (C2C).

**Figure 8.** Circular economy system diagram (Ellen MacArthur Foundation 2017 d).

Biological material flow is presented in the green circle and technical material flow in blue. Both circles aim to a balance between nature. The circular economy imitates natural circles from nature. For instance, a food chain is a good example that presents biological mechanisms. There is a resource such as a plant. An insect eats that plant and a bird eats the insect. A beast eats that bird and when the beast dies it returns as nutrient to nature. Humans is higher in the food chain and has made their own circles. Now the business tries to go back to the natural circle where the environment and sustainability is taken into account in design, business models and end-of-use phases. In a design stage companies that comply with principles of circular economy should build its core competencies to facilitate product reuse, recycling and cascading. Companies should concentrate in material selection, standardized components, designed-to-last products, design for easy end-of-life sorting, separation or reuse of products and materials, as well as design-for-manufacturing criteria that take into account possible useful applications of by-products and wastes. New business models should

shift a circular economy requires innovative business models replacing existing ones or occupying new opportunities. Companies that have significant market share can acquire circular economy methods within their business, but also driving circularity into the mainstream. The circular economy includes reverse cycles that considers delivery chain logistics, sorting, warehousing, risk management, power generation and even molecular biology and polymer chemistry. Material leakages out of the system will decrease with cost-efficient, better-quality collection and treatment systems. (Ellen MacArthur foundation 2017 e.)

The European Commission presented its new legislative proposal on a full economic cycle in December 2014. It contains circular economy principles with waste reduction targets, water reuse and resource efficiency. It reports on the delivery and progress of key initiatives of its 2015 Action Plan. It has implementation guidelines for a Circular Economy Package. Along with the European Investment Bank (EIB), the European Commission bring together investors and innovators aiming them for, instance, to converting waste to energy and reducing certain hazardous substances in electrical and electronical equipment. The European Commission has key initiatives also for 2017. Now it targets a strategy for plastics in the circular economy, an assessment of options for the improved interface between chemicals, products and waste legislation. It has also a legislative proposal on water reuse and monitoring framework on circular economy. (European Commission 2017.)

All targets based on the goal to close the loop of product life cycles. It aims towards greater recycling and re-use. The Circular Economy Package stimulates Europe's transition towards a circular economy. It will bring benefits for both the environment and the economy. The package will boost Europe's global competitiveness, promote sustainable economic growth and in addition generate new jobs. An EU Action Plan for the Circular Economy consists of the whole life cycle, such as production and consumption of products to waste management and the market for secondary raw materials. The package also has targets for waste reduction and establish an ambitious and credible long-term path for waste management and recycling. The legislative proposal on waste can be summarized in some bullets:

- A common EU target for recycling 65 % of municipal waste by 2030;
- A common EU target for recycling 75 % of packaging waste by 2030;
- A binding landfill target to reduce landfill to maximum of 10 % of municipal waste by 2030;
- A ban on landfilling of separately collected waste;

- Promotion of economic instruments to discourage landfilling;
- Simplified and improved definitions and harmonized calculation methods for recycling rates throughout the EU;
- Concrete measures to promote re-use and stimulate industrial symbiosis, An idea is turning one industry's by-product into another industry's raw material;
- Economic incentives for producers to put greener products on the market and support recovery and recycling schemes.

The circular economy offers benefits for economy making it more sustainable and competitive. Those changes will be increase European business, industries an also its citizens alike. Achieving all principles of circular economy, the member nations should increase measurements to cut resource use, waste reduction and recycling boosts. (European Commission 2017.)

What does the circular economy means in global companies? Business or operations should have a target to keep products, components and materials in continuous cycle instead of disposing them. There will be developed for example technologies and services for the customer converting renewable resources into sustainable products. The value chain may consist renewable material flows that are a part of biological circle and non-renewable material flows that are a part of technical circle. If a company designs, manufactures and supplies technologies and services, it will utilize resources in its circular economy by offering technologies and services for its customers. After customers' product consume there follow collection phase. The company will offer its customers efficient production with renewable and non-renewable resources and maintenance services. Reuse or refurbish services and recycling are after consumption of product. All collecting material and reusable products can be utilized in the company's other value chains or other business chains.

Technologies will be developed that help customers to improve and optimize their resource efficiency. For example, advanced automation and intelligent machines reduce use of resource, as well as water and energy consumption. They will allow circulation of materials within customers' production processes longer as usual. They will also decrease need for virgin materials in the processes. There are four main circular economy themes from customers' perspective: resource efficiency, closed circles, longer circulation and cascaded use across industries. (Ellen MacArthur foundation 2017 d.) The companies can offer resource efficiency designed and manufactured technologies and products improving and optimizing

of resource efficiency. They will also develop technologies for flexible energy production. Chemical and energy recovery based on closed circles in the value chain. Well-designed products enable reuse and conversion and active maintenance service and modernization of production technologies make the circulation longer. The value chains' new bio-based products cascade use across industries. The circular economy is not only for offered technologies and products. It implements the circular economy in companies' own operations by continuously improving resource efficiency and also maximizes utilization of raw materials, uses a resource efficient supply chain, shared use of belongings and preventive maintenance.

### **3 THE MAIN ENVIRONMENTAL STANDARDS FOR ASSESSMENT PROCEDURES**

There are different standards in use that guide the procedures of environmental aspect and impact assessment. ISO 14001:2015 has been used as the main standard and numerous other standards to support the developing of a usable assessment tool.

#### **3.1 The main principles of the Environmental Management System standard – ISO 14001:2015**

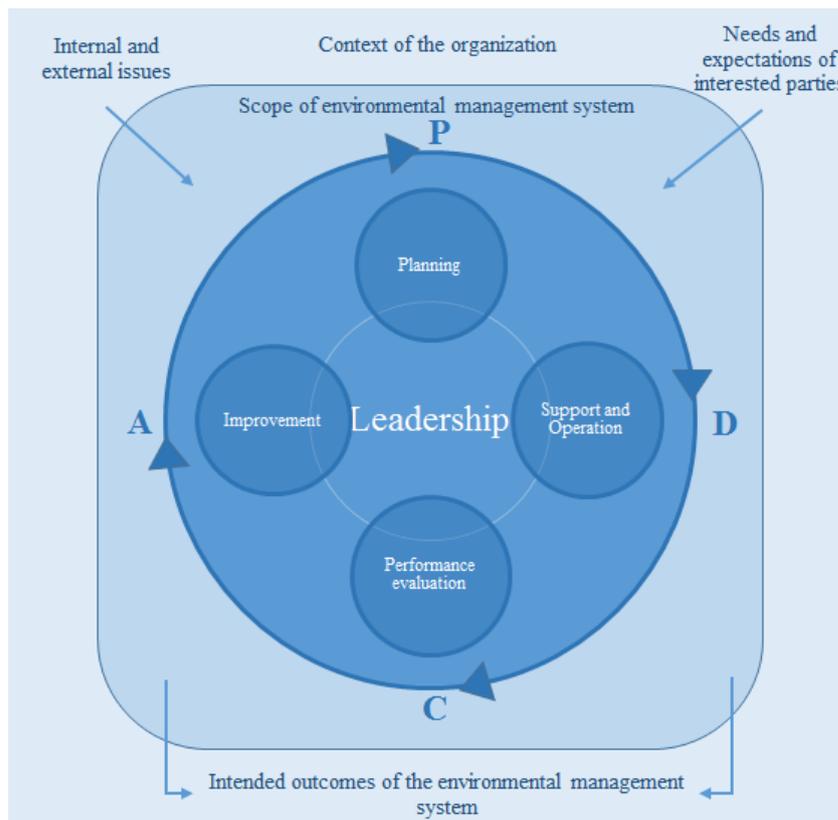
The ISO 14001:2015 Management System Standard is based on a balance between three pillars of sustainability: environment, society and economy. These consider compromising the ability of future generations to meet their needs. The need for an Environmental Management System arose from societal expectations of sustainable development, transparency and accountability that have evolved with increasingly stringent legislation, growing pressures and the environment from pollution, inefficient use of resources, improper waste management, climate change, degradation of ecosystems, and loss of biodiversity. The function of this standard is to protect the environment and respond to changing environmental conditions. (ISO 14001: 2015, 47.)

There are set requirements for the Environmental Management System that can act as a systematic tool to build success over the long term and create options for contributing to sustainable development with the following items:

- Protecting the environment mitigating disadvantageous environmental impacts;
- Mitigating the potential disadvantageous effect of environmental conditions on the company;
- Assisting the organization in the fulfillment of compliance obligations;
- Enhancing environmental performance;
- Influencing engineering, production, distribution, consuming and disposing of company's products and services preventing environmental impacts by using a life cycle perspective;
- Communicating environmental information to relevant interested parties. (ISO 14001: 2015, 47.)

There is a need to comply with the standard's requirements on all levels and the function of the company if there is an aim to successfully achieve the conditions above. The opportunities to prevent or mitigate adverse environmental impacts and enhance beneficial environmental impacts depend on if environmental principles are considered also in the company's business process, strategic direction and decision making. Although the company is one group, it will have separated business lines and areas that can have similar activities but with different compliance obligations, commitments in environmental policy, environmental technologies and environmental performance goals. However, all of them can comply with the requirements of this standard. The differences of conforming to the requirements will depend on the complexity context of the organization, the scope of the Environmental Management System, regional compliance obligations and the nature of the organization's activities, products and services. (ISO 14001: 2015, 47 – 48.)

The execution of the ISO 14001 standard based on the Plan – Do – Check – Act model that is foundation for an iterative process that is used by the company to achieve continuous improvement. Every step of this has a specific meaning in the scope of the Environmental Management System that consists of internal and external issues and where expectations of interested parties are needed. *Planning* formulates targets and processes necessary to deliver results considering the company's environmental policy. *Do* executes the planned process by implementing it with formulated targets. *Check* is the monitoring and measuring part of the leadership process utilizing environmental policy that evaluates performance. *Act* is the improvements phase that aims to achieve continuous improvements throughout the process. (ISO 14001: 2015, 48.) The process is described in figure 9.



**Figure 9.** PDCA model that helps to understand the importance of a system approach (ISO 14001: 2015, 48).

### 3.1.1 The scope of the standard

The ISO 14001 standard supports the company in achieving its environmental performance and intended outcomes of its Environmental Management System, which provides value for the environment, the company itself and interested parties by following the requirements of the standard. This is based on environmental pillars of sustainability and three main points:

- enhancement of environmental performance
- fulfillment of compliance obligations
- achievement of environmental objectives

The standard is suitable for any organization, regardless of size, type and nature. This also considers the environmental aspects of the organization's activities, products and services regardless of whether it has either control or influence considering the life cycle perspective. (ISO 14001: 2015, 50.)

### 3.1.2 Context of the company

The standard has requirements for the company to determine its external and internal issues that will affect its ability to achieve destined outcomes of management system. These

issues can be conditions or activities that are affected have or can be affected to the organization. The company should also take into account the needs and expectations of interested parties if they are relevant to the environmental management system, if the interested parties have for example requirements and if they have compliance obligations. (ISO 14001 2015, 55.)

The company should determine the boundaries and applicability of the environment system by considering the external and internal issues, the compliance obligations, its organizational units, functions and physical boundaries, activities, products and services, as well as its authority to exercise control and influence. (ISO 14001: 2015, 55.) Environmental objectives give targets and background for the environmental aspect and impact assessment process. These requirements will be of concern later in this thesis.

### **3.1.3 Leadership**

The main leader for an Environmental Management System is environmental policy that defines scope of management system. This gives the main requirements relating to the company's own environmental culture. Nature, scale and environmental impacts of company's activities, products and services are considered. With an environmental policy it is possible to provide a framework for environmental targets and it includes an obligation to protect the environment as well as to mitigate pollution. (ISO 14001: 2015, 56.)

The environmental policy should be kept updated with documented information and should be known within the company through internal communication. It should also be available to interested parties. (ISO 14001: 2015, 56.)

### **3.1.4 Planning**

The planning phase of the standard makes the main contents of the entity process. This gives requirements generally, but also for environmental aspects and compliance obligations. In addition, environmental targets and plans on how to achieve them are described. (ISO 14001: 2015, 57) Knowledge of the most significant aspects in the company is the main part of the Environmental Management System planning. The company should consider the issues, requirements and the scope of its Environmental Management System by determining the risks and opportunities that relate to its environmental aspects, compliance obligations and other issues and requirements. The Environmental Management System will achieve intended out-

comes and prevent or mitigate disadvantageous effects also containing external environmental conditions that affect the company, as well as achieve continuous improvement. Potential emergency situations especially those that can have an environmental impact should also be considered. Existing knowledge about risks and opportunities will help in determination. (ISO 14001: 2015, 57.)

The standard has requirements for environmental aspects and identification of them. The company should determine the environmental aspects of its activities, products and services that it can control and that it can influence, as well as impacts that relate on them. These will be considered in a life cycle perspective. There are some topics that should be taken into account when the company is determining its environmental aspects. It has to evaluate all changes, including planned or new developments, all activities, products and services despite whether they are new or modified. It is also necessary to evaluate abnormal conditions and reasonably foreseeable emergency situations. The main idea is to determine all aspects that have, or can have, a significant environmental impact. It is important to remember that significant environmental aspects can be risks or opportunities for the company and the environment. The environmental impacts that are caused from aspects can be either adverse environmental impacts, or as threats or beneficial environmental impacts or opportunities. (ISO 14001: 2015, 57–58.)

Compliance obligations are mandatory to fulfill. Hence the company should determine and have access to all compliance obligations that relate to its environmental aspects. It should also know how these compliance obligations affect operations in the company. After all, compliance obligations are determined, they should be considered every time when the company establishes, implements, maintains and continually improves its Environmental Management System. It is first rate to document all information of the company's compliance obligations. They could reveal risks and opportunities that the company has. (ISO 14001: 2015, 58.) It is necessary to take them seriously, because they guide activities towards being more in an environmentally friendly way in the company.

It will not be easy to achieve environmental objectives, hence the standard has guidelines how to make it possible. At first the company should determine relevant environmental targets considering its significant environmental aspects and compliance obligations and their risks and opportunities. Environmental objectives need continuous management. They must be consistent with the company's environmental policy and they should be measurable and

monitored. It is also necessary that the objectives are communicated to interest groups such as internally in all organizations and employees. In addition, they have to be updated. The environmental objectives need action that should be planned: what will be done, what resources will be required, who will be responsible and when it will be completed. It should also be planned how the results will be assessed. (ISO 14001: 2015, 59.)

### **3.1.5 Support**

The Environmental Management System needs support before it is ready to use and during its use in the company, it should determine and acquire the required resources for establishment, implementation, maintenance and continuous improvements of the Environmental Management System. The company should ensure that employees and other persons that are working, under the company's control, are aware of the environmental policy, significant environmental aspects and all impacts that related to their work. They should be also aware of their effects of the Environmental Management System and environmental performances. (ISO 14001: 2015, 60.)

As a part of supporting communication, it is a necessary part of this. The company should communicate internally and externally about establishment, implementation and maintaining the processes. It will always respond to relevant communications in its Environmental Management System and it is necessary to retain documented information as evidence of its communications. Internal communication helps management of the system; hence the communication should cover all organizations and employees in the company. The communication should include changes to the Environmental Management System. This also enhances all work under the company's control, contributing to continuous improvement. External communication ensures that the company can inform its processes and required compliance obligations. (ISO 14001: 2015, 60.)

### **3.1.6 Operation**

The ISO 14001 standard requires that the company should establish, implement, control and maintain the processes. An implementation can be following a hierarchy: elimination, substitution, administrative and can be used individually or in combination. The company should control planned changes and also mitigate any unfavorable effects. It is necessary to remember that there is a life cycle perspective that leads the operational planning and control. The company should establish controls to ensure that environmental requirements are added

in each life cycle stage such as the engineering and development processes. It should determine its environmental requirements for the procurement of products and services. Communication is a possible way to tell the company's most important environmental requirements to the interest group. There might be also be a need to provide information about potential significant environmental impacts associated with transportation or delivery, use, end-of-life treatment and final disposal of its products and services. (ISO 14001: 2015, 62.)

An efficient operational readiness demands the company also has a plan for emergency situations. Hence, the company should establish, implement and maintain the processes and their potential emergency situations. The ISO 14001 requires a few stages that the company should consider. It should plan actions to prevent or mitigate unfavorable environmental impacts from emergency situations and should react to actual emergency situations. If something might happen, the company should try to prevent or mitigate the consequences of emergency situations, appropriate to the magnitude of the emergency and the potential environmental impact. The plan itself is not sufficient, there is a need to test and revise the planned actions periodically, in particular after the occurrence of emergency situations. The company should also organize relevant information and training for interested parties including persons who are working under its control. All operations with emergency situations should be documented. The company should maintain information to ensure that the processes are carried out as planned. (ISO 14001: 2015, 62.)

### **3.1.7 Performance evaluation**

An efficient Environmental Management System needs monitoring, measurement, analysis and evaluation for its performance. The company should make a plan for performance evaluation. It should determine what needs to be monitored and measured, and what kind of methods need to be used to ensure valid results. The company can select by itself the criteria against which it will use by evaluating its environmental performance and it can determine when the monitoring and measuring will be performed and the results shall be analyzed and evaluated. Calibration or verification is needed for monitoring and measurement equipment that are used. In addition, the company should communicate relevant environmental performance information internally and externally. All documented information about monitoring, measurement, analysis and evaluation results should be retained as evidence. (ISO 14001: 2015, 63.)

Commonly the company has compliance obligations that it should fulfill, but also needs to evaluate the fulfillment of them. Hence, the company shall determine the frequency of compliance obligatory evaluation and maintain the knowledge and understanding of its compliance status. As for other actions, also documented information of the compliance evaluation results should be retained as evidence. The company should follow requirements of compliance obligations, its own demands for its Environmental Management System and the requirements of any Internal Standard. By ensuring that all of these requirements are fulfilled, the company should organize internal audits. There should be an internal audit programme that defines the audit criteria and scope for each audit, select auditors for objectivity and the impartiality of the audit process. There shall be ensured with a programme where the results of the audits are reported to the relevant management. The management review shall guide the environmental actions in the company. It shall include consideration of the status of actions from previous management reviews, demanded changes of the actions, such as its significant environmental aspects, risks and opportunities, as well as there shall be taken into account the extent to which environmental objectives have been achieved. There shall also be consideration of information on the company's environmental performance, including trends in nonconformities and corrective actions, monitoring and measurement results, fulfillment of its compliance obligations and audit results. The management review should consist of adequacy of resources, relevant communications from interested parties and opportunities for continuous improvement. (ISO 14001: 2015, 64–65.)

### **3.1.8 Improvement**

Commonly, the company should carry out improvements in order to improve its operations. They are a part of continuous improvement procedures that include the suitability, adequacy and effectiveness of the Environmental Management System to enhance environmental performance. The ISO 14001 standard requires the company determines opportunities for improvement and implement necessary actions to achieve the intended outcomes of its Environmental Management Systems. The company will check their operations regularly. If there are nonconformity operations it should plan and execute corrective actions by dealing with the consequences such as mitigating adverse environmental impacts. In addition, the company shall evaluate the need for action to eliminate the causes of the nonconformity and prevent the occurrence of similar nonconformity. There will also be a review of the effectiveness of any corrective actions that will include environmental impacts. (ISO 14001: 2015, 65–66.)

### **3.2 Benefits of global management systems**

One of the main benefits of the ISO 14001 Environmental Management System standard is its internationality. It sets out the requirements for organizations to improve their environmental performances through more efficient use of resources, reduction of waste, gaining a competitive advantage and the trust of stakeholders. (ISO 14001: 2015, 2.)

The global management system protects the environment from adverse environmental impacts that are caused from operations of a company. This provides tools to prevent or mitigate adverse environmental impacts, but also guides in enhancing beneficial environmental impacts. With the management system it is possible to support sustainable development, transparency and accountability in a company, decrease pollution, inefficient use of resources, improper waste management, climate change effects, degradation of ecosystems and loss of biodiversity. (ISO 14001: 2015, 47.)

The standard is suitable for all types and sizes whether the organization is private, non-profit or governmental requiring the organizations to consider their environmental issues that relate to their operations. These could be air pollution, water and sewage issues, waste management, soil contamination, climate change mitigation and adaptation, resource use and efficiency. This also includes the need for continuous improvement. (ISO 14001: 2015, 3.) This sets the same criteria for all companies and organizations. The Environmental Management System creates frameworks for common management principles and gives comparable results of sustainable conditions globally in companies. The Environmental Management System standard ensures the awareness of all persons who work at the company so they have effect on environmental performances in the company. (ISO 14001: 2015, 60.)

