Total Resource and Energy Efficiency
Management System for Process Industries

Deliverable 3.1

Internal challenges and barriers for energy and resource management

Date: 16/06/2016

WP3 Management System

T3.1 Analysis of organizational challenges and barriers

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Sustainable Process Industry through Resource and Energy Efficiency

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Executive Summary

Challenges and barriers for the energy and resource management can be classified as internal and external. This deliverable analyses and discusses the internal challenges and barriers identified based on the relevant literature review and industrial end-user experience study.

A total number of 12 internal barriers (non-technical and technical) were identified and categorized into five groups: (1) Strategy; (2) Alignment; (3) Management; (4) Mindset; (5) Technology. Thanks to Root Cause Analysis, the most prominent causes which impact each barrier were identified (a total number of 42). Results from this deliverable will guide the development of MAESTRI management system and low cost eco improvement methods (tasks T3.2, T3.3 and T3.4).

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Abbreviations

CSR - Corporate Social Responsibility

EMS - Environmental Management System

ERP - Enterprise Resource Planning

KPI - Key Performance Indicators

MES - Manufacturing Execution Systems

PDCA - Plan-Do-Check-Act

QCD - Quality, Cost, Delivery

RCA - Root Cause Analysis

SME - Small and Medium-sized Enterprises

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1 Introduction

1.1 Purpose, context and scope of this deliverable

The purpose of this deliverable is to identify the most prominent internal challenges and barriers for energy and resource management and investigate potential root cause analysis for defined barriers. The research is based on relevant literature review and industrial end-user experience study. Deliverable 3.1 reflects the work performed in Task 3.1 - Analysis of organizational challenges and barriers. Results from the analysis will guide the development of MAESTRI management system and low cost eco improvement methods (tasks T3.2, T3.3 and T3.4).

1.2 Deliverable organization

This deliverable is organized as follows:

- Chapter 2 presents results from literature review on classification of challenges and barriers for energy and resource management. It includes detailed description of both external and internal challenges and barriers.
- Chapter 3 presents results from the industrial end-user experience study conducted in chosen production companies. It includes detailed description of the most prominent challenges and problems identified in the organizations, which may have direct or indirect impact on the energy and resource management.
- Chapter 4 provides and discusses the most important internal challenges and barriers for energy and resource management, which were identified based on the analysis of the challenges and problems identified in industrial cases as well as on the current state-of-the-art.
- Chapter 5 presents outcomes from Root Cause Analysis applied to the identified barriers.
- Chapter 6 provides a conclusion regarding internal challenges and barriers for energy and resource management
- Appendix A illustrates the complete list of internal challenges and barriers for energy and resource management and associated causes in a table.

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2 Overview and general classification of challenges and barriers for energy and resource management

There are many challenges and barriers facing organizations interested in improving environmental behaviour. Since the early 90s they have been identified and classified by many authors.

Post and Altman (1994) classified barriers of environmental adaptation into two groups: industrial and organizational. Industrial barriers are related to the type of market in which the company operates and include capital costs, competitive pressures, industry regulations, technical information and uncertainty about potential results. Whereas organizational barriers originate from company specific structure and culture and affects adaptation regardless of the market type. The organization barriers include employees' attitudes, inadequate top management leadership, poor communication and past practice.

Another approach includes classification of external and internal barriers. External barriers are associated with external factors like policy, market or economy which cannot be directly controlled by company; such as insufficient drivers, lack of support and guidance, cost of certification. On the other hand, internal barriers describe company specific factors (socio-technical aspects) like management system, organizational structure, culture which may be controlled by the organization; such as lack of sufficient human resources, lack of understanding or wrong perception of environmental behaviour, employee's resistance (Hilary, 2004; Shi et al., 2008).

Classifications, even though using different terminology, describe the same characteristics. In both cases barriers hinder the implementation of environmental strategies. Whereas one group of barriers may be controlled by the organizations (organizational, internal), another one cannot (industrial, external). Although barriers have different degrees of difficulty, internal barriers are considered more problematic than external barriers (Post and Altman, 1994; Hillary, 2004; Dahlmann et al., 2008; Murillo-Luna et al., 2011).