Following the ISO 14001 standard offers companies success in their business because energy and water consumption decreases, there is a more systematic approach to legal compliance and, all in all, environmental performances improve. (ISO 14001: 2015, 8.) The ISO 14001 standard gives comprehensive, systematic, planned and documented manners for companies. This continuous improvement method is a system that provides a tool to improve environmental performance and information, for instance, in product engineering, pollution controlling and waste management. With the principles of continuous improvement, the company can minimize its environmental impacts. In addition to continuous improvement, the company balances with two other 'C's': customer focus and commitment. All of these aspects

are lined to sustainable development that improves by following the ISO 14001 standard's requirements.

## **4 SYSTEM SPECIFICATION FOR ENVIRONMENTAL ASSESSMENT**

The European Commission has set requirements for environmental assessment in that companies would take into account implications of their decisions before the decisions are made. Environmental assessment will be carried out on individual projects and larger entities. The assessment will be based on the Environmental Impact Assessment – EIA Directive or Strategic Environmental Assessment – SEA Directive. The aim of both directives is to ensure that plans, programmes and projects that will have significant aspects are evaluated beforehand in a company. They also ensure a high level of environment protection. If a company completes the principles of the directives in its projects, plans and programmes, it will have a view on how to reduce its environmental impacts. Directives are also determining tools for sustainable development. (European Commission 2017 a.)

Requirements of the European Commission are important part of operations in European companies. Global companies can operate all around the world and there are different legislations and requirements. This thesis has emphasis to European global companies that should follow local legislation. It is important that companies take into account national legislation, hence the requirements of the European Commission are relevant for many companies due to the fact that most of demands concern also those companies that only have businesses in Europe.

### **4.1 Background and targets of environmental monitoring and reporting**

Monitoring and reporting of environmental aspects are in the core of all documentation. It guides development of the Environmental Management System. Many companies evaluate their environmental risks and report and document results into their own systems. Many of them also use their own risk matrix or own criteria for the evaluation. These assessments are not comparable between other companies. There are many separated operations and their environmental aspects that will be different. However, it will be necessary for the one common global management system that all companies that will comply the common assessment system within their own company, have the same criteria to evaluate significant environmental aspects.

All reports should be clear, coordinated and easy to communicate as well as it should give a picture about level of implementation. It means the distance to target in other words how

much the company should do before it will achieve its goals. The European Commission has set specific compliance information per categories for environmental monitoring and reporting. There are own categories for seven separated policies:

- air
- chemicals
- industry and technology
- nature and biodiversity
- noise
- waste
- water and marine

All of these categories have number of the EU directives that lead operations and monitoring within those categories. (European Commission, 2017 d.)

As in figure 10 presents, the European Commission has a clear idea of simpler environmental reporting. It aims to more transparency and accountability reporting which will lower costs and reduce burden on information providers. If all EU countries comply principles of simpler environmental reporting, it will be easier compare between these countries. It also will enable maximum use of existing information and make better data and research. However, simpler environmental reporting will enhance monitoring on the ground.



**Figure 10.** Simpler environmental reporting by the European Commission (European Commission 2017 e).

The European Commission has created a Fitness Check method that is a requirement for a European Member States to transmit information to the European Commission ensuring planned successful implementation. The idea of the Fitness Check is to better support implementation by covering both reporting and monitoring. Used information is the result of monitoring the implementation. The monitoring as for provides the evidences for implementation and policy making. The Commission has created a Fitness Check evaluation and publish evaluation documents in June 2017, which will assist companies to follow their reporting and implementation procedures. (European Commission 2017 e.)

The European Commission has noticed that environmental monitoring and reporting can be inefficient due to outdated information or too minor used extents. The same information and data can also be asked several times when it will be ineffective. Reporting and monitoring will also create unnecessary extra administrative efforts without clear benefits. There will also be information that are not used efficient way and it will be processed in irrelevant way. In some cases, there will not use best practices sufficiently since monitoring and reporting are different in separated sectors. It creates silos and makes common environment assessment difficult in companies. The Fitness Check method enables obligation implementing and it would increase the availability of information and data at national level. An efficient monitoring and reporting system increase the need to collecting some data and organized system reporting of same issues many times. (European Commission 2017 e.)

The Fitness Check method aims to focus on agriculture, energy, environment and financial services that all are cause concern within stakeholders. It has separated to three different areas: timing, process and content. All of them affect to each other. Lower frequency of reporting and better synchronization assist the process that will be efficiency through automation, harmonization and centralization. The content will have less data requested, ensure key performance indicators and replace text with more automated data. (European Commission 2017 e.) Monitoring and reporting of environmental aspects are in the core of all documentation in companies. It also guides development of the Environmental Management System.

Many companies evaluate their environmental risks and report and document results into their own systems. Many of them also use their own risk matrix or own criteria for the evaluation. These assessments are not comparable between other companies. There are many separated operations and their environmental aspects that will be different. However, it will

be necessary for the one common global management system that all companies that will comply with the common assessment system within their own company, have the same criteria to evaluate significant environmental aspects.

Most global companies already report their carbon dioxide emissions and other releases to the air by using some international procedures, such as the Greenhouse Gas Protocol's principles. These are calculated as both direct and indirect emissions. Scope 3 emissions are indirect emissions and they arise before and after production, such as material acquisition and pre-processing but also distribution, storage, use and end-of-life. The scope 3 calculation gives information about purchase and distribution and transportation. It will be a foundation for supply chain assessment but also technologies and products. The GHG Protocol has already divided emission resources in clear way, hence those categories are easy to also utilize in companies' own environmental aspect and impact assessments.

Sustainability can be reported by using the GRI Standards (Global Reporting Initiative) in the companies. It assists companies and governments understand and communicate their impact globally on critical sustainability issues. This report shows the main sustainability targets, such as climate change, human rights, governance and social well-being, for development and in addition it is a good practice to follow all three operations: own operations, technologies and products, as well as the supply chain, due to the fact that environmental issues and sustainability go hand in hand. The standards enable real actions to create social, economic and environmental benefits. The GRI Sustainability Reporting standards are most widely adopted worldwide standards for sustainability. According to the survey of Corporate Responsibility Reporting, 92 % of the world's largest 250 companies report on their sustainability performance in 2015. Complying with the standards support all kind of companies protect the environment, improve society and enabling thriving economic. (GRI 2017.)

## **4.2 Requirements and limitations for the assessment system**

The ISO 14001 standard requires that the company shall identify the environmental aspects of its activities, products and services that are defined in the scope of the Environmental Management System and such aspects that have or can have significant impacts on the environment. The company can control or can have influence on those identified environmental aspects. It should determine which aspects of these have significant impacts. After this the company determines and takes measures for the selected significant aspects. All information about aspects should be documented and maintain the identification and evaluation

of environmental aspects up to date, so that they are ready to be utilized when setting up, implementing and maintaining the Environmental Management System. (SCCM 2014, 6.) The European Commission has set an Environmental Impact Assessment (EIA) directive which lists all projects and activities that are considered as having significant impacts on the environment. In the list there are, for instance, production and processing of metals, works for the initial smelting of cast iron and steel, as well as the energy industry. (European Commission 2017.) This directive obligates locations in Europe to comply with the requirements of this in other locations that are voluntary.

Significant environmental aspects can arise from many phases of the processes. Hence the company should look at the following phases of its processes when it evaluates its aspects of the operations. Following phases include the entire life cycle of the processes:

- Design and development,
- Production processes,
- Packaging and transportation,
- Environmental performance and procedures of contractors and suppliers,
- Waste processing,
- Extraction and distribution of raw materials and natural resources and
- Distribution, use and life span of products. (SCCM 2014, 9.)

Legislation and regulations have a close relationship between identifying significant environmental aspects. Therefore, legal requirements can be used as a checklist to ensure that all the environmental aspects have been identified. Consequences of legislation and regulations should be taken into account for the environmental aspects. The other group of significant aspects is those that have or can have a significant impact on the environment. There is the possibility to choose the three principles as follows when the company is determining its significant aspects:

- Environmental aspects with legislation and/or regulations are significant;
- Environmental aspects that have considerable environmental impacts are significant;
- Environmental aspects which have generated complaints are significant. (SCCM 2014, 10–11.)

An effective management system will mention the significant aspects. It ensures that measures of aspects and impacts are implemented. The management system should also have

an overview of which improvements are possible to execute for the significant aspects. However, there are few possible ways to determine the significance other aspects. The company can determine some criteria how they utilize evaluation of their environmental aspects. They should set priorities beforehand. Below are the possible criteria for aspects that should be evaluated if they exist?

- Legislation and regulations that the company should follow;
- Range and frequency of the environmental aspect is significant – minor aspect might be more significant if it occurs regularly;
- Internal standards are followed, such as ISO 14001;
- There are previous experiences on all environmental risks that can cause permanent environmental damage, in the worst case;
- The possibility to cause a nuisance for neighbors, or the neighbors have complained of the aspects, as well as aspects that have any significance on employees;
- There are local conditions that demand environmental permission or there are company's premises close to a nature preserve or the company is located in a water-collection area. (SCCM 2014, 12.)

The significance of aspects is also possible to evaluate using probability and consequences of the aspects. In addition, they will have the same criteria as above, such as compliance with legislation and regulations, the potential for improvement of the environmental aspect and all requirements that the company considers. This method is called the risk matrix method. It implies a precision that does not exist in reality and the estimation is always subjective. However, the strength of this method is that method users can estimate aspects in their perspective in that it reflects the real situation and evaluations are possible to identify together. Environmental impacts are possible to evaluate by using two approaches. Assessment can be based on the basis of the baseline situation where there are not any prevention or mitigation operations in place. The result of the assessment is a residual risk that needs prevention and mitigation procedures. Another way of evaluation is based on the basis of the impacts, keeping existing measures in mind. This evaluation takes into account the combined value of the probability and the consequences of failure or multifunction of the measures in place. It is important for the supervisors to know how well the prevention pro-

cedures function, hence the second evaluation procedure will be the best one. The best procedure is to evaluate the risk without mitigation procedures and residual risk once again with all prevention actions. (SCCM 2014, 15.)

The main phases of assessment will be summarized into three steps. At first, an inventory about environmental aspects and impacts will be made. In the second phase, aspects and impacts in order by weighed significance will be accounted for. The company will use its own criteria, in weighing the significance. The third step is the end results that show which aspects are significant that need measurements for improvements. (SCCM 2014, 12.)

### **4.3 Operational environment**

The operational environment in global companies can be complex there will be separated business areas or lines and the companies can consist number of corporate acquisitions in their history. In addition, there will be different types of business fields where the companies operate. Hence there will also be various types of operational environments. Specialized separate technical areas have different environmental aspects when they will be compared together. These differences should be taken into account in the assessment. Main operations within assessment categories are still very similar, such as office work, heavy engineering or automation operations. Therefore, it is possible to generalize the same kind of operations under on the order of category. The majority of these categories have similar environmental aspects. Though, categorizing the operations is a huge challenge. Companies have the best-known similarity regarding operations.

Generally, companies own operations have a wide stakeholder network due to the fact that operations have a long life cycle. Operational environments are complicated and environmental aspects and impacts can arise in a part of the value chain. Production and other operations that relate to this and are in the core business are a part of operational environment, which could be evaluated as own operations. These operations that are not in the company's core business, such as material acquisition and pre-processing, distribution and storage, are a part of the supply chain. At the end of the value chain is located use of products or service and end-of-life phase. These are included in customer use. It can be developed by the companies' own operations if the R&D operates in close cooperation with a network of research facilities and universities, as well as customers and suppliers that are within a large amount of technology developments. Procurement based on relations with customers and selected key suppliers by moving customers' performance forward in the global network. Results

after an evaluation will identify, for instance, the top ten most significant aspects in the company through using evaluation categories. Due to the fact that operational environments are quite similar within some operations, it would be possible to execute a pilot evaluation in one reference company. It would be necessary to determine the main processes that is included in the operational environment. Then the company would determine minor processes that are included in the operational environment and cause environmental impacts. Major processes would be easy to expand to other companies and their operational environments. Companies will be separated into certified companies and non-certified companies before the assessment. Companies with certification are used to report and monitor their aspects. Therefore, these companies can utilize their existing information about environmental aspects. They will only use a new common risk matrix in evaluation. In these companies, there are great amounts of existing information on energy and water consumption, waste treatment and use of raw materials. It is possible to utilize this information in the evaluation of environmental aspects. Companies that do not have certification or any assessment system, should start from the beginning and first determine their possible environmental aspects that relate to their operations.

Companies have a lot of information on their technologies and products, but globally there is large number of separated technologies and products. The operational environment of technologies and products is different than in the companies' own operations. It is not as well-known as in own operations, because it is a part of operations of customers. The operational environment varies between separated customers that cause a huge amount of actual environmental impacts during the product's lifetime. The technique of using, driving time or capacity will be totally different. It affects the significance environmental aspects. Many of supply chains and suppliers have been integrated into a part of the manufacturing and delivery processes of the companies. There is variable information on supply chains in companies which can have thousands active direct suppliers at the same time. Suppliers can be located around the world in many countries, hence the operational environment of the supply chain will be wide. It helps companies to assess environmental impacts if their suppliers have been audited internally or by external audits.

Variable operational environments demand their own assessment templates for own operations, technologies and products, as well as supply chains. There would be ready given ex-

isting information on relevant categories, such as energy, water and waste. Also, other information should users add and assess. The main users of the environmental aspect and impact assessment system will be employees. A HSE specialists will report and analyze the results for managers and the authorities. Employees will be responsible for monitoring impacts. Interest groups do not have a need to use the assessment system directly. However, communication of results, environmental actions and changes, are necessary to be communicate to them. For example, neighbors of mill sites and customers, as well as suppliers and policy-makers will be core groups for the communication.

#### **4.4 Existing environmental guidelines for operations**

There are many organizations that are set own environmental guidelines for business. One of them is International Finance Corporation (IFC), which is a member of the World Bank Group. It has developed the EHS Guidelines that are technical reference documents with general and industry-specific examples. The EHS Guidelines contain information about environmental, health and safety issues over the boundaries and gives it to all industry sectors. There exist the following guidelines for environment:

- air emissions and ambient air quality
- energy conversation
- wastewater and ambient water quality
- water conservation
- hazardous materials management
- waste management
- noise
- contaminated land

There are also separated industry sector guidelines that have specific overview to environmental issues in different industry sectors. There are eight separated categories: agribusiness/food production, chemicals, forestry, general manufacturing, infrastructure, mining, oil and gas, as well as power. (IFC 2017.) In these guideline sheets are described potential environmental issues that associated with each categories' activities. For instance, mining activities may include management of water use and quality, wastes, hazardous materials, land use and biodiversity, air quality, noise and vibrations, energy use and visual impacts. (IFC 2007, 2.) Many of these issues are included also in the ISO 14001 environmental aspect

assessment requirements. All of the main categories also have a subcategory such as water use and quality. There are guidelines for water use, water quality and storm water. (IFC 2007, 2–3.) There are also number of national guidelines set by governments. For instance, the government of India has set environmental guidelines for industries. These have been written to assist authorities and entrepreneurs and as a pendant for their concern about environment. There are parameters that should be taken into account while setting up an industry, but also recommendations for existing industry to ensure optimum use of natural and man-made resources in sustainable manners. The aim is to use resources with minimal depletion, degradation and destruction of environment. (Government of India 2017.)

Companies will have a number of own guidelines for all different types of operations. For instance, there will be guidelines for office work, research, product development and design, as well as traveling. All of these guidelines aim to support sustainable operations and use of products. Sustainability targets include the whole life cycle. They also aim to prevent environment pollution. Through complying with demands of guidelines, the companies try to ensure that they can operate sustainability and improve continuously their operations. Companies can promote sustainable use of resources and prevention of pollution in their operations by supporting especially following categories:

- Safe processes and equipment
- Improved process efficiency
- Lower water consumption
- Energy efficiency actions
- Chemical management
- Waste management
- Utilization of renewable energy
- Emergency action plan and response
- Raw material management
- Permits, periodical controls, reporting
- Emissions control and reduction
- Sustainability image

Many of these categories have specific guidelines that will guide minor environmental aspects and mitigate emissions of operations. (Director of Research & Development 2016.)

There will be processes that facilities and building systems to ensure that legal obligations will be fulfilled, such as obligatory ventilation control, systematic fire safety management and energy efficiency requirements as well as hazardous waste management. Offices are not the most significant place for operations that cause significant environmental impacts, but a large number of offices may cause a huge amount of companies' impacts. There will also be production operations that causes the major part of all environmental impacts in the company. It is necessary to take into account all production operations, but also mill site facilities. Favoring green options in procurement and also best practice technologies always whenever possible, such as automatic control systems and energy-rated appliances, is possible to reduce impact to the environment with daily operations. Energy and water consumption, as well as waste amounts, should be monitored in separated locations continuously in companies, because this ensures that accident leakage and other changes in the value chain are identified. (Director of Research & Development 2016.)

There will also be own guidelines for travelling. It will aim for a high level of environmental consciousness in travel choices. The purpose of guidelines will be to improve the cost efficiency and safety travel practices and increase sustainable and socially responsible travels. Therefore, environmental impacts should be considered during planning a travel and favor Skype meetings and other remote access forms always whenever possible. (Director of Research & Development 2016.) If the company follows up its CO<sub>2</sub> emission outputs from business travels, the travel policy will help to achieve the targets. Reporting and monitoring is easy to follow up annual action plans and results of procedures.

Products, processes and services are complicated, due to the fact that they might have impacts on the environment in one or all stages of the product life cycle. According to life cycle studies, great amount of environmental impacts of products arise during customer use and maintenance period. Solutions that the companies offer their customers should be designed in such a way so as to minimize emissions as much as possible and consume a minimum amount of energy, water and raw material during the use phase. There is a large amount of legal compliances that also require sustainable decisions for engineering and product development. These requirements have compliances for health, safety and environmental, such as Registration, Evaluation, Authorization and Restriction of Chemicals statute (REACH), Restriction of Hazardous Substances statute (RoHS) and Waste Electrical and Electronic Equipment statute (WEEE) that have applicable laws and regulations. The most important

phase of the R&D process is to improve reusability, recycling and assembly or disassembly of products. All sustainability related aspects that relate to targets to improve product end-of-use should be documented, especially if these are possible to be categorized into:

- Raw material savings;
- Energy savings;
- Water savings;
- Consumables, chemicals or hazardous materials savings;
- Shift to renewable or sustainable raw materials or fuels;
- Lower emissions (emissions to air, water or soil);
- Improved health and safety (including noise).

In the development and piloting phase methods on the circular economy should be taken into account. Recycled materials should be used and attempts to achieve construction material savings if possible and minimize the use of hazardous materials. The lifespan of machines and products, as well as components, will be extended as long as possible by efficient management. New products and technologies should also follow Best Available Techniques Reference Documents that gives guidelines for the best known efficient and sustainable technologies. Principles of BAT documents are presented later in this thesis. (Director of Research & Development 2016.)