2.1 External challenges and barriers

External barriers are specific for the environment and market in which company operates. Even though they affect the organization, they cannot be directly controlled. Because of that less attention is payed to the analysis of external challenges and barriers. Murrio-Luna et al. (2011) go beyond regular classification and describe problems associated to the external barriers of environmental proactivity (Table 1). This shows the challenge facing companies interested in changing to sustainable environmental behaviour.

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Table 1 - Problems associated to external challenges and barriers of environmental proactivity

External barriers	Associated problems
Inadequate industry regulations	• Rigidity of regulations • Scarcity of information • Bureaucratic obstacles
Priority of other external matters or requirements	• Other competitive pressures • Other regulatory pressures
High cost of environmental technologies/services	• High prices of environmental technologies • High prices of environmental services
Insufficient supply of equipment and information for environmental adaptation	• Poor development of clean technologies and procedures • Lack of information about technologies and procedures available • Uncertainty about the potential environmental and economic benefits resulting from the clean technologies

Source: Murrio-Luna et al. (2011), p. 1419

2.2 Internal challenges and barriers

Researchers and practitioners put much effort to identification and analysis of difficulties that can actually prevent companies from engaging in EMS. Studies focus on the internal barriers as they may be controlled (minimized, overcome) by the company. There are many difficulties classified within internal barriers, which generally can be associated either with technical (e.g. equipment) and non-technical (e.g. culture) aspects of the organization.

Tinsley and Pillai (2012) in their book '*Environmental management systems: understanding organizational drivers and barriers*' analysed environmental management and organizational theory and identifies 12 internal barriers to EMSs (Figure 1).

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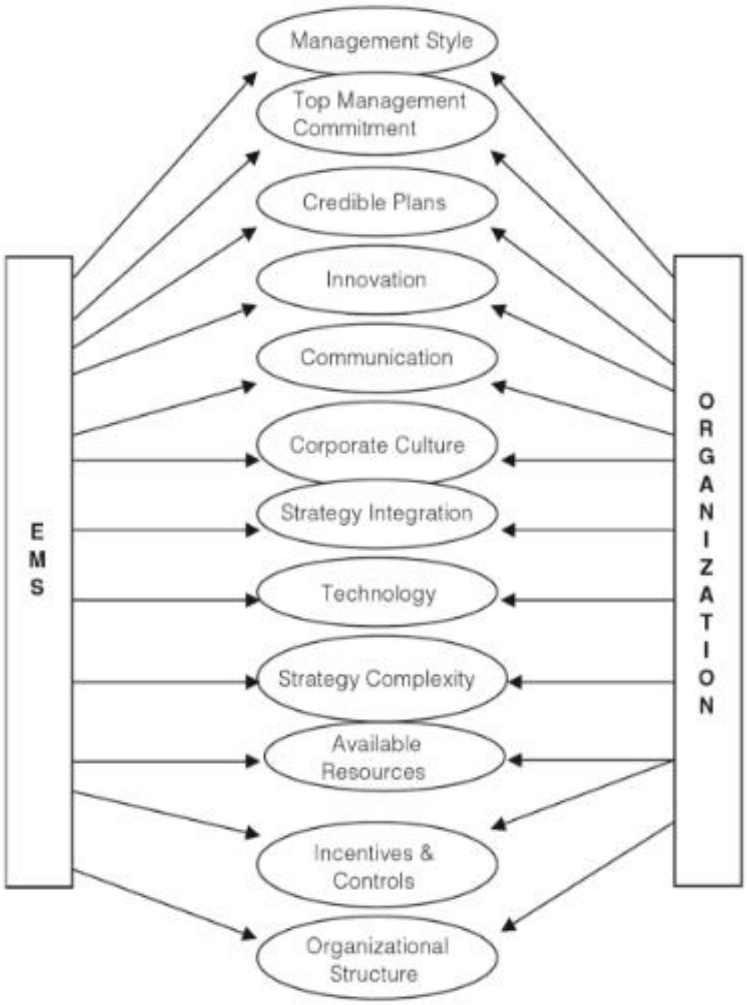

Figure 1 – Internal barriers for Environmental Management System
Source: Tinsley and Pillai (2012), p. 79

Murillo-Luna et al. (2011) analysed literature about EMS implementation problems and identified three internal barriers:

1. Lack of organizational capabilities (limited motivation and preparation of employees, inadequate leadership, lack of involvement, poor communication)
2. Lack of strategic capabilities (limited management commitment, lack of research and development, short term planning)
3. Lack of financial capabilities (high cost of investment and replacement of current technologies)