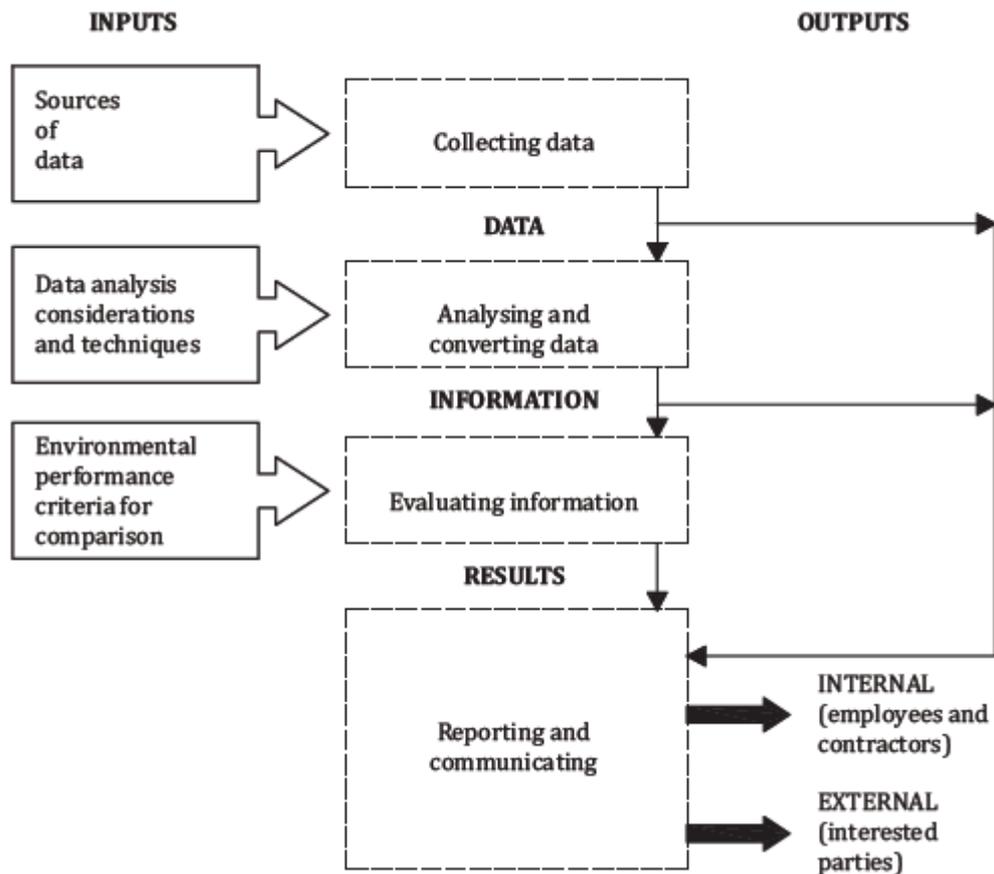
#### **4.5 Description of data collection methods**

Data will be collected by a quantitative survey that is based on a universe that answer pre-determined questions. The universe will be a part of a company's organization, all locations or separated business fields within a company. (Alasuutari 1999, 34.) The quantitative analysis based on search of statistical regularity and differences between research units as for separated variables. They are argued by average connections. (Alasuutari 1999, 37.) The quantitative analysis based on analytical research. Its analysis techniques are centered on numbers, figures and statistics. These methods are used in an assessment template as aspect significance estimation. Quantitative flow analysis will be utilized within the assessment. Aspects or process estimation will be performed for average duration or cycle time, or its efficiency and effectiveness according to time by cycle time analysis. There will be also used process simulation in pilot assessment that will generalize environmental aspects and im-

pacts of main operation categories. Process simulation is applicable for assess parallel activities due to the fact that the assessable process is modeled into a simulation model as the pilot operation. Then the general outputs are analyzed beforehand. (Martin 2017.) The quantitative analysis gives a result, but it does not give an explanation why it does be so (Alasuutari 1999, 38). Due to the fact, there are also needed to have qualitative analysis within assessment.

A qualitative analysis researches the data as completeness. This method aims to explain all issues that relate to the theme in that way that they are not in contravention of given interpretation. (Alasuutari 1999, 38.) The qualitative analysis based on simplifying of observations and solving of problem (Alasuutari 1999, 39). The qualitative analysis aims to identify wastes, redundancies or losses in the process eliminating them. In the assessment are used value-added analysis classifying and giving a value for some steps of the assessment. For instance, aspects that have environmental permit requirements are automatically significant. There have also utilized root-cause analysis, which is a technique making cause-and-effect diagrams and why-why diagrams. This is an effective analysis method for getting to the root of the issues, such as research which aspect cause impacts and is significant. (Martin 2017.)

Data collection is also a part of the Environmental Management System model, which has been called the Plan-Do-Check-Act model. Data collection is a do phase which uses data and information about researching operations. The following figure 11 presents the main process of data collection methods.



**Figure 11.** The main data collection model (ISO 14031: 2013, 41).

The data collection model ensures that collected data is reliable which depends on, for instance, availability, adequacy, scientific and statistical validity and verifiability of factors. Data collection will be a part of quality control ensuring that the data obtained is the required type and quality for assessment. Data collection will be through interviews and observations as well as records, such as monitoring, measuring, inventory, production, financial, accounting, purchasing, training, emergency situations and compliance, as well as incident records. Existing reports such as reviews, audits, assessments and studies will also be used. Data collection will be based also on government agencies, academic institutions, non-governmental organizations, suppliers and subcontractors, customers and other interested parties. Another management system, risk assessment, permits and licenses, as well as innovations will be used as the foundation for data collection. (ISO 14031: 2013, 43.)

The data collection method from locations has been empirical. The used data in the own operation assessment has been collected from locations that have used their existing data-

bases. They have implemented an Excel template survey that has separated tables for certified locations and non-certified locations. Data collection is based on subjective experience of locations. The collection method has been a qualitative research method which has a space for the users experience and overviews. They have used predefined categories in the template that the user can select from a drop down list. They have also used free text fields so that the user can explain details about the location's circumstances. The data collection method has been leading, but it has left a space for the users experience and know-how about the operation.

Assessment for technologies and products, as well as the supply chain, has been executed as with the literature data collection method. Existing information from internal databases, international research and scientific reports have been utilized. In this the main idea was to collect information together and create a template for the new information. After data collection, information should be analyzed and converted. The data should be handled into information describing the company's environmental performance and it shall be relevant and reliable. It should include consideration of data quality, validity, adequacy and completeness ensuring that statistical tools will be used to increase the reliability of data and decisions from which aspects are most significant. The statistic tools will include graphical techniques, indexing, aggregating and weighting. (ISO 14031: 2013, 43.)

#### **4.6 Background of LEAN procedures and effect to the environmental aspect assessment procedures**

LEAN is a model for management and production. It will support the company's approach in continuous improvement. The base idea is to work systematically to achieve desirable improvements in efficiency and quality by small changes in processes over the long-term. It is possible to achieve savings from waste of time, effort or money by identifying business processes step by step. Results reveal which parts of processes do not create value for the company. Elimination will be started from the major part of waste and value defining, business step defining and value-creating steps will be repeated as many times as needed until all waste has been eliminated. Lean management was developed for manufacturing in Japan in the late 1980s. (Rouse 2013.) Lean production is in the same methodology family as lean management. It is an assembly-line methodology which was originally developed for the manufacturing of automobiles. In addition to elimination of waste, the methodology supports workers empowerment, reducing inventory and improving productivity. Following this

methodology, the company can respond faster to customer demands than their competitors. It increases the competitive edge of the company, for business based on reactive networks, such as suppliers. The company will also be competitive with made-to-order principles and focusing resources in a flexible manner. Lean production is summarized in these ten rules:

- Eliminate waste;
- Minimize inventory;
- Maximize flow;
- Pull production from customer demand;
- Meet customer requirements;
- Do it right the first time;
- Empower workers;
- Design for rapid changeover;
- Partnership with suppliers;
- Create a culture of continuous improvement. (Rouse, 2009.)

The aim of a single global common assessment system is to clarify the environmental aspect assessment procedures and impact mitigation by utilizing LEAN principles that aims to shorten lead-time of processes and improve the quality of them. The first step towards the effective management of environmental aspects and impacts is to understand the existing process. Collaboration over business lines and common targets that suit all business lines, as well as multifold know-how about processes lead to the effective process and help in continuous improvement. Standardizing of process minimizes unnecessary work and gives more time for other duties. In addition, the Common Code of Conduct helps monitoring and reporting, as well as communication internally and externally. (Karjalainen 2015.)

## **5 ENVIRONMENTAL ASPECT IDENTIFICATION AND IMPACT ASSESSMENT**

Environmental performance evaluation helps the company to not only identify environmental aspects but also to assess environmental impacts. This management process uses key performance indicators to compare the company's past and present environmental performance with its environmental targets that it has set in the Environmental Management System. Systematic environmental performance evaluation will help the organization to identify its environmental aspects and determine which aspects it will treat as significant. It also will set objectives and targets for improving environmental performance and assess performance against these objectives and targets. It is a tool which can be utilized to identify opportunities for better management of its environmental aspects and trends in its environmental performance. In addition, environmental performance evaluation reviews and improves the efficiency and effectiveness of the company's operations, identifies strategic opportunities and evaluates compliance or risk of non-compliance with legal requirements and other requirements which related to the environmental aspects. It is also a tool for the reporting and communicating of environmental performance internally and externally. (ISO 14031: 2015, 15, 17.)

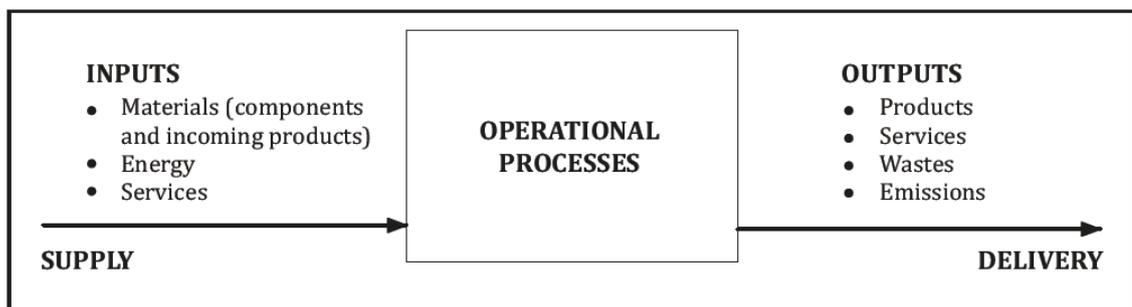
Environmental aspect identification complies with the International Standard's management model: "Plan-Do-Check-Act". Plan is a preparing phase where implementing performance evaluation by planning appropriate environmental performance evaluation system and selecting indicators for this system. The Do phase is data managing and information which consists of relevant data collecting to the selected indicators. (ISO 14031: 2015, 17.) Environmental aspects have separated characteristics in different sectors. The production sectors have usually major scale environmental aspects. The easiest way to approach environmental aspect identification is to list inputs of processes. If the aspects of the production processes are listed, there will include the following inputs in the list, such as all significant items of processes: raw materials, energy and water consumption, packaging, transportation and everything else that might have significant environmental impacts. (Nolan 2015 a.) The list may also contain aspects of abnormal situations for instance leakages, fires, explosions and other foreseeable incidents that might happen anyway. Through comparing production processes to office work it is possible to see that they have the same aspects, but normally the scale is different. Certainly, there are also differences between those aspects. Many times, effects of

production on the environment are clearer than the effects of office work. Issues that are under consideration in offices are for example: air conditioning, electricity and heat consumption, waste water systems, consumption of materials, waste disposal, noise pollution and traveling. As in the production processes, there is also a possibility of fire in offices. In addition, abnormal conditions are necessary to be considered in the identification process in both places. There may occur spills of chemicals or leakage of other hazardous materials in production, but in offices the probability of spillage is lower. Hence, fire is the most probable. In the assessment, there should be, for example, consideration of what happens to runoff water in a fire situation. Does it have the potential to damage with a negative impact on the environment, such as water overflows? (Nolan 2015 b.) After data collection the Do phase requires data analysis and converting into information that is described in the company's environmental performance and assessment information describing the company's environmental performance in comparison with the company's environmental performance objectives. Then it requires reporting and communicating information that describes the company's environmental performance. (ISO 14031: 2015, 17.) Check and Act phases are for reviewing and improving the environmental performance evaluation system in minimizing the environmental aspects of the company's operations. (ISO 14031: 2015, 17.) The company should firstly reduce environmental aspects which it has identified. It means the need for an environmental impact assessment, following this, there have to be in use effective reduction actions that mitigate impacts on the environment. A plan is required when removing or improving significant aspects that cause impacts. The plan should consist of information about how and when aspects will be assessed. This whole "Plan-Do-Check-Act" process ensures effective environmental management in the company. (Nolan 2015 a.)

In major companies, the assessment might be difficult to approach. The easiest way is to start with the obvious, such as buildings and compliance with legislation of the company. Buildings cause a major part of environmental impacts and compliance of legislation means always significant impacts that should be taken into account in assessment. The evaluation considers input and output flows that relate to operations of the company and it means evaluation of all processes of the company. There are a lot of issues that are needed in production such as energy, water, raw materials and natural resources, chemicals and other substances. All of these have environmental aspects that cause environmental impacts. (Nolan 2017 a.) Buildings and processes need a major part of energy and especially heavy engineering traditionally consumes a major part of electricity and fuels. Hence, it is important to concentrate

on energy efficiency. This could also mean heat and electricity efficiency or efficiency of buildings such as their insulation, as well as efficiency of machines. It is important to think, if machines are modern and energy efficient or are they outdated technology? Due to the fact that energy consumption is the major factor part, that causes environmental impacts in production operations. Hence, it is necessary to think is it possible to benefit from renewable energy, such as solar panels or wind turbines or utilize extra insulation or modernize machinery in the company or in buildings. Through these, it might be possible to much improve energy efficiency at the company. (Nolan 2017 a.)

Before the controlling of environmental impacts is possible, environmental aspects should be identified first and the setting of the criteria for these aspects before assessment. Four simple tips can be given in environmental aspect identification. Environmental aspects of operations are determined if there is a background team that is qualified and able to give inputs for the assessment. Assessment results are more reliable, at the end, if all data on operations is accurately recorded before and after actions. It is also necessary to have a time-bound plan to ensuring that all improvements to operations will be executed. In addition, it is important that reviews and an improvement plan ensure that improvement targets will be achieved. This is a part of continuous improvement work. (Verbenac 2016.) Figure 12, below describes how environmental aspects can be listed as inputs and environmental impacts as outputs. It is not commented if the aspects and impacts are adverse or beneficial for the company.



**Figure 12.** Operational flow (ISO 14031: 2015, 29).

The company should select environmental condition indicators due to the fact that they support the establishment of a baseline against which to measure change, as well as identification and management of the company's significant environmental aspects. Indicators guide assessment of the appropriateness of environmental performance objectives and selection of

key performances. Indicators are also part of the determination of environmental change over time in relation to an on-going environmental programme. In addition, condition indicators reveal investigation of possible relationships between environmental condition and the company's operations, products and services. They determine also needs for actions. (ISO 14031: 2015, 31.)

### **5.1 Global overview of process**

Before environmental aspect assessment, processes determination should be carried out that will reveal the value chain parts that will have the most significant aspects. It would be done during certification process if the company is certified by the ISO 14001 certificate. There would be identified environmental aspects by using international requirements such as IFC's EHS Guidelines in operations or GHG Protocol's emissions calculation as well as sustainable reporting guidelines, such as GRI standards. The best approach towards environmental aspects and impacts is to examine the whole life cycle of the value chain. If there is a production process under consideration it is wise to check that in the life cycle perspective, because there are many risks in the production that come out of the mill site. Of course, there are environmental impacts that are also caused directly from production.

Global companies have various combinations of operations within their value chain. There are upstream activities before the company's own operations and downstream activities after own operations in the value chain. It is known that supply chains will be complex, but also own operations will have variation. There will be different types of business, such as production, service, sale and management operations and lots of more processes. All of these categories have different types of environmental aspects. A company can have worldwide business operations, such as research and development centers, service centers, production units and sales offices. It has also at least one headcount in some country. A company can also have warehouses around the world, operations in its customers' facilities, but also delivery centers and trial run places near its mills or near the customers.

Companies use energy, other resources and produces waste. It is important to consider if there are existing processes to manage their use of resources and, for example, consumption of water and energy. All devices such as production machines, cranes, boilers, computers, mobile phones and printers and copy machines need energy, but also lighting, air conditioning and other refrigeration devices that are more unnoticeable need energy. Air conditioning might consume a major part of energy in offices. (Nolan 2017 b.) Especially locations that

are in the northern hemisphere, consume a lot of energy in the winter time when they heat their facilities. Locations might also use a lot of energy for cooling in the summer time. As for machines and other devices, they take a major part of energy in production.

Traveling during working hours is a part of working and causes emissions. In the same way, transportation is not a core business, but it is a significant aspect and causes notable emissions. Companies can encourage employees to cycle or walk to work and proposes employees to share their car with a colleague or colleagues as well as use public transportation, whenever possible. In global companies, emissions from traveling might increase to be huge and very significant. The best way to decrease emissions of traveling is to avoid travel. This means online conferences and video calls, meetings with clients online and such arrangements. (Nolan 2017 b.) The company can perform a reactive cooperation without face to face meetings. Transportation plays a significant part of the company's own operations but it is usually taken into account as part of the supply chain.

The supply chain and especially transportation, such as product shipping to customers, creates an amount of environmental impact. An impact assessment should consider logistics and partners and should encourage them to work in the most environmentally efficient way. Not only internal logistics but also external logistics should be executed in such a way that it is sustainable and efficient. Vehicles in the mill site and trucks routes should be as environmentally compliant as possible. It is necessary to note, if a company calculates its emissions by using the GHG Protocol's principles, then all emissions that it cause by using its own vehicles, are calculated as Scope 1 emissions. Other emissions that are caused by travelling, transportation and delivering are Scope 3 emissions and is calculated as a company's indirect emissions. Purchasing is not without environmental impacts. Typically, not only cost criteria are considered, but business does not consist only of costs. It also includes part of image, responsibility and requirements of customers and laws. Hence, it is necessary to examine also parts of the business that are not part of the core business. (Nolan 2017 b.) Environmental aspect assessment will be performed for all own operations. It will also be easiest to start to survey a company's own operations at first.

## **5.2 Environmental aspects of companies' own operations**

Before environmental aspect identification, comes own operations categorized by processes. During identification system boundaries are decided for unit processes and it should be determined how detailed these groups are and criteria established for system boundaries (ISO

14044: 2006, 25.) It is possible to describe the whole operation using unit processes from a process flow chart. It should show the point, in the process flow chart, where the unit process begins. It will not only mention raw materials and intermediate products but also the nature of the transformations and operations that occur as part of the unit processes. The last requirement for unit processes is that it should mention the point in the process flow chart where the unit process ends. (ISO 14044: 2006, 27.)

When the system boundaries are set, several flows that are mentioned below should be taken into account:

- Raw materials
- Inputs and outputs of process
- Distribution or transportation
- Production and use of fuels, electricity and heat
- Use of maintenance of products
- Disposal of process wastes and products
- Recovery of used products including reuse, recycling and energy recovery
- Manufacture of ancillary materials
- Manufacture, maintenance and decommissioning of capital equipment
- Additional operations, such as lightning and heating

The initially defined system boundaries might be too wide, so they need to be refined more specifically later. (ISO 14040: 2006, 33.)

The significant point in the assessment process is that all operations, in every group are evaluated with equivalent assumptions and context (ISO 14040: 2006, 11). Next, there is listed nine steps that lead to establishing the most remarkable aspects at the company.

- 1) At first identifying all a company's processes, such as workshops, foundry operations, service and logistics as well as offices are considered.
- 2) Then deepen the identification to defining all activities in process by order of execution. There is a long list of activities that relate to processes, such as coating, grinding, polishing and welding. Also, traveling, transportation and packing, etc. depending on a company's business field.

- 3) Each activity has input flows that could consist of resources. Identifying them makes it possible to see energy, materials and other flows to the activity. Those flows are environmental aspects of activity.
- 4) If the process has input flows, it also has output flows. Identifying outputs from each process or activity can establish environmental impact flows such as products, waste and air, water and soil emissions.
- 5) Besides input flows there are aspects in process or activity that should be identified, for example cooling oil, gases in air condition facilities, etc.
- 6) There are also aspects regarding maintenance of equipment and installations, such as spare parts, hydraulic and motor oils, filters and lubricants. They should be identified next.
- 7) If a very detailed evaluation is performed then all aspects have to be identified during design and development or changes in process, activities, product and services.
- 8) After all these, abnormal conditions and emergency situations should also be considered. Identify environmental aspects emerging from incidents, for example in cases of fire, there can be poisonous smoke, vapors and water etc.
- 9) When all aspects are identified then impacts should be identified, according to aspects. Impacts could be
  - pollution of biosphere, such as humans, plants and animals,
  - pollution of soil, water or air,
  - changes of climate and landscape,
  - exhaustion of natural resources,
  - impact on material goods and cultural heritage. (Stojanovic 2017.)

Identification will be carried out step by step and entered into the evaluation system. At first, the system will be in the form of an Excel file, but later it could be dedicated environmental management software.

Concrete environmental aspect identification needs people who are familiar with these products and processes. They can describe activities around these targets and inform environmental aspects related to these targets. Also, interested parties within the assessment should be considered due to the fact that for instance neighbors of mill sites often suffer the effects of environmental aspects and impacts. Together with people, for example employees who know the process, environmental issues should be checked that could relate to the process.

Through this it is possible to establish what kind of environmental aspects and risks could exist. It is necessary to remember to also consider unconventional incidents. These could be situations that occur rarely, but could create huge harm effects if something happens. These could also be situations that occur almost every time when the process is executed, but the effects are minor. Of course, there are also situations between these extremities. After aspect identifying, it is time to identify impacts. Here could be used all the monitored information about impacts. (Stojanovic 2017.)