Different barriers may be distinguished for large, medium-sized and small organizations. Welford (1999) argues that larger companies are more likely to adapt EMSs, however they may encounter more challenges because of formalized structure and complex culture. Medium-sized and small companies in this respect may adapt to change quicker. Internal barriers characteristic for smaller and mid-sized companies (SME) are (Fiho and Voudouris, 2010):

- Restricted resources and assets (financial and human capital, time, technologies)
- Less strategic/long-term planning and 'management by emotion'
- Hierarchical management structures

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- Active integration of employees but high dependency on single persons and individual knowledge
- Dependency on external knowledge
- General doubts on effectiveness of EMS and perception of bureaucracy
- Confusion on standards
- Inconsistent top management support

Some authors go beyond the classification and try to prioritize the importance of barriers on environmental performance. Results from the study conducted by Murrio-Luna et al. (2011) show that among different barriers only budgetary and organizational limitations as well as aversion to innovation and technological change actually prevent companies from implementing EMS. Managers and decision makers should concentrate on those barriers which control will bring the greatest benefits. Furthermore, identification of key barriers is crucial in allocating the necessary resources and finding adequate countermeasures.

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3 Challenges and problems identified in industrial research

This chapter presents results from the industrial end-user experience study conducted in chosen production companies. It includes detailed description of the most prominent challenges and problems, which organizations need to dealt with on the regular basis. Identified challenges and problems may have impact on the energy and resource management, and consequently are a good starting point to the further elicitation of the internal challenges and barriers.

The study is based on the industrial research carried within WP1 as well as on LEI Poland experience from consulting projects. Four business cases were identified and analysed representing different sectors and levels of sophistication regarding economic and environmental performance. The chronology of described companies correspond to the growing level of environment consciousness and commitment.

The selected challenges and problems identified from case organizations are listed below and classified in five groups: quality, cost/ efficiency, delivery/ planning, production measurement system and ecological performance. The criteria for that selection was that these challenges and problems may constrain directly or indirectly implementation of energy and resource management and in broader context, implementation of continuous improvement culture.

3.1 Company A

The company A is large a large manufacturer of metal parts with rapidly growing size and complexity of operations. Fast growth of the organization imposed many structural and operational changes.

Quality

- Number of defects above the accepted level
- Information about the level of defects is not based on data and facts (there is no tool supporting production in this respect)
- Variability in quality of numerous manual operations
- Relatively long adjustment time between prototyping phase and producing good parts (relates to new products; happens almost every week)
- Difference in raw material coming from different suppliers (causing additional need for adjustment in machines' parameter; possibility of losing first few parts)
- High number of reworking hours needed in some processes

Cost/efficiency

- The machine being a bottleneck needs maintenance every second day
- High rate of rejection at the assembly line (because of poor quality and inefficient quality control in previous process steps; causing rejection of the full kit of components for that machine)

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Delivery/planning

- Delay in production (due to raw-material missing)
- Often missed delivery deadline of the products
- Long lead times (because of widely distributed production locations)
- Production layout needs improvement (e.g. organisation of WIP storage areas)
- Frequent human mistakes in completing kits for assembly (causing delays and short time plan changes)
- No firm orders beyond 4 weeks horizon (forecasting only for some products like biomass stoves; weekly planning, once a month 'macro-planning')
- Unknown schedule of production by operators gathering pieces for assembly kits (sometimes kits with lower priority regarding product delivery date are finished before kits with higher priority)
- Short time plan change (people are busy with ad hoc planning)
- Frequent 'emergencies' (ad hoc reactions for problems; firefighting)
- Longer than expected prototyping time (causing consequent delays in the production schedule)

Production measurement system

- Not registered parts coming in and out from several production processes like bending (stock levels of WIP are not always registered)
- No MES between a business system such as ERP and a manufacturer's plant floor control equipment (production is carried out using Excel sheets, ERP and interhuman communication)
- No control of rejection rate and reasons of quality problems
- Not fully measured and analysed downtimes in critical machines (setup time, malfunction, etc.)
- KPI's tend to lack enough definition or impact in some cases (failing to provide the exact status of the operation and provide basis for problem solving and root cause analysis)
- Machinery not connected to servers (all of production status is based on operator written information loaded in the ERP)
- One gage for energy consumption measurement for the entire shop

Ecological performance

- High consumption of energy but no monitoring of individual machines
- Not exact measurements of energy consumption on building or machines
- Unused space in transportation containers (size of container do not fit the parts transported inside, causing transportation of 'air')
- Every new program causes elimination of 1-2 pieces before the machine starts producing good pieces
- Energy being a small part of total costs (low priority on measuring and improving energy itself; more control on energy will impose more control on production flow in general)

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3.2 Company B

The company B is a large manufacturer of plastic parts existing in market for more than a decade. The organization recognises the need to invest in pro-ecological solutions as a way for selling strategy as well as added-value for clients.