The identification process enables an evaluation process of environmental issues. At first, it is important to decide what kind of system is usable for assessment. It has to be a methodology that is easy to execute and it gives relevant, useful and unambiguous information. In this case, the methodology is an Excel based system where the user makes selections using drop-down menus. This leads the user to think about issues in sufficient detailed. Before the creation project, the criteria was defined on how detailed information is sufficient to collect. Then the user adds inputs and outputs of the activity since they give beneficial information for evaluation. (Stojanovic 2017.)

After evaluation, it is time to manage significant aspects. General procedures start from operational controls defining. It is a phase where improvement actions are created of processes, tools are developed for effective way to handle them, and the way to work is created. Working is not the only part that should be considered. Almost as important as operational controls defining, it is used to define the need for training and awareness among people in a company. Management is meaningful if there is monitoring of environmental activity. Monitoring reveals if the process does not work according to the idea. This also shows where the potential to improve the process is. (Stojanovic 2017.)

### **5.3 Environmental impacts of companies' own operations**

After grouping of environmental aspects, occurred environmental impacts will be classified. Major impacts derive from the following:

- Energy inputs, raw material inputs, ancillary inputs, other physical inputs;
- Products, co-products and waste;
- Releases to air, water and soil, and
- Other environmental impacts (ISO 14044: 2006, 33.)

In evaluating environmental aspects it is possible to utilize principles of Life Cycle Impact Assessment (LCIA). The company can select impact categories, category indicators and evaluation procedures for its impacts. Selected indicators can be based on an environmental mechanism that is dependent on impact category. In some cases, environmental mechanism reflects the end point of category meaning the point where the scope of impact assessment ends. (ISO 14044: 2006, 43.)

An impact characterization model will show all effects of an environmental impact within the selected scope by using an environmental mechanism. After environmental aspect assessment, environmental impacts that related to the aspect will be found. These impacts could be, for example, air emissions, such as sulfur dioxide (SO<sub>2</sub>) or hydrochloric acid (HCl). In this case, impact category will be acidification and impact category has acidifying emissions, such as nitrogen oxide (NO<sub>x</sub>) or SO<sub>2</sub> or other assigned to acidification. Category endpoints, in this case, will be forest or vegetation or other targets that suffer from acidification. (ISO 14044: 2006, 45.) In addition, there are some requirements for the impact categories:

- The impact category should be internationally accepted, because this ensures comparison between all evaluated targets.
- The impact categories should represent the completeness of input and output impacts of the operation system on the endpoint category.
- Value-choices and assumption should be minimized during the selection of impact categories.
- Double counting should be avoided by evaluating environmental impacts in separated operational units, such as own operations and supply chains.
- Each category indicator of the categorization model should be scientifically and technically valid, and based upon a distinct identifiable environmental mechanism and reproducible empirical observation.
- The extent of the characterization model should be identified to confirm it is scientifically and technically valid.
- The category indicators should be environmentally relevant. (ISO 14044: 2006, 47.)

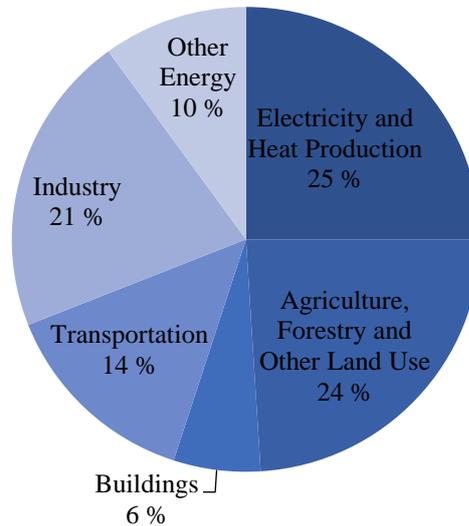
After this, the assessment results should be reported. First, assessment will be performed without mitigation operations. Hence, if the results of the impact are too high, mitigation operations should be executed and after this assess the impact once again. Environmental

impact assessment, based on evaluation of operational groups' emissions that will be evaluated by separated indicator parameters. Assessment follows environmental aspect categories that consider emissions to air, and discharges to water and soil, use of energy, raw materials and natural resources, waste management and use of space.

As environmental aspects, there will be number of variations of environmental impacts depending on a company's business field.

#### 5.4 Results of environmental aspect and impact assessment in own operations by business fields

The assessment was executed by using nine separate environmental aspect categories. In dividing all assessment results from separated companies into the categories, it will inform which category is the most significant. Intergovernmental Panel on Climate Change (IPPC) has released Climate Change 2014 – Mitigation of Climate change issue that has a research of global greenhouse gas emissions by economic sectors. It presents the greatest business sectors that cause significant impacts and affect to climate change. Picture 13 shows the most important economic sectors.



**Figure 13.** Global greenhouse gas emissions by economic sector by IPCC report 2014 (EPA 2017).

The international Finance Corporation has written industry sector guidelines where it has divided separated business fields in eight categories and they under sub-categories.

Agribusiness or food production has 13 different sub-categories at the moment. They are sectors that are typically resource intensive. Now days there are also opportunities for efficiency improvements. (IFC 2017 b.) Agribusiness and food production consist following sub-categories:

- annual crop production
- aquaculture
- breweries
- dairy processing
- fish processing
- food and beverage processing
- mammalian livestock production
- meat processing
- perennial crop production
- poultry processing and production
- sugar manufacturing
- vegetable oil production and processing

Commonly, agriculture includes wastewater and water management, causes air emissions, soil waste and by-products, land use management and crop and grain storage as well as cause environmental impact throughout the supply chain. There are possibilities of cost-savings and efficiency throughout the production processes. There are opportunities to improve following operations and generate savings and higher efficiency. Increasing water recycling and reuse and reduce water consumption, increasing cogeneration capacity, increasing energy from renewable resources and improving waste heat recovery, steam efficiency or combustion efficiency. There will also be responsibly managed biofuels from organic by-products for energy. Resources will be sugar canes, corns and methane from manure. In addition, impacts will be reduced by carbon credits sales. Transportation and supply chain have also significant part of agribusiness and food production. Increasing use of efficient vehicles, such as hybrid and electric cars and greening supply chain by addressing resource efficiencies of suppliers is possible to reduce impacts. (IFC 2017 a.) Agriculture, forestry and other land use cause 24 % of all greenhouse gas emission in the world. Most of them occur from cultivation of crops and livestock deforestation. (EPA 2017.)

Infrastructure consists of 14 sub-contractors such as transportation in air, water and land. Commonly, the infrastructure sector has a wide range of activities that vary from medium to high environmental impacts. The most resource intensives are typically constructions and decommissioning. Many infrastructure operations cause air emissions, wastewater discharges and need solid waste management. Impacts will be caused in construction and building materials poor quality as well as through transport and telecom. The infrastructure sector can increase cost-savings and improve efficiency by using environmentally friendly building and construction materials, reducing and reusing construction waste, and increasing water recycling and reuse of wastewater. The sector can reduce air emissions by switching to alternative fuel sources for operating machinery. Transportation has significant role of infrastructure. Increasing use of efficient vehicles transportation impacts will decrease. Disposing of obsolete telecom equipment by renewable energy it will reduce impacts of telecom. (IFC 2017 c.) Subcategories are:

- airlines and airports
- crude oil and petroleum product terminals
- gas distribution systems
- health care facilities
- ports, harbors and terminals
- railways
- retail petroleum networks
- shipping
- telecommunications
- toll roads
- tourism and hospitality development
- waste management facilities
- water and sanitation (IFC 2017 a.)

14 % of all greenhouse gas emissions are caused by transportation and most emissions come from fossil fuel based vehicles. The transportation sector needs new innovations to its fuel alternatives. Around 95 % of world's all transportation energy based on petroleum-based fuels, largely gasoline and diesel. (EPA 2017.)

General manufacturing is a huge sector that can include all kind of production. It has emissions to air; water pollutions; energy consumption; waste, including both solid and hazardous waste and environmental impact throughout the supply chain. The manufacturing sector can make its processes more efficient and saving cost by improving its energy efficiency, pollution controls, co-generation and waste heat recovery. There will also be improvements in utilization of renewable energy resources, recycling water and reducing water consumption, manufacturing products with fewer raw materials and greening of supply chain by addressing resource efficiencies of suppliers. (IFC 2017 d.) Industry business field cause 21 % of global greenhouse emissions. Commonly, emissions occur from onsite burned fossil fuels for energy of facilities. It is the third largest economic sector which causes global greenhouse gas including chemical, metallurgical and mineral transformation processes' emissions. (EPA 2017.)

Oil and gas are commonly used fuels in the world. They cause air emissions, waste water discharges and soil and liquid waste management. (IFC 2017 e.) Oil and gas are for example:

- Liquefied natural gas (LNG) facilities,
- Offshore oil and gas development,
- Onshore oil and gas development. (IFC 2017 a.)

Increasing co-generation, waste heat recovery and combustion efficiency, as well as recycling wastewater and reducing water consumption it is possible to decrease emissions of oil and gas sector. Reducing also the amount of energy consuming or increasing amount of energy from renewable sources decrease impacts on the environment. (IFC 2017 e.)

Mining is located at the beginning of many products life cycle. It causes air emissions, solid and hazardous waste and use water. It also causes environmental impact throughout the supply chain. Using less carbon intensive fossil fuels or co-firing with carbon neutral fuels, such as biomass decrease impacts of the mining. (IFC 2017 f.)

Most typical impacts of forestry are wastewater, due to the forestry water intensiveness, air emissions, solid waste and by-products. As many of other business fields, forestry has also environmental impacts throughout the supply chain. Forestry included:

- board and particle-based products
- forest harvesting operations

- pulp and paper mills
- sawmilling and wood-based products

There are many possibilities to improve efficiency of the forestry sector for example by increasing water recycling and reusing but also reducing water consumption. Increased co-generation capacity and energy use from renewable sources mitigate the impacts. Improvements of waste heat recovery and steam efficiency as well as combustion efficiency increase need of energy. The forestry sector produces a lot of organic by-products. Using them into energy production mitigates the amount of waste and need of virgin energy resources. (IFC 2017 g.)

Power generation is the greatest business field in the world. It causes 25 % of global greenhouse gas emissions. The burning of coal, natural gas and oil for demand of electricity and heat affect the largest single source of global greenhouse gas emissions. (EPA 2017.) The following are the separated categories for power generation:

- electric power transmission and distribution
- geothermal power generation,
- thermal power,
- wind energy (IFC 2017 a.)

Power generation is one of most remarkable cause of air emissions that includes greenhouse gas emissions. It also uses water and cause waste water discharges. If the power sector use less carbon intensive fossil fuels or it co-firing with carbon neutral fuels it will mitigate impacts on the environment. Combined heat and power plants (CHP) is recommended to use if it is feasible. Energy efficiency will be possible to improve through use of higher energy conversion efficiency technology. The power sector will increase its water recycling and reduce its wastewater discharges by investing in closed-cycle, recirculating cooling water systems by using natural or forced draft cooling water. It can also invest in closed circuit dry cooling systems that based on air cooled condensers. (IFC 2017 h.)

The IFC has also a list of the chemical sector. It consists of following sub-categories:

- Coal processing,
- Large volume inorganic compounds manufacturing and coal tar distillation,
- Large volume petroleum-based organic chemicals manufacturing,

- Natural gas processing,
- Nitrogenous fertilizer manufacturing,
- Oleochemicals manufacturing,
- Pesticides formulation, manufacturing and packaging,
- Petroleum refining,
- Petroleum-based polymers manufacturing,
- Pharmaceuticals and biotechnology manufacturing,
- Phosphate fertilizer manufacturing. (IFC 2017 a.)

Typically, chemical sector need management on air emissions, wastewater as well as solid and hazardous waste. The chemical sector can decrease its emissions by increasing co-generation, waste heat recovery and combustion efficiency. It will also increase recycling and reduce water consumption as well as reduce amount of energy consumed or increased amount of energy from renewable sources. (IFC 2017 i.)

#### **5.4.1 Air emissions**

Air emissions can occur from a wide range of activities. They can relate to construction, operations and decommissioning phases of processes. There will be number of facilities and processes that generate emissions to air at any stage of the operations life cycle. Commonly, all emissions on the environment should be avoided, minimized and controlled, but if this is not possible, the generation and release of emissions should be managed through a combination of efficient energy use, process modification, selection of fuels or other materials. There will be selected materials that pollute less of emissions. There will also utilized application of emissions control techniques. (IFC 2007 b, 3.) Some business operations can be located in ecologically sensitive areas. In those areas should be ensured that any increase in pollution levels is as small as feasible. Use of cleaner fuels or technologies and applications of comprehensive pollution control measures will mitigate emissions to air by industry-specific basis. Air emissions will occur from point sources which are discrete, stationary, identifiable sources of emissions. They release pollutants to the atmosphere. Commonly, they are associated with combustion of fossil fuels causing, such as NO<sub>x</sub>, SO<sub>2</sub>, CO, particulate matter (PM) and VOCs, as well as other air pollutants. They are also associated to industrial activities and it does not a wrong assumption, because they are typically located in production plants. (IFC 2007 b, p. 5.)

Most typical air emissions are carbon dioxide (CO<sub>2</sub>), volatile organic chemicals (VOC), nitrogen oxide (NO<sub>x</sub>), and sulfur oxide (SO<sub>x</sub>) and methane (CH<sub>4</sub>). There will be also carbon oxide (CO) and absorbable organic halogen compounds (AOX) releases. All of emissions cause impacts on the environment. CO<sub>2</sub> and CH<sub>4</sub> cause significant effects to the climate change. CO<sub>2</sub> emissions can be human-induced impacts that can be released from land use, agriculture or degradation soils. Methane is caused by agricultural activities, waste management, energy use and biomass burning. It is stronger greenhouse gas than CO<sub>2</sub>, but its lifetime is shorter in the atmosphere. (EPA 2017.) VOCs are the most sources of fugitive emissions that are distributed spatially over a wide area and not confined to a specific discharge point. VOC emissions associated usually with industrial activities, due to the production operations, storage and warehouses and used VOC-containing materials, such as liquids and gases which are under pressure, exposed to a lower vapor pressure or displaced from an enclosed space. Typically, VOC emissions occur from equipment leaks, open vats and mixing tanks, storage tanks, unit operations in wastewater treatment systems and accidental releases. Particulate emissions cause health problems and effect to the air quality and ozone depletion. They are tiny particles that grab respiratory tracks and lungs and in the atmosphere to the other particles such as heavy metals and hydrocarbons. Common pollutants are occur transportation, open storage of solid materials and exposed soil surfaces, such as unpaved roads. (IFC 2007 b, 8.) Ozone depletion is a real problem that some chemicals further and intensify. Those chemicals are classified as ozone depleting substances and they are scheduled for phase-out. There are CFCs, halons, 1,1,1-trichloroethane, carbon tetrachloride, methyl bromide and HBFCs that are forbidden to use in new systems and processes. Greenhouse gas emissions are the greatest part of air emissions. Potentially most significant emissions are related to energy, transport and heavy industry, such as cement production, iron and steel manufacturing, aluminum smelting, petrochemical industries, petroleum refining and fertilizer manufacturing. Agriculture, forestry and waste management cause also significant emissions. GHG emissions can be direct emissions that caused by physical facilities and processes, but also indirect emissions that associated with the off-site production, such as from used power production. IFC 2007 b, 9–10.)

#### **5.4.2 Water emissions**

There have been appointed a few guidelines for business operators to prevent their water emissions. They should plan and implement the segregation of liquid effluents principally along industrial, utility, sanitary and storm water categories. In addition, they should identify

opportunities to prevent or reduce wastewater pollution by recycling or reusing water for example within their facilities. (IFC 2007 c, 25.) Wastewater can be industrial or sanitary wastewater. Industrial wastewater occurs from industrial operations, such as processes, utility operations, runoffs from processes and materials staging areas. There will also be miscellaneous activities that consist of wastewater for example from laboratories. Industrial wastewater can include acids or bases that affect to its pH as low or high. There will be soluble organic chemicals that cause depletion of dissolved oxygen, which indicators are BOD and COD. Suspended solids as well as phosphorous and nitrogen nutrients are also common in industrial wastewater. It will also include heavy metals, for example cadmium, chromium, cooper, lead, mercury, nickel and zinc. Cyanides, toxic organic chemicals, oily materials and volatile materials are also common in wastewater. It is necessary to ensure by suitable treatment that pollutants cannot transfer to another place, such as air, soil or the sub-surface. (IFC 2007 c, 27.) Wastewater utility operations can be cooling towers and demineralization systems that can increase water consumption and potentially release high temperature water to water systems containing high dissolved solid, residues of biocides and other cooling system anti-fouling agents. In many places in the world storm water management is a lifeline occasionally, because storm water includes any surface runoff and flows. It will include suspended sediments, metals, coliform, petroleum hydrocarbons and Polycyclic Aromatic Hydrocarbons (PAHs) (IFC 2007 c, 28.) Wastewater management consists of also sanitary wastewater from industrial facilities. In the office work based business field, sanitary water is only wastewater that should be taken into account in assessment. It will include effluents from domestic sewage, food service and laundry facilities that will serve employees. Miscellaneous wastewater from laboratories, medical infirmaries and water softening include also in the sanitary wastewater treatment systems. (IFC 2007 c, 29.)

#### **5.4.3 Soil emissions**

Industrial releases to soil are hazardous materials, wastes, oil and natural occurring substances. Soil emissions will be related to the historical activities onsite or current operations in the mill or other operation site. They can be accidentally released for instance during materials handling and storage due to their poor management or disposal. Soil can include naturally some of hazardous materials or heavy metals, but it is considered contaminated when it contains hazardous materials or its oil concentrations are above background or naturally occurring levels. Contaminated surficial soils or subsurface soils can affect quality of surface

water and adjacent sites. If soil contains volatile substances, soil vapor can affect also contamination of air. Contaminated soil not only cause always risks to human health but also ecological losses. (IFC 2007 e, p. 54.) Contaminated soil can include PAHs and separated heavy metals, such as cadmium, chromium, copper and mercury that can be from fuel leakages. Its total organic carbon level can also be high or it can have benzene compounds.

#### **5.4.4 Use of raw materials and natural resources**

Use of raw materials and natural resources cause environmental impacts even in processing, such as a mining phase, enrichment and refining. Use of material needs a lot of work before it is possible to be utilized in production operations. A significant amount of energy and water have been used and processes have generated waste.

It is possible hazardous materials in their production or products manufacturing phase have been used when they relate to the whole process. Most of industrial production phases can include hazardous substances which physical or chemical characteristics can create hazard to the environment. These materials can be categorized as explosives, such as compressed gases, toxic gases and flammable gases, liquids and solids. There will also be oxidizing substances, toxic and radioactive materials and corrosive substances. (IFC 2007 h, 36.)

#### **5.4.5 Use of energy**

Use of energy is the greatest source of emissions in the world. Mitigation of energy usage is very important. If emissions of energy usage cannot decrease, reduction of other emission resources is inconsequential. Only reduction of other sources is not sufficient to prevent all impacts that cause for instance climate change. Fossil fuels caused 65 % of all emissions in the world in 2010. Utilization of coal oil and natural gas as fuel caused 31.6 billion CO<sub>2, eq.</sub> tonnes of emissions. (Partanen & Korhonen 2016, 23.)

Energy usage will consist of consumer energy in process heating and cooling, process and auxiliary systems that are needed in processes, such as motors, pumps and fans. Also compressed air systems and heating, ventilation and air conditioning systems, as well as lighting systems consume energy. (IFC 2007 f, 18.) Many combustion systems cause CO, CO<sub>2</sub>, CH<sub>4</sub>, NO<sub>x</sub> and SO<sub>2</sub> emissions and particulate matter and dust. Fossil fuels are primary sources of CO<sub>2</sub> emissions. CO<sub>2</sub> can be released direct on human based land use, such as through forestation, agriculture and degradation of soils. These emissions are possible to prevent by

combustion circumstances, such as using the minimum practical excess air volumes or utilizing optimal combustion temperature. (IFC 2007 f, 19–20.) Amount of occurred emissions and also their inconvenience is possible to affect by selected fuel and combustion technique. (Jyväskylän Energia Yhtiöt 2017.) Usually, a major amount of companies' utilized energy is electricity, not only different fuels in their power plants but also in vehicles and district heating that is used in the facility. Steam is also used in some production processes.

#### **5.4.6 Impacts of emitted energy**

There are many different categories of emitted energy. Typically, it can be for example heat, radiation, vibration, noise and light. These occur when there is residual energy that is emitted in another form. There will be, for instance, process that produce process heating. It is vital for many production operations, such as heating for fluids, calcining, drying, heat treating, metal heating, melting, melting agglomeration, curing and forming. Emissions will be an imbalance between heat and mass or energy losses from the process. (IFC 2007 f, 19.)