Quality

- High volume of complains from the automotive customer (causing 100% control plus double check)
- High rate of rejection rate from the automotive customer (in KPI 2%, in reality up to 30%)
- High volume of lost parts (too late reaction of operator; parameters need to be adjusted to a specific viscosity of raw material, but operators wait until they see bad parts to take an action)
- 100% visual control of capsules but little or no root cause analysis of quality problems and not enough quality at the source

Cost/efficiency

- Reduction of the cycle time being a top priority
- Increasing costs connected with more tools/moulds and more change over and setup times
- Significant levels of inefficiencies (especially rework and poor quality)
- Long time to repair machines e.g. 3 weeks when a mold is broken or a couple of hours only in minor problems (repair is done when quality control process spots defects in the finished products)
- Maintenance of machines carried out once a year (tools/machines are not in good condition)
- Long setup times
- Lack of knowledge and experience from middle management on how to solve problems effectively e.g. with exceeding setup times
- No systematic picking and storage layout in warehouse (warehouse management depends on people having the knowledge where packs have been placed)
- Trial and error approach to changes in machine parameters (causing scrap)

Delivery/planning

- Highly needed stabilization of production process (procedures, standards, training, passing knowledge)
- Frequent 'emergencies' i.e. ad hoc reactions for problems, firefighting, no RCA, try and error approach
- High customers pressure for individualization of products (increasing complexity in production process, imposing pressure to operates in smaller batches)
- Often missed delivery dates

Production measurement system

- No support for calculating reorder amount for raw material (calculation depending much on the experience of people)
- Lack of KPIs awareness among operators
- No KPI monitoring tools (besides tablets attached to the machines)

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Ecological performance

- "Contaminated" raw material (recycled raw material is mixed up to 30% with non-recycled material, other plastic that cannot be recycled (e.g. PA6) is sold; e.g. when a part is partially painted it cannot be reused in injection, it is waste and it is sold)
- Outsourcing of energy consumption monitoring (no monitoring tools; monitoring performed with installed sensors, no internal routine on monitoring)

3.3 Company C

The company C is an example of the organization demonstrating strong commitment to the environmental and climate protection. It has already invested much effort into energy and resource efficiency, however there are still many optimisation potentials possible, especially on the process improvement site.

Quality

- High effort needed for the process of manual taking samples for quality control

Delivery/planning

- Short term production plan (production plan is known just for current week and part of the next week; high scheduling efforts and additional cleaning cycles)
- Long-time of cleaning of chemical reactor (between 8% and 50%of production cycle)
- Urgent customer orders (leading to non-optimal production scheduling)
- Customer orders coming shortly in advance (causing changes of the production schedule)
- Problems with information exchange with customers

Production measurement system

- Not integrated systems of ERP, process control and energy data monitoring (an amount of additional manual work needed to import data from one system to another is implicated and prone to mistakes)

Ecological performance

- Expensive measuring equipment for the energy consumption monitoring
- Smaller portion of the total energy consumption is related to the production processes (60% of the energy consumption is not production related like infrastructure, heat generation, process heat)
- Peak-loads management for electrical power (concerning thermal energy there is always a peak load on Mondays morning when all chemical reactors are turned on at once to start production)

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3.4 Company D

The company D is a large organization with advanced environmental management system and strong commitment to the environmental and climate protection.

Delivery/planning

- Short delivery times and large number of products (causing challenges in the production planning and scheduling)
- Varying customer demands over time (due to the weather or sales campaigns in the retailer stores causing peaks in production and in resource and energy usage)
- Delays in supply (causing changes in production schedules)

Ecological performance

- High customers' requirements on eco performance (causing the need to get even more knowledge about the ecological footprint of individual products like energy consumption per litre of paint)
- The electricity consumption measurements are not adapted to monitor the energy consumption of each specific batch

4 Internal barriers for energy and resource management

This chapter provides description of internal barriers for energy and resource management identified both in industrial research and literature review (Figure 2). To obtain the list of the most prominent internal barriers for energy and resource management the following steps were undertaken:

1. Challenges and problems identified from case organizations were assessed regarding their potential impact on the energy and resource management.
2. Selected challenges and problems were grouped together, analysed and summarized and, if possible, assigned to one of the categories of internal barriers described in the literature (see point 2.2).
3. Literature categories that had no challenges and problems assigned were discussed and analysed whether they reflect LEI Poland previous experience from consulting projects.
4. Based on step 2 and 3 the list of categories was mapped out.
5. Based on assigned challenges and problems, the LEI Poland previous experience as well as current state of the art the list of most prominent internal barriers for energy and resource management was formulated.

The above sequence of steps reflects the study approach which was performed to analyse the organizational challenges and barriers for the energy and resource management. Challenges and problems existing in industrial business cases were taken as a starting point. The reason behind is that problems tend to be a visible effect of hidden barriers. When problems are exposed, corresponding barriers can be uncovered and their root causes can be listed. The current state-of-the-art informed our understanding of the problems existing in case organizations in terms of having potential direct or indirect impact on the energy and resource management and reflecting internal barriers which may prevent energy and resource management.

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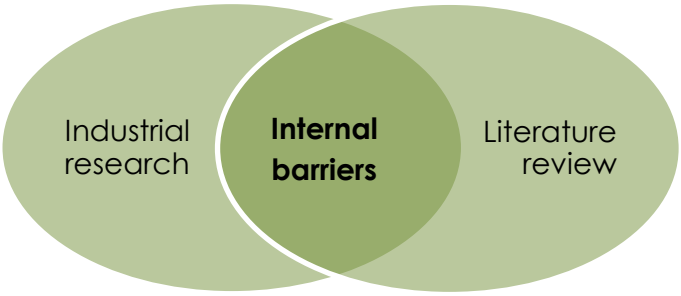

Figure 2 – Research design model applied for internal barriers identification

Each step was preceded by brainstorming session which involved LEI Poland research team. Final list of categories and internal barriers was obtained after the mutual agreement of all participants. Five main categories were distinguished:

1. Strategy
2. Alignment
3. Management
4. Mindset
5. Technology

First four groups relate to the non-technical aspects of the organization, whereas the last group relates to the technical aspects of the organization. The next section provides detailed description of each barrier. Description was made based on the problems identified in business cases, LEI Poland previous experience from consulting projects or results from the literature review. Where possible problems presented in Chapter 3 were mapped to described barriers.

4.1 Strategy

Ecological aspects are not an integral part of corporate strategy

Environmental issues usually do not impose themselves during everyday tasks and activities within production company. To become an integral part of organisation's culture they need to become rooted in the strategy, which is a natural place for planning long term and important activities. Embedding ecological performance into strategy is more natural for companies which operate with direct connection with the end customer (as the society environmental awareness increases) or there is other strong pressure e.g. legal or corporate customers' pressure. Examples of the problems from Company A like low priority on measuring and improving energy and resource usage or reflect this barrier.

Ecological challenges are long term issues by their nature

Based on literature review and LEI experience from previous consulting projects a tendency, can be noticed, that is, any improvement in ecological performance can be achieved only when organisations "leave the room" for long term projects. Energy and resource management gains importance when seen from long term perspective. A broader context than one particular production facility is also needed. Organisations

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asking constantly about the level and time of ROI (return on investments) might have difficulties to assign resources and commitment to improve ecological performance.

4.2 Alignment

Lack of ecological aspects in strategy deployment to the operational level

Actual activities contributing to improvement of environmental performance take place on the operational level of the company. This is quite a typical situation when no ecological improvements can be observed within the company despite the top management declares strong environmental commitment. Ecological aspects need to be 'translated' into a language understood by all organisational levels of company in order to be less abstract and easier to deal with.