Noise emissions affect occupational health and safety risks, hence they should be reduced with relevant options. There will be indoor or outdoor emissions. Employees of a company suffer from indoor emission. In many case neighbors of mill sites suffer outdoor noise emissions. There will be limitations to operation hours, noise sources will be re-located and there will be permanent protectors that mitigate noise emissions. (IFC 2007 g, 52.) There will be information about noise, vibration, land use, radiation, odor and waste heat besides typical air, water and soil emissions will be collected (ISO 14044: 2006, 29). Emitted energy will cause environmental impacts as other aspect categories.

#### **5.4.7 Generation of waste and/or by-products**

Waste can have many forms. It can be any solid, liquid or contained gaseous material that will be taken out of use by disposal, recycling, burning or incineration. It can also be a by-product of a production process. Solid waste that is not hazardous can contain any garbage. Commonly, it includes domestic waste, inert construction and demolition material, metal scrap and empty containers. There is also residual waste from industrial operations. Hazardous waste can be ignitability, corrosivity, reactivity or toxicity material, or other physical, chemical or biological characteristics that can cause potential impacts to the environment. There is also a case-by-case basis that should be evaluated before categorizing into hazardous or non-hazardous waste. This kind of waste can be sludge from a waste treatment plant,

air pollution facility and other discarded material. It will be solid, liquid, semisolid or contained gaseous material that is caused by industrial operations. In waste management, a waste management hierarchy should be complied with, that starts from prevention. Other steps are reduction, reuse, recovery, recycling, removal and finally disposal of wastes. (IFC 2007 i, 46.)

#### **5.4.8 Use of space**

Use of space can cause physical and chemical impacts. There is used space in the mill site, such as machines layouts. They can be placed efficiently or inefficient. The mill site will be located in a good position in logistic overview or that can be in risk area and always have possibilities to pollute the nature. There will be also impacts that caused by business processes indirect, such as landfills. As greater the business is as greater the amount of waste will be and the needed space of waste disposal.

#### **5.4.9 Other impacts**

Business operations can aim also flora and fauna impacts, nuisance or site security. In addition, impacts can be visual and there will be community and transportation related. 16 % of global greenhouse gas emissions are caused by other impacts including buildings' emissions. Other impacts greenhouse gas emissions can be all emissions from energy sector that does not relate directly to electricity or heat production, such as fuel extraction, refining, processing and transportation. It will also be emissions that arise from onsite energy generation and burning fuels for heat in buildings or cooking in homes. However, electricity use in buildings included in electricity and heat production sector's emissions. (EPA 2017.)

In analyzing, the principles of GHG Protocol will be used that have determined the operations under scope 1, 2 and 3 depending on their emissions' resource. Scope 1 has direct emissions which the company will report for the authorities. It includes all emissions from the company's own facilities such as buildings, machines and other properties at the mill site. It also consists of company vehicles which means transportation in own facilities operated by the company's employees and transportation in company cars and other vehicles. Scope 2 includes indirect emissions, such as from purchased electricity, steam, heating and cooling for own use. Business travel, as well as transportation and distribution of goods by logistic suppliers, are part of the supply chain assessment that is calculated and evaluated by using scope 3 determinations. (GHG Protocol 2011, 6.)

## 5.5 Technologies and products

There is a wide range of technologies and products worldwide due to this fact there are not listed all kind of technologies and products that are in the world. This thesis only gives tips how to assess environmental aspects and impacts of technologies and products.

New products of a company will offer to its customer possibility to produce its products cost-efficiently, smooth running machines, energy-efficiency and use of economically prudent materials. Technologies and products will be evaluated using those categories that the ISO 14001 standard has appointed, such as amount of energy and water consumption, utilized chemicals and other raw materials as well as natural resources. There will also be taken into account specific details of a product, such as what kind of energy does the product use and how much annually? Does it use electricity or heat, or does it combust natural gas? How much waste water does it produce and is it possible to recycle or clean the water using normal methods? How much does the product produce waste annually? Is it hazardous or is it combustible or recoverable? Also, the packaging of the products is significant. Recycled materials and packaging will be used, which are possible to reuse. For example, there were developed boilers and gasification technologies that enable the use of a wide range of renewable energy reducing the need for non-renewables in energy production. These renewable energy systems recover energy efficiently from various waste flows such as agricultural, industrial and municipal waste. Technologies and products will also be assessed with benefit categories in the assessment. There are eleven different category that represent environmental impacts, but also effects on the environment.

- Emission Reduction
- End product quality
- Energy efficiency
- Life cycle cost optimization
- Maintenance efficiency
- Material efficiency
- Performance
- Productivity
- Reliability
- Safety
- Water efficiency

## **5.6 Environmental impacts per technology and products**

Society, economy and environment are three main pillars that will be utilized in environmental aspect and impact assessment. There are also used principles of GHG Protocol in the assessment where technologies and products are located in downstream phase of value chain. There will be used requirements of Scope 3 with the following categories for technologies and products: processing of sold products, use of sold products and end-of-life treatment of sold products. (GHG Protocol 2011, 6.)

The customers will set criteria for the company that it complies with in its technology and product offering. All technologies and products should be safe and process will be improved to be energy efficient and they will reduce emissions. Regulation and national requirements will be complied with. As there is a lower consumption of raw materials, fresh water, energy and chemicals are better. The customers also demand fuel flexibility, utilization of renewable energy and increased possibility for recycling. In addition, the customers assume reduced sustainable risks in supply chain. All of them improve a company's sustainable image which is a part of competitiveness in the market. R&D teams develop new technologies and products that improve the customers' performances.

Technologies aim to energy efficiency and life cycle optimization. Customers demand excellent end product quality and the companies also want to offer high-quality products its customers, hence this category is also important. Most improvements increase product performance, productivity and reliability. Customers appreciate low life cycle costs and maintenance efficiency, but they cannot decrease the operational high safety level. The companies comply with sustainability requirements designing and producing products with emission reduction systems, increasing energy and material as well as water efficiency. All sustainable themes are growing, but they are still under progress. In many cases production needs huge amount of energy, water and raw material. Production machines, energy production equipment and other products that are significant part of customer's production are in many case energy intensive technologies and products will consume a huge amount of energy and it will be quite difficult to improve its efficiency. Some technologies utilize bio-based fuels in energy production reducing emissions due to the fact that biomaterials are carbon neutral. When the performance, productivity and reliability increases also the material efficiency increases due to better efficiency. For example, bio-based energy productions increase sustainability in many ways. The new technologies are energy efficient and there are optimized

life cycle costs. The new energy production technologies do not need necessarily much water. Companies have influence on their products. Hence designing more efficient, environmental sustainable and long-lived products and technologies, they can reduce environmental impacts of them.

### **5.7 Responsibility of supply chain and evaluation process**

Arise awareness of environment has increased companies' interest to the whole value chain. Before the producers' responsibilities were finished when the product was delivered to the customer or its guarantee period was over. (Golinska & Romano 2012.) Nowadays environment is more important for companies' interested groups and it is a part of business and competitiveness. Due to the wide supply chains, the focus of the companies should be on supply chain management. The target is to enhance supply chain management and increase transparency of value chain. Traditionally, supply chain management is concentrated on its low costs, high quality, reduced lead time and high service level (Golinska & Romano 2012). At present, it is responsible operations throughout the value chain from post-consumption phase to the products end-of-life phase. There will also be local and global regulation and standard accepted materials and components in main focus. Favoring transparency relationships in the entire value chain, the companies can influence to sustainability of entire value chain. The circulation of production materials, such as stainless steel increases reuse and recycling of material. Here the supply chain has an active role. All suppliers should comply with requirements of companies supply chain policy that will consist of activities as the starting point to end point during all business phases. A responsible supply chain will connect environmentally friendly partners together and enhance competitiveness and creates better customer service, resilience and increases profitability. (Golinska & Romano 2012.) The aim is to strive transparency and traceability of entire value chain. Documentation system, which has information about in production used materials, ensures traceability in the supply chain and gives information about materials recycling. Documentation of materials and products ensure the guaranteed traceability all the way back and forward in the supply chain. Because of stainless steel is fully recyclable, it would be recycled multiple times without losing any of its properties. It can be said that steel is the most recycled material in the world. The company can reduce the environmental impacts in the most effective way by

using the steel with high recycling content. It reduces the carbon footprint and save the natural resources, due to the fact that there are need less virgin materials for the products. (Salonsaari-Posti et.al., 2016, 65–67.)

There will be supply chain management systems for companies' global suppliers, which ensure for example management practices and financial and operative performance to ethical business practices, human and labor rights, occupational health and safety, environmental management and product safety. The system enables assessment of suppliers by country of purchases, and purchasing categories. The existing system assess the potential adverse indirect impacts and risks related to human rights, labor practices, ethical business practices, environmental performance as well as health and safety.

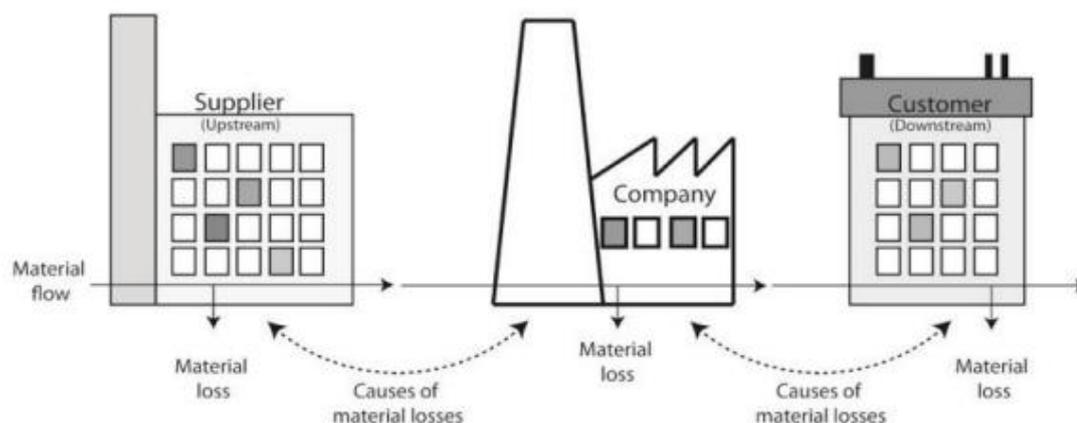
## **5.8 Environmental impacts in global supply chains**

There are many places in the value chain which cause environmental impacts. They will be caused by for example purchasing of goods and services, fuel and energy related activities, transportation and distribution as well as business travels. The companies can report their value chain emissions through a CDP report utilizing principles of GHG Protocol which determine emissions from the company's supply chain under scope 3. It includes all emissions that relate to the following categories before and after the company's own operations:

- Purchased goods and services;
- Capital goods;
- Fuel and energy related activities;
- Transportation and distribution;
- Waste generated in operations;
- Business travels;
- Employee commuting;
- Leased assets;
- Franchises;
- Investments (GHG Protocol 2011, 6).

Emissions can occur from purchased goods and services. Transportation and distribution can also have significant emissions. Other relevant emissions will be caused by business travels such as travelling by air planes, trains and busses and fuel and energy related activities.

Some impacts are global and can be a root cause for the greenhouse effect and other global environmental problems. Some of these are smaller and concern some operation flow such as material flow, which is described in figure 14.



**Figure 14.** Material losing in the supply chain (ISO 14052: 2017, 7.)

The supply chain is located upstream and downstream in the value chain. Environmental impacts will arise from both sides. Impacts can occur due to various causes. For example, material losses can happen upstream due to causes of dimensions or various in qualities of supplied materials. These impacts have a strength link to the suppliers. Material losses downstream will occur due to the design and specifications. Also, the excessive standards of quality of customers will lead to material losses. In many cases, downstream impacts occur in inadequate operations in the company. (ISO 14052: 2017, 7.)

A foundation report has been made, as a part of this thesis, which includes for example information about the UNEP reports of regional environmental assessments (UNEP 2017). Generally, supply chains are long and they have impacts on the environment but also regional impacts will be taken into account when companies are selected their suppliers. Companies can affect impacts from their supply chain, as well as the global impact by selecting sustainable suppliers and supply chains. This foundation report presents the results of the regional concerns about environmental conditions globally. These results are based on ISO 14001 standard categories concerning environmental aspects and the UNEP reports about regional environmental assessments (UNEP 2017.) Table 3 has summary of results.

**Table 3.** General summary of regional environmental assessments by utilizing the results of the UNEP report.

ENVIRONMENTAL ASPECT CATEGORY	REPORTED ASPECTS	REPORTED IMPACTS
<b>North America</b>		
Emissions to air	Air quality Climate change	Air quality has improved. The energy systems cause climate change.
Releases to water	Water	In some area water quality is poor. Water scarcity is increased problem. Depletion of groundwater.
Releases to land	-	-
Use of raw materials and natural resources	Chemicals	Cause air and water quality problems.
Use of energy	-	-
Energy emitted (heat, radiation, noise etc.)	-	-
Generation of waste and/or by-products	Waste	Coal scrubbers, abandoned mines, pharmaceuticals and microplastic are increased.
Use of space	Coastal and marine environment	Nutrition loads, ocean acidification, ocean warming and sea level have risen. Novel forms of marine debris have increased.
Other impacts	-	-
<b>Latin America and the Caribbean</b>		
Emissions to air	Air quality Greenhouse gas emissions	Poor air quality Increased amount of particulate matter and changes in ozone layer. GHG emissions from transportation, fossil fuels, cement manufacturing.
Releases to water	Water quality	Polluted surface water
Releases to land	-	-
Use of raw materials and natural resources	-	-
Use of energy	-	-
Energy emitted (heat, radiation, noise etc.)	-	-
Generation of waste and/or by-products	-	-
Use of space	Biodiversity Urban areas	Major part of export products is one-sided. Coral coverage is declined and there are lots species losses. Water erosion. Huge growth of cities Polluted surface water by urbanization.

Other impacts	-	-
<b>Pan-Europe</b>		
Emissions to air	Climate change Air quality	Increasing greenhouse emissions in transportation, refrigeration, air conditioning, agriculture, energy, raw materials. Poor indoor and ambient air quality
Releases to water	Freshwater	Freshwater is polluted due to agriculture. Microplastic in the water.
Releases to land	Land use	Condition of soil caused from land use, effect water and air pollution. Increased erosion. Increased floods.
Use of raw materials and natural resources	Chemicals Coastal, marine and ocean resources	Hazardous substances form many products to the environment. Resources are over exploited and with wide-ranging impacts
Use of energy	-	-
Energy emitted (heat, radiation, noise etc.)	-	-
Generation of waste and/or by-products	Waste	Amount of waste is still growing. Recycling
Use of space	Biodiversity	Agricultural intensification. Urbanization. Habitat fragmentation by transport infrastructure.
Other impacts	-	-
<b>Africa</b>		
Emissions to air	Indoor air pollution	Bad indoor quality. Urbanization and transportation cause pollutants.
Releases to water	Water	Poor quality of drinkable water. Water scarcity and need of process water.
Releases to land	Land	Poor soil quality. Lack of critical resources.
Use of raw materials and natural resources	-	-
Use of energy	Energy	Huge need for development of energy production systems.
Energy emitted (heat, radiation, noise etc.)	-	-
Generation of waste and/or by-products	-	-
Use of space	Biodiversity	A rich biodiversity has encountered losses and invasive of alien species.
Other impacts	Food	Dependent of food importation

Asia Pacific		
Emissions to air	Air	Sulphur dioxide Nitrogen oxide Fine particles Ozone Poor indoor quality.
Releases to water	Freshwater	Ground water and water content problems. Water scarcity and deteriorating water quality. Increased amount of floods. Sewage contaminant problems. Poor groundwater quality.
Releases to land	Land use	Pollution of soil.
Use of raw materials and natural resources	-	-
Use of energy	-	-
Energy emitted (heat, radiation, noise etc.)	-	-
Generation of waste and/or by-products	Waste	Plastic emissions into the ocean. Complex waste streams. No disposal methods.
Use of space	Ecosystems and biodiversity Coast and oceans	Losses of biodiversity. Unbalanced plantations. The coastal zone has a huge urbanization Coral reefs are under the risk. Increased erosion.
Other impacts	-	-
West Asia		
Emissions to air	Air quality	High pollution level of air.
Releases to water	Water	No general integrated water management system. Increased water demand. Unsustainable water consumption.
Releases to land	-	-
Use of raw materials and natural resources	-	-
Use of energy	Energy	Unsustainable consumption patterns.
Energy emitted (heat, radiation, noise etc.)	-	-
Generation of waste and/or by-products	Waste	No general integrated waste management system.
Use of space	Biodiversity	Biodiversity has met losses. Desertification. Degradation of ecosystem.
Other impacts	Other	Unsustainable consumption patterns.

According to the summary table it is said there are numerous environmental challenges around the world. There are three main categories that affect the major part of emissions: air quality problems and impacts that are caused by urbanization, water and water scarcity and energy consumption that affect climate change. The major problems are nearby the Equator. It suffers water scarcity and water quality problems. Often the soil is also barren in that area. Water is the lifeline in every area, despite whether industry is located or not. Water reliability is needed to be secured for everyone and companies are also responsibility for this. Energy is also an important part of business. Responsible energy production can use renewable energy resources or utilize efficient production types. Energy production is one of the most significant reasons for climate change which affects every area in the world. It is important to control impacts of climate change and decrease activities that cause climate change, for instance reduce greenhouse gas emissions.

The area report of the UNEP presents that all areas have their own separated environmental problems that also affect the activities in these countries. In North America, there is a need for reducing GHG emissions and take into account energy transitions and city level innovations. Latin America and the Caribbean have major problems with biological resources. They have wasted a lot of resources and nowadays they should be considering sustainable management of biological resources. Most parts of Pan-Europe have a long industrial history, hence there are possibilities for sophisticated solutions for environmental impacts. These are aimed at achieving low-carbon resource efficient societies and smart cities. Health is one of the most important issues for society as a whole, hence improvements for health are worthwhile. During the long industrial history, there was, and is, a huge need for adaptation to climate change, due to the fact that there have been major releases of carbon dioxide and other emissions. Africa is struggling with land management and use, hence before major industry and export of products there should be clear plans for land. Asia Pacific is one of the areas that suffers from climate change impacts, hence there is the main target in decreasing the vulnerability of the area. As for West Asia, it is a highly unstable area where wars and raw nature creates an almost impossible framework for business and sustainability work. According to a UNEP report, the target is set for peace, security and the environment.

One of the most important effects on the environment is climate change, which causes, for example, greenhouse gas emissions. The climate change effect relates to all phases of the

supply chain's life cycle. There are six main GHG emissions: Carbon dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous oxide (N<sub>2</sub>O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF<sub>6</sub>). Those are the gases that are most necessary to mitigate at industry level.

It is important to consider in social issues due to the fact that, these are the main pillars of sustainable work. It is necessary to remember that the customer will have influence on its suppliers and it can affect what kind of suppliers it accepts to the cooperation. Therefore, it is needed to carry out supplier chain assessment that shows how responsible partners are. This defines the global companies' sustainability and creates the framework for continual improvements.

## **6 IMPLEMENTATION OF THE ASSESSMENT SYSTEM**

The evaluation system is not sufficient alone. It needs updating and re-evaluation occasionally. The company could use indicators that it will create and they could be called key performance indicators (KPI). Key indicators describe operations and profitability of the company. KPIs might be for instance indicate the amount of orders or proceeds of the sale. The organization should identify key performance indicators by itself and measure and follow results actively. (Omni Partners Oy 2017.) KPI could be used for example to indicate the results of major environmental projects and cost savings. KPI could also show the results of minor projects such as the benefits of common improvements. Since the company could develop their own KPIs, it is necessary to develop indicators that provide as beneficial results as possible. Some KPIs are standardized such as measurement of performance versus legislation in engineering industry. It means that failure against the ISO 14001 standard does not mean only potential damage to the environment, but the possibility of being fined by the authorities. It also means that legislation is a very important part of environmental impact assessment. (Nolan 2017 a.)