Lack of employees' involvement and engagement into ecological aspects

It is extremely difficult to improve ecological performance of the company if there is lack of employees' involvement and engagement. It concerns production employees as well as the middle management level. The typical problem in this area is that any ecological improvements are assigned to a single person responsible for environmental issues and resource management. This leads to the situation where any ecological oriented improvement projects are perceived by the rest of production team as something additional, optional and therefore of little importance comparing to QCD production indicators. Engaging employees to improve ecological performance is especially difficult when in the organization there is no culture of following the performance indicators at all. The Company B is a clear example of the foregoing. One of the company's problems indicates that operators are not aware of the existence of KPIs in the organization.

Success is achieved by those companies which managers are good at empowering employees. Management support is very important to achieve success. Mangers needs to translate environmental requirements, legislations and policies into achievable objectives before implementing EMS. Ramus (2002) distinguished six managerial behaviours that improve environmental performance:

1. Communication (managers are willing to listen to employees' ideas, they encourage creativity, participation and problem solving)
2. Competence building (managers provide problem-solving tools, time and resources to commit to environmental improvements)
3. Rewards and recognition (awards and regular feedback to improve environmental performance)
4. Management of goals and responsibilities (setting of targets and delegating responsibilities)
5. Innovation (managers are open to new ideas, have experimental approach to problem solving)
6. Dissemination (managers are aligned with environmental strategy and motivated towards environmental improvements)

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4.3 Management

Ad hoc reactions to problems (firefighting)

Dealing with the problems in the ad hoc mode (called also sometimes "firefighting") in most cases leads to implementing solutions which are far from optimal and deal mostly with visible part of problems without addressing their root causes. This approach, in turn, allows the problems to appear again, forcing people to deal with them in hurry and without deeper reflection, consuming resources etc. Dealing with such a vicious circle makes it impossible for any long term improvements and is very tiring for the staff. This barrier is reflected by many problems identified in Company A and Company B. The Company A needs to troubleshoot in many occasions like adjusting machine parameters depending on the unpredicted variability of incoming raw material, rejecting full kits of components because of inefficient quality control, delaying production due to missed raw-material or human mistakes in completing kits for assembly and many more. The Company B also deals with problems in the ad hoc mode when for example needs to double check of the final products because of the high volume of complains or repairing machines when quality control spots defects in the finished products caused by the broken machines.

Neglecting long term challenges because of constant dealing with urgent tasks

Improving ecological performance of the company needs assigning some resources to deal with it. In the reality of constant pressure for quality and cost, solving emerging problems, hurry to meet imposed deadlines, it is extremely difficult and counter intuitive to take 'step back' and deal with planned tasks which seems not to be urgent and therefore with lower priority. The examples of the foregoing can be found in the characteristics of the problems in Company A and Company C. The Company A do extend firm orders beyond 4 weeks horizon. The production schedule is changing so quickly that there is no place for long term planning. As a result, it does happen that operators finished kits with lower priority regarding product delivery date before kits with higher priority. The examples of the Company C are also related to the short term planning and problems with establishing long term perspective. The production plan is known just for the current week. Operators need to deal with urgent customer orders coming shortly in advanced, which need to be made 'right now'.

Performance management system do not support improving ecological performance

People's behaviour is mostly driven by metrics, indicators and goals (which make the performance management system). The way in which performance management system is constructed determine the way in which people behave and which tasks they concentrate on.

Ecological goals are not challenging

Implementing an EMS based on ISO 14001 impose on companies an obligation of defining significant environmental aspects and setting goals for improving ecological performance. It happens sometimes that these goals are set for such a level which is achieved regardless there are any actions undertaken or not.

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4.4 Mindset

Perception that any improvement in ecological performance is achieved thanks to high cost of investments

Survey conducted by LEI Poland among Polish companies in 2015 showed that many managers perceive the only possibility to reduce negative impact of the company on the environment in technological investments (which implies relatively high costs). This effect is additionally, strengthen by government subsidiaries for innovation where innovation equals to investment.

4.5 Technology

Lack of appropriate data for energy and resource management

To establish an efficient system of energy and resource management the appropriate data about consumption is needed. The data is often not available or requires high effort to collect and convert it into useful information. The examples of the foregoing are reflected by the problems identified in Company A and Company B. Machines in the Company A are not connected to servers causing problems to monitor their energy usage. All of production status is based on operator written information. The Company B faces problems with production measurements in general which, in turns, makes management of energy and resource very difficult. There is no KPI monitoring system and no support for calculating reorder amounts of raw material.

Current technology does not support EMS application (implementation and functioning)

The technology solutions used in the companies may not be suitable for the requirements of EMS e.g. there are no sensors enabling to associate resource usage to particular machines. Like in the Company A, where high amount of energy are consumed, but there is only one gage for energy consumption measurement for the entire shop. As a result, there is lack of appropriate data needed to monitor energy consumption of individual machines. This barrier is also reflected by the Company B problem. Although the Company B possess needed technology, monitoring of the energy consumption is outsourced. As a result there is no internal routine on energy monitoring and the data is not used for the EMS purposes. Another examples can be found in Company C and Company D. The company C has not integrated ERP with other monitoring systems yet, causing additional manual work needed to import data from one system to another. There is no one integrated system which would support EMS. And finally, in the Company D the electricity consumption measurements are not adapted to monitor the energy consumption of each specific batch, which in turns make it more difficult to apply EMS principles and accurately monitor energy consumption.

High cost of investment and replacement of current technologies

Replacing the existing technology with 'greener' solution relates to significant cost which might be an important barrier for many companies, especially the small ones. This applies to the production technologies (machines) and resource usage monitoring equipment.

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5 Root Cause Analysis of internal barriers

Internal barriers relate to the problems which may be overcome by the organization. To look deeper into problems and find out why they are happening the Root Cause Analysis (RCA) was applied. Accordingly, RCA causes for each barrier were analysed and defined. The following section provides outcomes of the RCA examination with the most prominent causes for each internal barrier for energy and resource management.

5.1 Strategy

Barrier: Ecological aspects are not an integral part of corporate strategy

Potential causes:

- Corporate strategies are oriented mainly on QCD aspects
- Impact of ecological aspects on QCD is indirect and therefore difficult to grasp
- Top management tend to omit ecological aspects while building corporate strategy
- Ecological aspects are foreseen as CSR related issue
- Ecological aspects on regular basis are perceived as long term and therefore they are not prioritised in short term planning horizon. Usually, there is no establishment of costs or gains to apply environmental measures.

Barrier: Ecological challenges are long term issues by their nature

Potential causes:

- Ecological results have long payback period
- Ecological aspects on regular basis are perceived as long term and therefore they are not prioritised in short term planning horizon

5.2 Alignment

Barrier: Lack of ecological aspects in strategy deployment to the operational level
Barrier: Lack of employees' involvement and engagement into ecological aspects

Potential causes:

- No policy of strategy deployment in general
- Ecological aspects are not treated equally to operational aspects in terms of strategy deployment
- Top management is not aligned regarding ecological aspects deployment
- Middle management do not receive clear massage from top management in regards to ecological aspects
- Middle management performance is assessed based on QCD aspects not on ecological ones

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5.3 Management

Barrier: Ad hoc reactions to problems (firefighting)

Potential causes:

- Inefficient management routines
- Lack of structured problem solving and root cause analysis
- Lack of PDCA thinking
- Lack of standards and procedures
- Insufficient knowledge dissemination within organisation
- Limited preparation and training of employees

Barrier: Neglecting long term challenges because of constant dealing with urgent tasks

Potential causes:

- Lack of credible plans (frequent plan changes)
- Short term planning
- Lack of continuous improvement culture and long term approach within organisation
- Lack of stability of production process
- Contrary management commands

Barrier: Performance management system do not support improving ecological performance

Potential causes:

- Ecological indicators are not included in performance management system on the operational level
- Ecological indicators are not visualized and easy accessible
- Ecological indicators are reviewed on less frequent basis than QCD

Barrier: Ecological goals are not challenging

Potential causes:

- People do not see the opportunity to take advantage from improving ecological performance
- Ecological goals are perceived only as a compulsory part of implemented EMS and therefore treated as unwanted additional workload

5.4 Mindset

Barrier: Perception that any improvement in ecological performance is achieved thanks to high cost of investments

Potential causes:

- Lack of knowledge and previous experience about the results of low cost improvement methods
- Lack of knowledge on improving ecological performance itself
- Neglecting the role of work organisation
- Tendency to associate ecological performance with innovation and innovation with new technology, and consequently with high cost

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5.5 Technology

Barrier: Lack of appropriate data for energy and resource management

Potential causes:

- High cost of investment in monitoring equipment to improve control of resource usage
- Data collection is time and effort consuming when performed manually
- There is no need for precise measurements of energy usage on particular machines

Barrier: Current technology does not support EMS application (implementation and functioning)

Potential cause:

- No market pressure on developing technological solutions supporting

Barrier: High cost of investment and replacement of current technologies

Potential cause:

- Technologies for energy and resource management are relatively new

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6 Conclusion

There are many challenges and barriers which may hinder the implementation of environmental strategies. Challenges and barriers can be classified into two groups: external and internal. External are those which are dependent on the market and cannot be controlled by the organisation, whereas the internal barriers may be influenced by the organisation. Although barriers have different degrees of difficulty, internal barriers are considered more problematic than external barriers.