Consequently, the first steps are to consider legislation and compliance obligation, and concentrate on for example buildings and their energy consumption. This phase contains also processes for the environmental impact assessment tool. For instance, in production operations, raw materials might form the greatest part of environment impacts that are caused directly and indirectly in processes. The supply chain plays also a major role in this section. A conscious company checks the background of their suppliers before the cooperation asking the following questions: Do they have an environmental policy, do they comply with ISO 14001 under the terms of the agreement and do they include environmental criteria in their purchasing decisions? (Nolan 2017 a.) Raw materials utilizing leads easily to wastage of material and this could result in an enormous amount of impacts in production. Unnecessary usage of raw materials can lead to huge costs and significant environmental impacts. (Nolan 2017 a.) Production processes, but also other business operations create wastes that are needed to recycle correctly or reuse. Waste will be a normal waste sections, such as municipal waste or recyclable paper, metal or plastic, but also waste of energy, heat or raw materials. There are many possibilities to create production wastes. Mitigation of waste requires good planning. Process efficiency has to be developed, such as energy efficiency through modernizing machines or adding insulations. Continuous improvement supposes to

observe the amount of waste and process to see if it could be more efficient. Typically, waste in production processes is seen in oil, grease and other lubrication agents as well as raw material waste. (Nolan 2017 a.) The amount of waste changes with the amount of production. Commonly, global companies report internally or externally amount of their waste types annually. This kind of report can give a quite detailed view of not only waste, energy and water consumptions, but also emissions to air and water.

Public consciousness of the environment has increased the requirements of environmental management. Not only directed government policies and regulations, but also interested groups are more interested in waste minimization, pollution prevention, energy conservation and other health, safety and environmental issues in companies, which have increased environmental management in companies. Effective implementing of an environmental management system simultaneously establishes, develops and reviews the company's business practices towards both corporate and environmental goals. (Hui et.al. 2001.)

Implementation of an Environmental Management System will affect operational costs. An Environmental Management System can make procedural or technical changes and reduce operational costs by improving the value of the company's products. It ensures that the company uses, for instance, raw materials, energy and labor in a more effective way. There is research showing that environmentally-friendly production or services will not necessarily increase business or operational costs, due to the fact that the company uses raw materials in a more efficient way. In complying with the Environmental Management System, a company can affect its image. The certified company with ISO 14001 can fulfill the demands of customers and marketers. The implementation of a management system strengthens the competitive position of the company. There are three sub-factors that are used for assessing the company's image: product quality, service quality, social responsibility. An Environmental Management System helps the company to be aligned with market trends. The adopting of a management system is voluntary, but most large-sized companies comply with its requirements. They have set four sub-factors that lead market trends. The company should take into account government policy, market pressure, customer requirements and investor criteria. In addition, complying with an Environmental Management System will improve the performance of the company. The company's operations such as products design and production should follow requirements from an environmental perspective. The performance can be

improved proactively because plain reactive actions are not sufficient. Engineers should proactively improve or develop operations in a minimal environmental impact way. The company should also have an environmental conversation which leads to reduced environmental impacts. The company can achieve its goal with the aid of the following indicators: waste reduction, waste reuse, waste recycle, waste treatment and use of sustainable resources. (Hui et.al. 2001.)

The Environmental Management System requires EMS that the processes should be planned, designed, implemented and reviewed from an environmental protection perspective. In complying with these requirements, it is possible to increase environmental quality. (Hui et.al. 2001.) The entire implementation process is described below. Flow chart of the Environmental Management System implementation is presented in figure 15

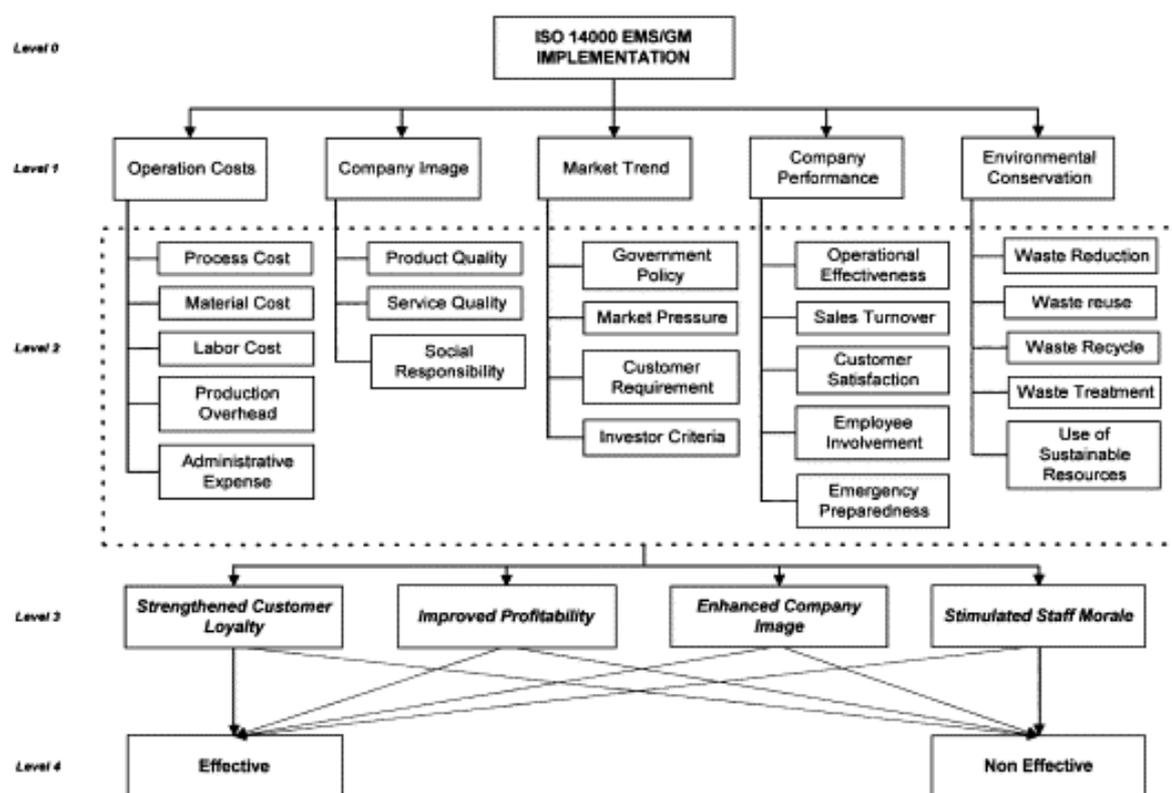


Figure 15. The environmental management system implementation (Hui et.al. 2001).

## 6.1 Internal communication

Ensuring effective implementation of the system in operations of the company, requires environmental communication through sharing information by building trust, credibility and partnership, raising awareness and being a part of decision making. Environmental commu-

nication will vary depending on the targets of the company, but also its circumstances. Environmental communication is not the same as environmental reporting, which is more formal. Communication can have many purposes and many forms. It could be planned or be reactive with different interested groups. Communication will be one-way, two-way or participatory. One-way communication includes situations where the company only reports on environmental issues without any opportunities for questions or discussion. Two-way communication has a close relationship with interested groups. There will be an exchange of information and ideas. Participatory decision-making is in an effective feedback format where the company collaborates with interested groups. If the company has a close relationship with interested groups, such as employees or customers it has the possibility to learn more about problems and concerns that relate to the interested group. Both sides can influence opinions and perceptions in this way. The most effective environmental communication includes ongoing contacts with internal and external interested parties. (ISO 14063: 2010, 9.)

Environmental communication has lots of benefits. Effective communication enables interested parties to understand the company's environmental commitments, policies and performance. It can also give suggestions to improve the environmental performance of the company's activities, products and services. In addition, it will lead towards sustainability. Effective communication increases the company's understand of interested parties' needs due to trust and dialogue. It also supports the company's environmental credentials, achievements and performance. Created awareness of environmental issues improves an environmentally responsible culture and values within the company. Environmental communication takes into account operational and emergency environmental hazards that affect concern in interested parties. Communication is also a part of business. It enhances interested parties' knowledge about the company and supports the business and shareholder's confidence. (ISO 14063: 2010, 11–13.)

Environmental communication can be divided into principles that the company should acquire. The communication should be transparent which makes the processes, procedures, methods, data sources and assumptions available to be used by all interested parties. However, confidentiality of information should be considered. Communication should be relevant and through using formats, language and media that are possible to be utilized by inter-

ested groups. It should also be honest and use fair manners. The information should be truthful, accurate, substantive and not misleading to interested parties. Effective environmental communication ensures it is available for the needs of the interested parties. It will respond to the interested parties' queries and concerns immediately and ensure that interested parties are aware of how their queries and concerns have been addressed. Also, it should be ensured that there are no misunderstandings or unclarity concerning language or communication manners. (ISO 14063: 2010, 17.) An implementation manual has been created and distributed to locations. It will support assessment, management system implementation and impact mitigation procedures. The manual will be one common global document for all own operations.

## **6.2 Implementation manual for companies and introduction for the use of an assessment system**

An implementation manual for companies has been written supporting assessment and system implementation procedures. The manual guides the users in determining the environmental aspects of a company's activities, products and services that it can control and those that it can influence. There are also guidelines for the aspects associated environmental impacts. Environmental aspect and impact assessment system should be implement at all organizational levels: group, business lines and areas, as well as locations. The manual helps with all phases of management procedures: objectives, targets, actions and operational controls, as well as performance monitoring. (HSE Manager & Hakanpää 2017.) The implementation manual is in an internal database, where everyone can correctly check the required principles.

All employees are responsible for actions to control, monitor and mitigate adverse environmental impacts. They are also responsible for actions to maximize beneficial environmental impacts within these activities, products and services that they have control or influence. In addition, managers of separated operations will be responsible for identifying environmental aspects and evaluating impacts in cooperation with HSE Managers. They should also mitigate, control and monitor impacts together. The HSE Manager is responsible for maintaining the frequency and accuracy of implementation procedures. It should consider relevant international standards, best practice and corporate changes. (HSE Manager & Hakanpää 2017.)

All own operations of companies should use general guidelines performing environmental aspect and impact assessment if they comply with common assessment procedures. The assessment procedures have been broken down into four global steps. At first, the environmental aspects should be identified that the operation or organization can control or influence. In the assessment template there are the predefined categories for location. The categories are related to the ISO 14001:2015 requirements A6.1.2. Then it should be determined which environmental aspects have significant impact. The organization can write a detailed description of the aspect, for instance “*air emissions from consumption of indirect energy*”. Information will be added upon impact, such as “*CO<sub>2</sub> emissions and contribution to greenhouse gas effect*”. Because of an evaluation of separate operating conditions, the correct condition will be mentioned in the assessment template. Significant environmental aspects should be selected and will be made with an evaluation and risk matrix in the assessment template. After this, measures for selected aspects will be taken. If the value of the evaluation is too high, the aspect needs operational controls, actions or monitoring and then a re-evaluation. The fourth step is updating the identification and evaluation of environmental aspects. The assessment should be up-dated. After evaluation, it will be possible to mitigate environmental aspects and impacts by developing a way of working. (HSE Manager & Hakanpää 2017.)

Environmental aspect and impact assessment can be based on separate environmental investigation. The locations that have an existing own assessment system for environmental aspects, can utilize the results beforehand. These results can be based on emissions’ monitoring and measuring and experience, as well as audited results and results from the previous year’s environmental programs. If there are changes in operations or in the environment, the assessment should be executed all over again. Non-certified locations should start to utilize information on law and requirements, HSE committees, reports and analysis, surveys and feedback from interest groups. All of them should evaluate aspects by using risk matrix principles. An effective assessment system fulfils also compliance obligations and addresses possible risks in own operations. (HSE Manager & Hakanpää 2017.)

### **6.3 Supporting of assessment system implementation**

The environmental aspect and impact evaluation system will be one common global system that serves companies globally. One of the most important issues in that system is that it has a common risk matrix for assessment of aspects. A common scale of significance enables

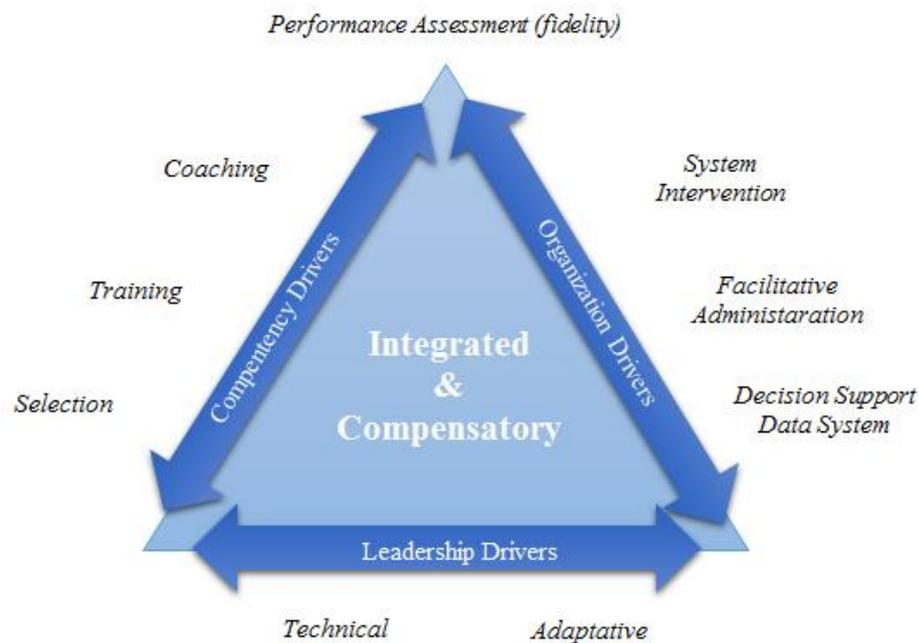
comparison between separate locations. It needs effective support so that all locations will use the same assessment system and evaluation criteria.

Environmental aspect and impact assessment will be a huge task in companies, especially those that do not have an existing evaluation system. Identification and evaluation will be difficult, though the risk matrix as a scoring system will help significantly in the assessment. (Nolan 2016.) There are many ways to clarify environmental aspects and managing their impacts. The very basic, but also important issue is to ensure that significant aspects are mentioned on a regular environmental basis. The assessment system is a part of team working. A group of creative people will be organized that can help in finding solutions to solve the most significant environmental aspects. Generally, employees who are under an evaluated operation can uncover solutions for significant aspects. Selecting responsible persons for the assessment process, ensures that all operations will be evaluated and same criteria will be used in all assessments on operations. The same reporting tools for all operations ensures accuracy in measuring actions and progress. Recording results in the same template will ensure conformity with the principles of the Environmental Management System globally. Reporting also helps follow-up operations actions. (Nolan 2016.)

Ensuring that the assessment system is used effectively, it will provide some concrete results for the operations. Root causes of environmental aspects in the assessment should be researched, if the significance value of the aspect is too high. Mitigation procedures are required and after their execution, the aspects should be reassessed once again, enabling removal of the root causes. Regular monitoring and up-dating is good for aspects ensuring that there is no risk of major impacts and cost saving may even be made. Good communication also supports the implementation of the assessment system. Effective communication needs both internal and external communication, which should be accurate and transparent. Effective communication will help in relationships with stakeholders, because it is possible to prove with an effective assessment system that the company has complied with legislation and requirements in dealing correctly with significant aspects. (Nolan 2016.)

There are three categories of implementation drivers that support the use of the assessment system: *competency drivers*, *organization drivers*, *leadership drivers*. Competency drivers are mechanisms, such as coaching, training and selection. These drivers improve and sustain users' skills to implement an environmental aspect and impact assessment system. Organization drivers are mechanisms, such as system intervention, facilitative administration and a

decision support data system, that create and sustain beneficial organizational and system environments for effective service. Leadership drivers can be technical or an adaptive driver that focus on requiring the correct leadership strategies for the types of leadership challenges. Figure 16 describes the relationship between these three categories. (Fixen et.al. 2015, 2.)

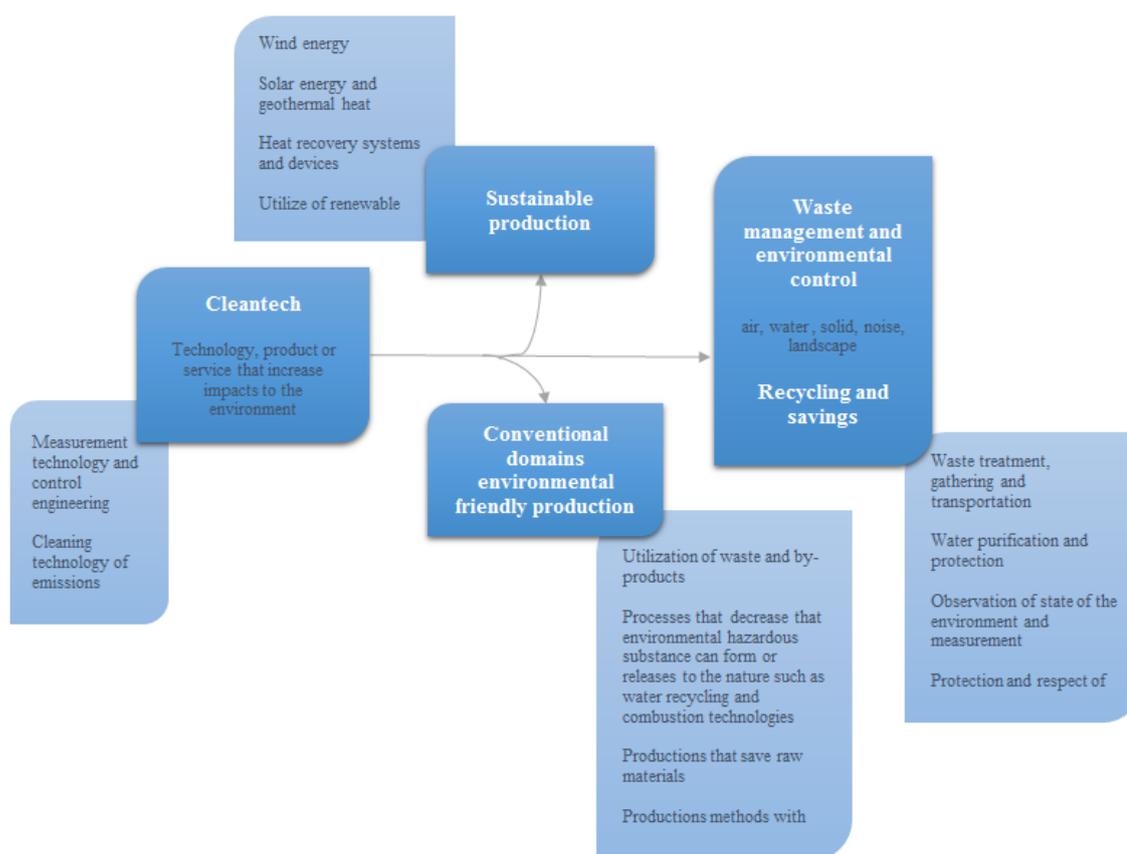


**Figure 16.** Implementation drivers (Fixen et.al. 2015, 2).

The use of implementation drivers leads to performance assessment. When the assessment system has been taken into action in all locations and the system use is consistent, this increases the reliable benefits for the company. Use of the implementation drivers determines the best practices of environmental management. (Fixen et.al. 2015, 32.) The implementation drivers help to improve and achieve users' competence and confidence implementing the new way of work. The aim is to achieve effective assessment procedures creating practice, organizational and system change at all levels in the company. Best practices will be used, such as best available technologies in operations. If the best practices cannot be adhered to, then it should be compensated for by other drivers in a way it is possible to achieve an efficient environmental aspect and impact assessment system. (Fixen et.al. 2015, 4.)

## **7 MITIGATION PROCEDURES**

There are many ways how to mitigate environmental impacts in the company. Businesses have been formed in this area during the last years. Traditionally, environmental impacts were attempted to mitigate by environmental protection. This means an action that repairs damages that are caused by production such as waste treatment and water purification. These protection actions are executed after pollution has happened. The current way is to work by anticipating the emissions. This should be called sustainable production, which for example consists of energy production by renewable resources, such as solar, water and wind power, wave energy and biofuels. The third alternative to work environmental friendly is to utilize the best available techniques and reference documents. These documents give facts about the best environmental technologies that save raw materials and cause minimum emissions. Products that were produced by using the best available techniques are also the easiest to recycle. Technology can also be based on recycled materials and mitigate the impacts in this way. The newest environmental business area that can help to mitigate the environmental impacts is cleantech. This consists of elements that support other business areas and technologies, and are described below. Cleantech is a bundle of service and product groups. It produces also measuring and controlling engineering for observing the state of the environment and environmental impacts. These four business areas, which are described below, are on view in companies. Figure 17 shows the four development targets for organizations that would like to mitigate their impacts. (Teknologiategollisuus ry, 2011 d.)



**Figure 17.** Business possibilities of environmental engineering (Teknoliateollisuus ry 2011 d).

Mitigation procedures, in own operations, might be on view in operations through integrated technologies. These are meant to make an invocation of natural recourses through more effective use of these technologies. Adverse environmental impacts decrease at the same time. Resource saving production technology can create new ways to work and produce productions and through this indirectly mitigate impacts during production and use. There are three ways how to integrate new environmental technologies in operations. The first one is non-utilized energy and raw material flows that are used to help new processes. Without these processes, flows will cause environmental impacts. The second is production processes that can become more effective and new processes that can utilize by-products in helping new processes. The third and last is decreasing the creation of problematic substances by new processes. (Teknoliateollisuus ry 2011 d.)

After determining environmental aspects, it is possible to identify environmental impacts that relate to the aspects. The company should reduce its impacts on the environment with effective actives. Monitoring should reveal how effective mitigation procedures are. Internal audits help in the mitigation process. They are an excellent way to follow the effect of impact

mitigation, develop an Environmental Management System and identify aspects and impacts that have not been considered earlier. Audits also help to develop current processes and mitigate their impacts. Generally, environmental improvements go hand in hand with process improvements. They reduce the amount of waste, consumables and material as well as energy and water consumption. Mitigations increase the benefit on the environment and for the business. (Nolan 2015 c.)

The whole assessment process could be written in a nut shell. At first, is the need to identify the environmental aspects that will be assessed and measures. Then environmental impacts that relate to the aspects should be determined a decision on objectives and then they are communicated to the team which is responsible for mitigation actions. The formulation of plan to improve objectives is an important part of the process. There should be an internal audit process to support improvement of existing aspects and impacts and identification of supplementary aspects and impacts. This is the core of the ISO standard: *Plan, Check, Do, Act*, which drives continuous improvements forward in the company. This circle both develops the environmental management system to deal with environmental aspects and minimizes the impact on the environment, as well as increase the benefits in business. (Nolan 2015 c.)

There will be written hierarchy methods for risk reduction. Environmental impact mitigation procedures will utilize same methods. At first, a hazard that leads to the impact should be eliminated. If there are some parts of the process, such as chemicals or methods of operation that cause environmental impacts, they will be replaced with less hazardous one. If this is not feasible then the harm will be isolated or restricted in a way that the impact is decreased. Next, the mitigation procedures will be measured and a reduction should be followed-up. It will require the use of collective protective measurements. If it is not sufficient to ensure that the impact mitigates then there will also be added individual protective measurements such as for the production machine or personal protective equipment if the impact, for instance, falls upon employees. If the impact is impossible to eliminate and it is not possible to execute sufficient mitigation procedures, the impact will be informed and warned about. Training and instructions will be organized with the aim to mitigate any impact. (HSE Manager 2014.)

## **7.1 BAT & BREF – Best available techniques and best available techniques reference documents**

Best available techniques (BAT) are references for a company at issue, but also for its customers. The best available technique reference documents are a series of published results of information between varieties of stakeholders within the EU. They have requirements for industrial activities that aim to follow the best available techniques. Both of them are also covered by the Industrial Emissions Directive (IED). BAT is the best available technique which is possible to achieve technically. As for BREF bringing together users' real-world experience that regulators can utilize when they determine permitted conditions. The reference documents consist of applied techniques, present emissions and consumption levels. Requirements of BAT techniques and emerging techniques have been taken into account. The IED requires that all the European Union member states monitor and develop their processes. (HSE Manager 2016 b.)

BAT conclusions that are the final assessments of best available techniques have also been used. They determine the reference points to the permitted conditions covering the IED. BAT conclusions include a description of each conclusion and an assessment of each appropriate application of the conclusions. Associated emission levels that comply with the best available techniques have also been set. The conclusion also has associated monitoring and consumption levels. In addition, there are relevant site remediation measures. BAT conclusions should be used for any new installations where BAT conclusions are available. They must achieve the required standard before they can start the operation. Otherwise, the existing installations should be up-dated by using the relevant BAT conclusion within four years of its publication. If BAT conclusions are not available, the installation should follow the highest standards of environmental control by basing BATs and associated BREFs. The European Integrated Pollution Prevention and Control Bureau (IPPC) is responsible for offering the most up-to-date version of BREF. (HSE Manager 2016 b.)

For instance, pulp, paper and board production has its own BAT conclusion that has been set as a target for consideration by 1<sup>st</sup> of October in 2018 by all European pulp, paper and board producers. This BAT conclusion should be also adhered to them in their operating permit. The guide for use of the BAT conclusion is developed by and for industry, supporting discussions between pulp and paper mills with authorities. The permit conditions of producers are based on the BAT conclusion that has emissions limits. (BAT conclusion 2015, 1.)

Next are examples of the BAT document that is the target for industry with the purpose to assist pulp and paper mills during discussion with authorities on the implementation of the new BAT conclusions. This General BAT Conclusion for Pulp and Paper industry is of relevance to all sub-sectors of pulp and paper production. BAT conclusions implement and adhere to the Environmental Management Systems and according to the BAT Conclusion an operator should implement all of the Environmental Management Systems measurement list. (CEPI 2015, 4) Next in line are listed BAT principles that companies should consider in pulp and paper production. Some of them are difficult to comply with or they are unnecessary for a company.

Good housekeeping and materials management minimizes environmental impacts of the production process. For most pulp and paper mills it should be difficult, anyway, to demonstrate compliance with this BAT. Pulp and paper mills produce chelating agents from bleaching. They eddy to the wastewater treatment plants. Reductions in carbon dioxide, water and inorganic nitrogen compounds should be made. Biodegradable agents from waste water will be mitigated. Wood storage and preparation increases the pollution load of waste water, hence the generation of them should be reduced. Five techniques in emission mitigation will be executed. The wood will be dry debarking. Contamination of wood and bark with sand and stones will be avoided. Wood yards will be paved and there will be a control system for sprinkler water flows and runoff water minimized. There will also be a collection of contaminated runoff water and it should follow the system for separation of suspended solids before biological treatment. (CEPI 2015, 5) The BAT conclusion has also principles for reduction of fresh water use. There are considerable differences in need among EU member states to reduce fresh water use depending on location, such as river basin, population density and seasonal variations. The company should consider all specifications when it offers its products for its customers. Generally, there will be options for water recirculation reuse and closing of water loops to new plant or major refurbishment situations. There will also be water and product quality requirements, technical constraints or decrease in odor nuisance. The BAT conclusion has set performance levels in  $\text{m}^3/\text{tonne}$  of product for the waste water flow at the point of discharge after waste treatment. It is necessary to take into account that reducing water flow can impact the concentration of emissions in  $\text{mg}/\text{liter}$  if these are transformed from BAT-AEL upper level to load. The conclusion has also limits for the BAT-AEL. (CEPI 2015, 6) Pulp and paper industry consumes a huge amount of energy, hence mitigation of energy consumption and energy efficiency principles are an important part of

the BAT conclusion to follow. An own energy management system will be created that can be within the company's Environmental Management System or that can stand alone. Exact or specific energy consumption data on the BAT Conclusion has not been set, but there are relevant chapters of in BREF documents that demand the operator utilizes technical possibilities and costs for reaching lower levels of energy consumption. Requirements for the company in line with the EED directive that ensures companies energy efficiency have also been set. (CEPI 2015, 7)

Organic compounds in wastewater from the pulp and paper industry has odor emissions which should be prevented and reduced. Conditions in the water systems should be avoided where wastewater or sludge becomes anaerobic. There is a need for a number of measures that ensures prevention of odors. The BAT conclusion also requires monitoring of key process parameters which are dealt with in this conclusion for combustion processes and waste water treatment. In addition, there are requirements for monitoring emissions to water. The BAT conclusion demands that frequency of monitoring should be based on stability of emissions to water and relevant impacts. There will be a need for daily monitoring frequency for chemical oxygen demand (COD) and total suspended solids (TSS) due to a reasonable daily deviation. (CEPI 2015, 8)

Some air emissions should also be monitored. They should be monitored frequently based on stability of emissions to air and relevance of the impact. Frequency will provide a normal expectation level for emissions by pulp and paper mills of large or medium size today. The mills cause also adverse sulfur emissions and for this reason they should be monitored for relevant sources. There are weak and strong odorous gases that all cause harmful odors and acidification of the atmosphere. Weak odorous gases are non-condensable total reduce sulfur. It contains gases which typically come from washing filters, tanks, chip bins and lime mud filters. These can be burned with strong odorous gases in recovery boilers. A diffused total reduces sulfur emissions that are defined as emissions resulting from direct contact of volatile odorous compounds (VOC) with the environment. The BAT conclusion has not set a specific requirement for the frequency of the monitoring. It should be discussed with authorities as to what is the sufficient frequency for monitoring. In pulp and paper production there are needs for chemical additives. BAT aims to substitute utilizing of these chemicals due to the nutrition loads in the waters. There will be a nutrient balance, meaning that it will

be necessary to substitute chemical additives with a high content of nitrogen and phosphor, with additives containing low nitrogen and phosphorous contents. (CEPI 2015, 9)

BAT has implemented a waste assessment which includes waste inventory. It means that it is necessary to reduce the quantities of wastes in the disposal system. Facilities for reuse of waste, waste recycling and other recovery systems in the mill sites will be planned. (CEPI 2015, 9) Wastewater treatment will reduce pollutants into receiving waters. Mills will take into account different waste water treatment systems (primary and secondary) by achieving emission levels of waste water. For instance, mills could install membrane technology for the flows and characteristics of pulp and paper effluents. Also, tertiary wastewater treatment that removes organic substances or phosphorous is needed. BAT conclusions have given the freedom to choose what kind of measures companies will use. There will be a discussion with authorities where mills can focus on the fact that it is an additional measure in nutrient removal considering sensitive reception water bodies. Hence, it can move or cause environmental impacts somewhere else. According to the BAT conclusion, if mills will treat its biological wastewaters on the mill site, it will have self-evident measures. (CEPI 2015, 10)

Pulp and paper mills should also mitigate noise emissions. They will have a noise-reduction programme which has strategic planning and management techniques to mitigate the emission. The authorities might have set requirements for a mill to reduce its noise emissions due to the fact that it is a subjective experience. Although, there will be official measures that shows the scientific level of noise. The BAT conclusion has set also requirements for companies to comply with BAT when decommission a plant. Then there should be monitoring for soil and groundwater. In addition, the company should have prepared a baseline report. (CEPI 2015, 11)

## **7.2 Mitigation and improvement procedures**

It has been known that not only consumption of raw material, water and energy usage, but also emissions to air, water and soil are the most significant impacts on the environment. Also, global challenges, such as the greenhouse gas effect, have driven impact mitigations with global requirements, for instance UN contracts. Investing in sustainability it ensures long-term business success. In addition, developed produce technologies and services benefit also customers and strengthen the companies' image. Increased consumption of raw materials and other needs mean lower costs for companies, reduced environmental impacts and

improve the position compared to competitors and partners and employers. (Global Management System Manager 2014.)

Impact mitigation needs actions in not only own operations, but also solutions that support customers' environmental work. It will need increased awareness of environmental issues in the companies and mitigation programs, such as energy efficiency program. There will also be local environmental programs and goals for production facilities and other business operations. R&D and marketing can be focused on to increased awareness of products and technologies that benefits the environment. They can support advanced and competitive technologies and services, raw material, water and energy efficiency and promoting of renewable materials. (Global Management System Manager 2014.)

Selected environmental impact indicators help in mitigation procedures. Environmental impact indicator monitoring may reveal changes over a period of time identifying environmental performance trends of the company. It should be noticed that some increases or decreases of environmental burdens will be due to other reasons of the company such as expansion or reduction of production as well as outsourcing or relocations of certain activities. It will be necessary to organized internal performance comparison within the company's other locations. The comparison of locations and performances should be based on the same functions in separate locations. It should also be a qualified comparison of processes, products and services. (ISO 14031: 2013, 33.)

Risk matrix is one of the assessment indicators. It assists to evaluate the significance of environmental aspects and impacts. It contains required actions that determine how the organization should mitigate significance impacts. If the value of the aspect is insignificant, the aspect or impact is acceptable and there is no need for immediate actions. These aspects and impacts that have a low value can be continued, but the factor should be monitored and risk reducing actions should be implemented. Medium is the first class of values that needs preventative actions. Activities can be continued, but risk shall be systematically monitored ensuring that the risk stays under control. The proper risk might need more specific risk assessment methods ensuring monitoring. If the aspect or impact has a high value, mitigation actions should be started as quickly as reasonably possible. These actions are mandatory and an action plan must be created immediately. It is also necessary to perceive that this risk needs regular monitoring and reporting. In the worst case, the significance of aspect or impact is extreme. Then the activities must be stopped immediately. Risk mitigation actions

are mandatory and they have to conduct immediate actions to change and improve process. The actions cannot start again before measures have been taken. The risk must be mitigated to an acceptable level before the works are allowed to restart. If risk reduction is not possible then the work in question must be permanently prohibited.

The risk matrix gives probability and consequence of the environmental aspect and impact indicating a risk class that is presented above. Companies can have only aspects which risk is identified as at an acceptable level. If a risk level has been set by an authority as an environmental permit, non-governmental organization as requirements or other interested parties as demands, they might have solutions for any mitigation. In the case of another situation, the company should follow the best available techniques reference documents (BREFs) and determine its own acceptable level for risks. The assessment based on the worst case of the process. The amount of emission and a diffusion mechanism, consequences on the environment will be considered. Following assessment, the company knows how significant the risk is. Then it can present a proposal for improvement and a plan of hazards prevention. There should be also be a plan which has a code of conduct for ensuring that the mitigation procedures will be executed. This kind of analysis should be updated always when the process will change and after abnormal conditions or emergency situation. The analysis for impact mitigation should also be updated regularly. The report will be communicated internally and externally. (Wessberg et.al. 2006, 4.)

There are many aspects that should be taken into account in mitigation procedures. The company's facilities take a major part of all impacts. Energy and water are needed. For example, air conditioning needs energy and produces harmful gases. It depends on operation what kind of gases does it contain. Commonly air conditioning causes also noise pollution on the environment and there will be permitted conditions that have set acceptable levels for not only gas emissions, but also noise pollution. In offices there are no emissions into wastewater systems normally, but production workshops such as paper technology, can have significant emission levels of wastewater. Normally, these operations have permitted conditions that should be monitored and reported to the authorities. In case of fire whichever operation can cause water emissions, because runoff waters may have different types of pollutions. There should be a collection system for these waters and an ensured system that prevents water overflows to the environment. Unused spaces affect to impacts of the company. If there are unnecessary lighting or heating on in unused rooms it consumes unnecessarily financial and

environmental properties. (Nolan 2015 b.) There will also be environmental targets that should be taken into account in the companies. These will support energy and water consumption mitigation targets and also limits for air emissions.

Calculating the carbon footprint of the company will show the main risk places for significant environmental aspects. In offices the major part of emissions occur from business travelling. If the meetings are organized through encouraging conference calls, video conferences and other possibilities, it then decreases unnecessary flights and car journeys. Travel policy will assist companies to mitigate impacts of travelling. Transportation and distribution cause also amount of companies' footprint. Share of emissions and resource of them will vary, but commonly there will be sea and costal water transportation services, as well as road, air and railway transportation services. Intelligent packing and transportation can mitigate huge amount of emissions.

Daily consumed materials also increase the risk of environmental aspects and impacts, hence it should be ensured that operations are as efficient as possible in the company. Minor actions in offices, such as printing on both sides of paper with unnecessary prints being prevented, no lighting in unused rooms and electronic devices are shut down during the nights. These actions reduce paper and also energy. In workshops there will be an effective recycling and reuse systems for by-products and waste. Energy efficient led lights will be used in production rooms and front doors will be closed.

Impact mitigation can be executed in the supply chain through favoring suppliers and companies that hold the same values as the company at issue and also are ISO 14001 certified. Improvements in the value chain to the environment can be driven if the supply chain works according to the same environmental principles as the company. In complying with legal and national legislation the company ensures that it mitigates the most significant aspects through meeting the requirements of authorities. (Nolan 2015 b.)

The circular economy will also increase the beneficial cycle in the value chain. There will be increased actions that mitigate environmental impacts through the entire value chain. It will also improve the company's environmental performance by encouraging suppliers and other operators in the supply chain to improve their operations.

### **7.3 Emission mitigation through aspect categories**

Most of emissions are possible to prevent or mitigate with new technologies and process renovations. Usually, they need investments, but they pay back themselves during the years. Companies have greatest influence on their own emissions, hence here are presented prevention and control techniques that will decrease significantly impacts that caused by own operations environmental aspect categories.

Many of production businesses cause air emissions that are global problem affecting for instance global warming and greenhouse gas effect. VOC emissions can be prevented and controlled with separated techniques. Hazardous substances can be substituted by less volatile substances, such as aqueous solvents, in processes arisen vapors can be collected through air extractors and subsequent treatment of gas system by removing VOCs with control devices. Condensers or activated carbon absorption will be used. There can also be used destructive control devices, such as catalytic incinerators, thermal incinerators and enclosed oxidizing flares. (IFC 2007 b, 8.) Particulate emissions are possible to prevent by using dust control methods, such as cover, water suppression, increased moisture contents for open materials storage piles, and also with air extraction and treatment through a baghouse or cyclone for material handling sources. Paved and unpaved roads' surfaces can be covered with water by preventing loose of material. (IFC 2007 b, 9.) Greenhouse gas emissions can be restricted and controlled by carbon financing, energy efficiency, supporting sustainable forms of agriculture and forestry, supporting, developing and increasing use of renewable energy resources, developing carbon capture and storage technologies that consists of the separated CO<sub>2</sub> from industrial and energy-related sources. GHG emission reduction can also be limitation and reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy, such as coal, oil and gas. (IFC 2007 b, 10.)

Wastewater generation and discharges can be prevented by using water efficiently and reducing the amount of wastewater generation. There will also be utilized process modifications, such as minimizing and reducing the use of hazardous materials in reduction of pollutants' load in treatment. (IFC 2007 c, 25.) Companies can comply with water conservation programs that will be implemented commensurate with the magnitude and cost of water use. The aim will be to support the continuous reduction in water consumption and achieve savings in the water pumping, treatment and disposal costs. Water conservation will include

storm water harvesting and efficient use, zero discharge design or use of treated waste water to be included in processes. Local recirculation systems will be used that will be located in plants, mill sites, facilities and shops. Also developing of dry process technologies minimizes water use in industrial processes. Process water system pressure management and process design that adequate water collection, spill control and leakage control system mitigate water consumption. (IFC 2007 d, 33.)

Soil emissions can be prevented by controlling the releases of hazardous materials and wastes and also oil contamination to the environment. If there are any uncontrolled releases to soil, those should be immediately identified and corrected to avoid further releases and associated adverse impacts. There are huge amounts of contaminated soil in the world, which is risk to human health and ecological receptors. There should be executed decontamination procedure reducing levels of contamination at the site. (IFC 2007 e, 54.)

Energy efficiency is one significant way to reduce impacts of energy consumption. There will be reduced losses in energy distribution, improved energy conversion efficiency, exploit energy purchasing opportunities and use lower-carbon fuels. (IFC 2007 f, 18.) Same efficiency principles concern also other materials such as raw materials and natural resources and water consumption. The best way to mitigate impacts of these categories is to prevent them, but also efficient consumption habits assist to reduce environmental effects.

Commonly, all industrial processes generate wastes. There is a waste management hierarchy that aims to the reduce impacts of the waste. Hierarchy based on consumption habits. Reducing waste generation, it also decreases consumption of materials and impacts that are caused by consumption. Prevention of waste is the best way to mitigate impacts. Other steps are reduction, reuse, recovery, recycling, removal and finally disposal of wastes. (IFC 2007 i, 46.)

## 8 CONCLUSION

The complexity and number of processes is a challenge for the global aspect and impact assessment system. There are a number of operations that have own variations. In achieving the requirements of the Environmental Management System there should be known, what the most significant environmental aspects in different processes in the companies are.

### 8.1 Requirements for the environmental aspect and impact assessment

The environmental aspect and impact assessment is based on principles of the ISO 14001 standard. It has set requirements for the aspect assessments and impact mitigation procedures giving guidelines for leadership, planning and support of management operations. It has also information for performance evaluation and improvements. *Plan-Do-Check-Act* method based on the ISO 14001 principles and gives guidelines for the company about how to achieve an effective assessment system. *Plan* phase sets the targets for the company. *Do* implements appointed targets. *Check* phase monitors and measures whole processes, as well as evaluates performance. *Act* ensures that improvements will be executed. The ISO 14001 gives the requirements for the aspect assessment. There are categories that should be taken into account in assessment and there are also principles that guide how to implement the system into the company. The ISO 14001 standard and its requirements are possible to be utilized in all kinds of companies. There are different types of operations, but environmental impact mitigation target is the same in all companies.