The purpose of this deliverable was to identify the most prominent internal barriers for energy and resource management and investigate their potential causes. Work performed within Task 3.1 reflected in this deliverable allowed to identify 12 the most prominent internal barriers and investigate 42 causes which may lead to those barriers. Identified barriers are associated with the company's strategy, alignment, management, mindset of the people and technology. Internal barriers were identified based on the industrial research and relevant literature review. To each barrier, LEI team associated potential causes which came as a result of Root Cause Analysis. Findings from this deliverable are a solid foundation for the work ahead, especially will guide the development of the MAESTRI Management System and low cost eco improvement methods.

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Appendix A – Complete list of internal barriers for energy and resource management and associated causes

Classification	Group	Identified barriers	Causes
Internal	**Strategy**	Ecological aspects are not an integral part of corporate strategy	Corporate strategies are oriented mainly on QCD aspects
			Impact of ecological aspects on QCD is indirect and therefore difficult to grasp
			Top management tend to omit ecological aspects while building corporate strategy
			Ecological aspects are foreseen as CSR related issue
			Ecological aspects on regular basis are perceived as long term and therefore they are not prioritised in short term planning horizon. Usually, there is no establishment of costs or gains to apply environmental measures.
		Ecological challenges are long term issues by their nature	Ecological results have long payback period
			Ecological aspects on regular basis are perceived as long term and therefore they are not prioritised in short term planning horizon
	Alignment	Lack of ecological aspects in strategy deployment to the operational level	No policy of strategy deployment in general
			Ecological aspects are not treated equally to operational aspects in terms of strategy deployment
			Top management is not aligned regarding ecological aspects deployment
			Middle management do not receive clear massage from top management in regards to ecological aspects
			Middle management performance is assessed based on QCD aspects not on ecological ones

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		Lack of employees' involvement and engagement into ecological aspects	No policy of strategy deployment in general
			Ecological aspects are not treated equally to operational aspects in terms of strategy deployment
			Top management is not aligned regarding ecological aspects deployment
			Middle management do not receive clear massage from top management in regards to ecological aspects
			Middle management performance is assessed based on QCD aspects not on ecological ones
	Management	Ad hoc reactions to problems (firefighting)	Inefficient management routines
			Lack of structured problem solving and root cause analysis
			Lack of PDCA thinking
			Lack of standards and procedures
			Insufficient knowledge dissemination within organisation
			Limited preparation and training of employees
		Neglecting long term challenges because of constant dealing with urgent tasks	Lack of credible plans (frequent plan changes)
			Short term planning
			Lack of continuous improvement culture and long term approach within organisation
			Lack of stability of production process
			Contrary management commands
		Performance management system do not support improving ecological performance	Ecological indicators are not included in performance management system on the operational level
			Ecological indicators are not visualized and easy accessible
			Ecological indicators are reviewed on less frequent basis than QCD

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		Ecological goals are not challenging	People do not see the opportunity to take advantage from improving eco performance
			Ecological goals are perceived only as a compulsory part of implemented EMS and therefore treated as unwanted additional workload
	Mindset	Perception that any improvement in ecological performance is achieved thanks to high cost of investments	Lack of knowledge and previous experience about the results of low cost improvement methods
			Lack of knowledge on improving ecological performance itself
			Neglecting the role of work organisation
			Tendency to associate ecological performance with innovation and innovation with new technology and high cost
	Technology	Lack of appropriate data for energy and resource management	High cost of investment in monitoring equipment to improve control of resource usage
			Data collection is time and effort consuming when performed manually
			There is no need for precise measurements of energy usage on particular machines
		Current technology does not support EMS application (implementation and functioning)	No market pressure on developing technological solutions supporting EMS application
		High cost of investment and replacement of current technologies	Technologies for energy and resource management are relatively new

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