The ISO 14001 standard demands first to select the scope of the standard. Implementation of the standard into a part of the company should be consistent with requirements of the standard. Comprehensive implementation planning ensures success and an effective Environmental Management System for the company. The ISO 14001 standard assists in this process requiring that the company establishes, implements, controls and maintains it operations. It gives tools to comply with those demands by describing a hierarchy that the company can follow in its implementation process. Eliminating factors that affect environmental impacts is the most effective way to manage environmental impacts. Substituting the most adverse aspects and impacts with less adverse ones decreases the impacts on the environment. The impacts can be managed also with administrative procedures. These three phases are possible to be used individually or in combination. The ISO 14001 standard has also set demands for the performance evaluation of the company. An efficient Environmental Management System needs active monitoring, measurements, analysis and evaluation for the

company's performance. The environmental aspect and impact assessment is a part of the performance evaluation which needs a plan. There should be determined monitored and measured processes as well as methods that were used in the assessment ensuring valid results. The ISO 14001 standard does not order all steps of the assessment. The company can select its own criteria that it uses as a foundation for the assessment. The criteria selection is remarkable for the company's performance evaluation. Valid criteria support the company's environmental performances and can mitigate significant aspects and impacts. System creation bases also on continuous improvement procedures that aim to better and better performance and more sustainable operations. Criteria lead the company in the right way in continuous improvement process.

## **8.2 The environmental aspects and impacts**

Environmental aspects are identified by using the ISO 14001 categories for the aspect assessment. Aspect categories are possible to utilize in the assessment of not only in companies' own operations, but also technologies and products as well as supply chain. The aim of the assessment is to reveal own operations' the most significant aspects. The impacts have been determined by using redefined aspect categories, but also utilizing subjective experience about operations. Most impacts can be defined in the assessment process by using general information about environmental impacts that are in the public domain. Some of the impacts are process specific and in the many case they are also environmental permit conditions which demand impact definition and monitoring. In addition, the assessment principles of the risk matrix also give general definition for the environmental impacts. Environmental aspect identification and assessment is easier than impact definition and assessment, due to the fact that aspect can have either beneficial or adverse impacts and the same aspect can have many impacts. Due to most significant aspects, the most significant impacts also relate to these aspects.

The major global aspects are air emissions that cause greenhouse gas effect and global warming. Impacts of those suffering the whole world due to the fact that extreme circumstances increase and impact of them are stronger. The assessment reveals also other impacts of companies. It will represent that the most significant aspect is waste generation, hence there will be opportunity for developing more efficient internal waste reuse systems to mitigate impacts of waste generation. If greater amount of raw materials will be recycled, the need of

virgin materials will decrease. Waste and by-product generation causes water and soil pollutions. In many cases, there are hazardous substances that can be released to the environment. These are heavy metals, oils and chemicals. Generation of waste affects also the greenhouse effect. Waste generation has also land occupation effect, if the landfill placement is decreasing due to the landfill directive of the European Union (1999/31/EC). It demands member states to reduce biodegradable waste placements to the landfill. (Ministry of the Environment 2013.) Use of energy causes the major part of air emissions. It causes carbon dioxide emissions and contributes to the greenhouse effect. There are also particle emissions that relate not only to combustion processes but also emissions to soil. Air emissions have a separate amount of impacts. There are particulate matter emissions that have small particle sizes and a large specific surface area, which enables highly absorbing and easy carrying of various toxic substances in air. CO<sub>2</sub> emissions contribute to the greenhouse effect and VOC emissions produce ground level ozone that significantly contributes to the formation of local smog and also to the greenhouse gas effect.

Most of business based emissions will be possible to mitigate by using familiar hierarchy from waste management. At first all potential aspects should be prevented. If this is not possible the circumstances should be organized in that there are possible to reduce impacts. It will need recovery operations to the processes by developing unit processes and acquiring new technologies. Utilizing a circular economy and avoiding an emissions resource can reduce most of impacts. Companies can also utilize international and their own environmental based policies. They can have an environmental policy, travel policy and research and development guidelines. In addition, companies can also have environmental targets, such as energy consumption targets, which need a support of all organizations within a company.

The supply chains are long and they include number of suppliers and other operators. Companies can influence to its supply chain by selecting cooperators that has same values and desire to achieve sustainable operation processes. It might need training, common targets and agreements for continuous improvements. Behind the literature study, there were created four separated environmental aspect and impact assessment templates. One for own operations certified locations, one for non-certified location, one for the supply chain and one for technologies and products, but all of them have the same main elements. The main elements of the assessment are to select aspect category and identify the aspect. Impacts that are related to the aspect should be determined. Before the evaluation part background factors

should be described such as, what kind of activity or source cause those aspect and impacts, what is the operating condition and does it have compliance obligations. Then there is risk matrix based evaluation that gives the value of the significance. There is also a place for the mitigation procedures that should be described and executed before the second estimation of the risk significance. Due to the same risk matrix, different assessment is comparable. In the assessment, GHG Protocol principles were utilized. The processes are divided to three categories. Scope 1 which consists of direct emissions from the company's facilities and vehicles. Scope 2 which includes upstream indirect emissions, such as purchased electricity, steam, heating and cooling for own use. These scopes defined the main categories for own operations. Scope 3 consists of upstream activities and downstream activities that cause indirect emissions. It includes both emissions of technologies and products, such as processing and use of sold products, end-of-life treatment of sold products and supply chain emissions that have rest of value chain emissions. All of them are divided separated impact assessment templates by serving different types of operation developing. Some of evaluated impacts are easier to mitigate than other. After environmental aspect and impact assessment there are on the record what are the most significant aspects and impacts in global companies. The most significant environmental issues need improvement procedures to mitigate impacts. Companies have the best influence on their own operations, hence the mitigation will be started from these impacts.

### **8.3 Mitigation of environmental impacts**

Impact mitigation of own operations is a part of continual improvement procedures in companies. Following *Plan-Do-Check-Act* model and other international principles are possible to achieve benefit changes within companies. More efficient, more sustainable and more environmental friendly activities do not always need major improvements for the processes. The best improvements can happen whit the positive changes of working habits by employees. Most improvements needs changes in customary habits. Energy consumption is one of the most important aspects in global companies. The energy savings can happen by minor activities. If unused lights are switched off, and unused rooms are not heated, the front doors are closed, and unnecessary electronic devices are switched off, it will make huge saving during the year. Greater savings can happen with renovation improvements such as building insulations, machine updates and energy efficient air conditionings. Many of improvements need investments, but it is necessary to recognize that improvements decrease costs in the

long term. For instance, energy efficient systems save the energy costs. It is easier to effect to the environmental issues if there were given common instruction for working. A Global travel policy and the Environmental guide for offices are good examples about common improvements of environmental issues. Successful changes demand support and engagement for the managers, supervisors and all employees in the company. Clear targets and plans to achieve goals are in necessary roles. After own operations' assessments there should be real conversation about the next steps. If the assessment shows that there is a huge amount of impacts from waste generation, processes that produce the major part of waste should be considered. Concentration should be on possibilities to reduce waste generation and possibilities to improve the process and reuse materials and use recycled materials. If the major parts of a company's impacts are air emission such as particulate or dust emissions, then there consideration as to whether it is possible to acquire more effective filters to the ventilation systems. Improvement plans based on cause and effect. All improvements of environmental issues will be possible to achieve. Some of them take longer time than others, but all of them need engagement of the whole company.

#### **8.4 Development of the global environmental procedures**

Global operations are a challenge for the assessment system project, because there are separate operations around the world with different legislations and requirements. There are also different circumstances in nature, capital of the area and working culture. When developing a common global system there should be taken into account international standards and requirements such as the ISO 14001 that gives a great base for the Environmental Management System and assessment system. Also, international agreements, which companies comply with, guide operations globally. There are also number of national requirements and directives such as the European Union has appointed, which demands should be taken into account. In the global environment it will be easiest to utilize requirements of common national or the EU's requirements in the whole company, because then it is possible to harmonized procedures in the company. Commonly, it also leads to the best available activities that ensure the most sustainable and efficient operations. The action field of global companies is wide and it is impossible to integrate new ways of working by one employee within companies. It needs an active team behind the change. It will support, lead and improve action all around the world. Communication between separated business lines and areas, but also locations is particularly important in global companies.

There are differences in impacts within companies, due to the fact that there are separate impacts for example in offices and production operations. Also, different production operations have different impacts than automation that commonly has even impacts beneficially to the environment. Commonly, all fields of business consume energy and water and generate waste. The amounts of emissions vary. The other categories, such as emissions to air, water and soil depends on the field of business. Assessing the aspects by using the ISO 14001 principles the assessment will present the main general aspects from these categories. There are general observations that illustrate main impact categories of the business. There are consumption of water, energy and raw materials also generation of waste. Specific impacts of the field of business appear in detailed assessment. There will be emissions to air, water and soil, but also energy emitted emissions that based on only specific operations. For example, the paper industry causes significant amounts of water emissions such as suspended solids and biological and chemical compounds. Foundry operations have air emissions such as dust, CO<sub>2</sub> and noise emissions. Some machinery operations cause VOC emissions and combustion boilers cause CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>2</sub> emissions and also ash. Emissions of office businesses are smaller combined to the production operations. Office work has quite similar impacts to households. In conclusion it can be said that there will be various amounts of emissions from separate business fields. Hence extending assessment globally to all business fields, there will be a huge amount of different emissions.

The headcounts of global companies can be located only in one country, but the main parts of businesses will be situated all around the world. It will be challenge for companies hence they need active area management which is aware of its areas specifications. Efficient communication between business areas and headcount ensure that it is possible to implement common procedures to the whole company. If only one specific location, business line or area were taken into account in the creation project of the environmental assessment system, then the whole system will represent only that operation. Active cooperation with all parts of the company ensures that the created system will be suitable for the whole company. It is important for companies that they have one common global environmental assessment procedure, because it ensures comparable operations and makes improvement operations easier. Active cooperation with all operators in the company and upgrading ensure that the system will be available for use all around the world. Common environmental policy and global codes of conduct leads all locations to act in a similar way. There is a huge amount of different cultures which will affect the working habits in companies. Common procedures, that

all employees and operators under the companies' processes will comply with, enables that the companies' established own operation cultures are followed. International standards, agreements and requirements, such as from the UN, ensure that the global assessment procedures are possible to utilize. It might be necessary to also add national specifications into the assessment procedures. A clear risk matrix enables objective evaluation about environmental aspect significance. Nevertheless, there will be differences between locations when they fill in the assessment template. Evaluation is always subjective and culture based on occasion that will need calibration before the common summary and result analysis.

### **8.5 Future of the environmental aspect and impact assessment**

This thesis is also a background research for possibilities to execute environmental aspect and impact assessment that enables global use. The most important part of impact mitigation is to integrate procedures that were presented in this thesis within the companies and ensure that they comply with requirements of the ISO 14001 standard. There will be made the future plan that aims to the targets of impact mitigations. There will be also roadmap that ensures implementation of management software that will replace an Excel template in the future. There is a wish that it would be possible to use common global software for assessment of own operations, technologies and products as well as supply chains in the future. The software will contain risk assessment for all three aspects: health, safety and environment. There will also be a template for near miss and emergency notifications. Generally, companies should be aware about the significant environmental aspects and impacts before they can plan mitigation or prevention procedures for the emissions. Nowadays increased awareness and know-how about environmental issues have increased the companies' desire to affect their operations. Sustainability is also part of company's competitiveness.

The business field of companies can be wide and will range from heavy engineering to automation and service, as well as office operations, such as sales and design. The heavy engineering, especially metal, field should consider material and energy consumption. It will be difficult to decrease consumption of material, but the use of raw material will be reduced. If there are any possibilities to use recycled material they should be utilized. Also, the product quality and LEAN management methods help to mitigate consumption of materials. If the product quality is bad and there are a huge amount of disqualifications, it increases waste volume. Energy consumption will be mitigated with more efficient machines and mill site facilities. There will be also used renewable energy resources always when possible. In many

cases the technology of the manufacturing sector is outdated and also facilities where production operations are located. Automation operations are usually quite new operations and usually they have benefit environmental impacts. They also utilize energy, but the amount of it is quite low compared, for example, to heavy engineering or other production operations. Automation systems are also developed to improve system performances and through this also improving environmental operations. Automation solutions decrease generation of waste, consumption of energy and water, unplanned shutdowns and their caused emissions. Many global companies have also service operations that can be a part of production businesses. The impacts of the services are as minor as closer the customer service centers are located. Making machine lifetime longer, it extends their life cycle and decreases impacts of new lines production. Using environmental friendly auxiliary substances, decreasing the amount of chemicals and oils, companies reduce environmental impacts. Far-reaching maintenance in all fields of business ensures environmental friendly operations, but also lower costs.

Environmental issues are as complex as wider the global operational environment is. Building the environmental aspect and impact assessment system should be started from a common level. There will be clear requirements behind it, due to the fact that the international Environmental Management Standard 14001 is a great base for all environmental issues. Although, companies comply with international standards, legislation and requirements it does not mean that they manage their environmental issues the most efficient or sustainable way. Environmental aspect assessment and impact mitigation in its completeness ensures the best know-how about environmental performances for companies. Environmental awareness improves companies' environmental performances, decreases impacts on the environment and improves sustainability of companies. Globally, environmental awareness should be increased so that the condition of the environment can improve.

## 9 SUMMARY

Environmental awareness has arisen globally. Most leading companies have an Environmental Management System to manage environmental issues such as environmental aspects and impacts. The aim of this thesis was to develop global procedures for aspect and impact assessment. Presently, many companies have several reporting systems that include monitored information. There are requirements for a common process that facilitates effective impact evaluation which will support the global management system within global companies. Companies aim also to continuous improvement of the operations' environmental performance. The operations of the evaluation system have to be acceptably simple to all employees ensuring global use. Also, technologies and products were considered, as well as supply chains and their environmental aspects and impacts in this study.

The assessment of the environmental aspects and impacts will comply with ISO 14001 standard's requirements. There are also other standards and international requirements and agreements, such as the United Nations' Sustainable Development Goals that are considered and companies' own environmental principles. Environmental aspects and impacts have a close relationship that are based on cause and effect. Environmental aspects cause environmental impacts that will be adverse or beneficial to the environment. These are consequences of company activity, services and products. Environmental aspects could be direct aspects, such as from activities, products and services of companies. They will also be indirect aspects that can be affected by the activities of suppliers of companies and contractors that work on activities of the companies. The ISO 14001 standard has determined separate categories for different aspects and their assessments. There are nine categories that the ISO 14001 standard recommended to use: *emissions to air, releases to water, releases to soil, use of raw materials and natural resources, use of energy, generation of waste and/or by-products, energy emitted, use of space and others*. These categories were used by classifying environmental aspect in the assessment templates. There are also criteria that could be related either to aspects or impacts. According to the criteria, environmental protection should be considered identifying the risks types, sizes of aspects and frequencies and defining scales, severities and durations of impacts. Legal and other requirements should also considered, such as limitation of emissions, licenses for emissions and all kinds of requirements. There is also a demand to identify the values of the company and reputations for needs and expectations of

interested parties. Successful evaluation needs clear steps to the goal and periodically reassessment ensuring that results of assessments are consistent and updated. Evaluation should be updated, especially when the operation has changed or circumstances are different. Then operations should be reassessed. It is impossible to create an environmental assessment system that is irreproachable the first time. The system needs developing many times during its lifetime. There are aspects that the company can control directly, but also aspects that it can only have influence on. Commonly, they are related to services and products that are produced by others such as suppliers. Environmental aspects and impacts were assessed by using an environmental impact assessment matrix that was influenced from health and safety matrixes. The matrix takes into account consequences and probability of the impact risks.

Environmental aspects and impacts related to value chain which consists of three parts: supply chain, own operations and services and technologies of a company. Generally, supply chains consist of long chains around the world. There are three main global categories that should be taken into account in supply chains: air quality problems and impacts that are caused by urbanization, water and water scarcity and energy that affect to climate change. The greatest problems of the whole world are nearby the Equator. It is important to control impacts to the environment and decrease activities that cause impacts. Existing information was collected about technologies and products together. The following categories in assessment were used: *emission reduction, end product quality, energy efficiency, life cycle cost optimization, maintenance efficiency, material efficiency, performance, productivity, reliability, safety and water efficiency*. There will be more research and development around technologies and products ensuring their environmental friendly and sustainability in companies. Some technologies are more efficient and environmental friendly than others, but there is a huge amount of sustainable technologies and products. Customers have a significant role in the assessment, due to the fact that they affect the major part of the products' impact by their using habits.

There is a written implementation manual for locations supporting the assessment and system implementation procedures. It ensures that the users determine the environmental aspects of the company's activities, products and services that it can control and that it can have influence by using the same criteria. The environmental aspect and impact assessment system should be implemented at all organizational levels. The implementation manual helps management procedures of objectives, targets, actions and operational controls as well as

performance monitoring. Environmental communication has lots of benefit, because effective communication enables interested parties to understand the company's environmental commitments, policies and performance. Effective communication can also give suggestions on how to improve environmental performance of activities, products and services in the company.

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**Personal communications**

Director, Research & Development

Manager, HSE

Manager, HSEQ

Manager, Global Management System

**APPENDIX 1: Example of environmental aspect and impact assessment template for certified location by the ISO 14001 standard**

Summary										
Category	Aspect	Impact	Activity / Source	Operating conditions	Operational controls / actions / monitoring in place	Compliance obligation	Severity of consequences	Probability of occurrence	Total evaluation	More information
Use of energy	Air emissions from consumption of indirect energy (electricity)	CO2 emissions and contribution to greenhouse gas effect	Electricity use in location (all activities)	Normal conditions	<ol style="list-style-type: none"> <li>1. Energy efficiency investments</li> <li>2. Energy efficiency audits to identify improvements (every 3 years)</li> <li>3. Annual environmental reporting of consumption to the company</li> <li>4. Local energy reduction targets</li> <li>5. Purchase of green electricity (20% of annual consumption)</li> </ol>	Requirements in laws and regulations	2	5	10	<p><i>Explanation of evaluation: Electricity is consumed continuously (occurrence = 5) and since 80% of this location's electricity consumption is from a coal power station, although we can assume emissions are within permits, there will always be an environmental impact (severity = 2). Activities can be continued, but risk shall be systematically monitored to ensure that risk stays under control.</i></p>
Emissions to air	VOC emissions	VOCs produce ground level ozone (a harmful, photochemical oxidant) that significantly contributes to the formation of local smog. Contributes also to greenhouse gas effect	In foundry, painting hall and roll covering workshop: painting of equipment, use of solvents for cleaning of equipment and washing of products, and also when gluing of roller covers.	Normal conditions	<ol style="list-style-type: none"> <li>1. Periodic monitoring of emissions to ensure permits are observed</li> <li>2. Annual reporting to local environmental authorities</li> <li>3. Annual environmental reporting of emissions to the company</li> <li>4. Action plan to replace solvent based paints with water based alternatives by 2017</li> </ol>	Requirement in local environmental permits or licenses	3	5	15	<p><i>Explanation of evaluation: VOCs are emitted continuously (occurrence = 5) and in 2016 we exceeded our local permit. Risk mitigation actions are mandatory and now in 2017 we have an action plan to reduce VOC emissions by replacing paints.</i></p>

**APPENDIX 2: Example of environmental aspect and impact assessment template for supply chains**

Assessmnet of supply chain											
Region	Location	Entity	Environmental aspect category	Environmental aspect	Environmental impact	Activity / Source	Severity of consequences	Probability of occurrence	Total evaluation	Operational controls / actions / monitoring in place	More information
<i>Pan-Europe</i>	<i>FI</i>	<i>Material suppliers</i>	<i>Air</i>	<i>Air emissions from consumption of energy</i>	<i>CO2 emissions and contribution to greenhouse gas effect</i>	<i>Iron ores</i>	<i>2</i>	<i>5</i>	<i>10</i>	<i>Optimization of logistics, use of buffer storages</i>	<i>Materials are moved continuously (Probability = 5)</i>
<i>North America</i>	<i>CA</i>	<i>Customers</i>	<i>Water</i>	<i>Oxygen consuming substances</i>	<i>Consuming oxygen during life cycle of products. Dangerous to environment.</i>	<i>Pulp, paper and paper products</i>	<i>4</i>	<i>3</i>	<i>12</i>		