Process Industry and Sustainability

Making your existing assets more sustainable

nap

The Process Industry Competence Network

SIG Sustainability

September 2013

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Abbreviations and terminology

IPPC	Integrated Pollutions and Prevention Control
BAT	Best Available Technology
CAPEX	Capital Expenditures
CSR	Corporate Social Responsibility
GRI	Global Reporting Initiative
LCA	Life Cycle Assessment
OPEX	Operational Expenditures
SIG	Special Interest Group

Preface

The Process Industry Competence Network (NAP) is pleased to present the final report of the Special Interest Group Sustainability (SIG-S), concerning the key question “how to get a grip on sustainability through the NAP value chain by sharing best practices, knowledge, tools and creating new ideas where possible ". Improved interaction was sought between:

- Asset owners
- Equipment suppliers (utility consumption, materials of construction, waste)
- Engineers, Consultants and Technology Providers (design and specifications of equipment and process units)
- Maintenance Service providers (cleaning, no/less waste, preventive maintenance)

The SIG-S was founded to improve the sustainability of existing Production Assets in the following fields:

- **Energy.** Energy efficiency, renewable energy sources and CO_2 emissions
- **Water**. Water efficiency, reuse of water
- **Materials**. Material efficiency recycling

In order to answer the general questions and to meet the objective, 18 companies shared their experiences. We found that many companies have ambitious sustainability targets, induced by both governmental regulations and also by demand from the market. However, it is not always easy to translate improvements in sustainability into practical tools. We discovered that there are many barriers hindering the application of sustainable solutions. These barriers involve:

- Lack of knowledge
- Financial issues like the payback period on investments of more than two years
- Risks - sustainable solutions are not always proven solutions
- Governmental regulations, difficult procedures and very short-term incentives
- Organizational, top down is essential.

To find sustainable solutions that deal with these barriers, the experiences of 18 companies were shared. This resulted in a set of practical examples that can easily be implemented by other companies. The solutions are brief examples, to inspire sustainability practices in your own company.

Without the contribution and dedication of Sinta de Wildt of Tebodin, it would have been impossible to complete this report. Stichting NAP is grateful for her contribution.

Eelco Linnert
Chairman of the NAP Special Interest Group – Sustainability

"It is about time to use the Power of the Process Industry Chain also in realizing our sustainability ambitions. Hopefully this study will give you a trigger to activate the value chain and thereby ensure a sustainable future for the Dutch Process Industry.
Robert Claasen, Chairman NAP

"Sustainability is such a general and broad concept that we can easily get stuck in definition discussions as well as complexity issues. In order to provide some guidance, inspiration and stepping stones for the Dutch Process Industry, our very motivated Special Interest Group drafted this report with input from across the value chain."
Koen Bogers, Chairman NAP Program Production

Table of Contents

NAP Special Interest Group Sustainability

Members of the Process Industry Competence Network (NAP) are perfectly aware of the fact that sustainability is not a hype. The NAP Special Interest Group Energy (SIG-E) has already focused on the subject of energy: working on energy efficiency and using renewable energy sources to lower companies' carbon footprint. As sustainability entails more than energy, the Special Interest Group Sustainability (SIG Sustainability) was called into existence.

The SIG Sustainability objective

How can we improve the sustainability of our existing assets in the process industry? It focuses on improvements within the value chain.

Firstly, sustainability is defined. Most of the NAP members use the Brundtland definition (UN):

> *"Sustainable Development meets the needs of the present without compromising the ability of future generations to meet their own needs."*

Most members submit annual sustainability reports which follow the Global Reporting Guidelines (GRI www.globalreporting.org). 'People, Planet and Profit' describes the triple bottom line and the goal of sustainability. SIG Sustainability focused on the following '***People, Planet and Profit***' topics:

"Planet" (www.naturalcapital.org) refers to sustainable environmental practices. The environmental dimension of sustainability concerns the impact of assets on living and non-living natural systems including ecosystems, land, air, and water. We focused on the indicators:

- **Energy.** Energy efficiency, renewable energy sources and CO_2 emissions
- **Water**. Water efficiency, reuse of water
- **Materials**. Material efficiency and recycling

In this study we focused on Planet, but we also considered the effects on People and Profit.

"People" pertains to fair and beneficial business practices regarding labor and the community and region in which a corporation conducts its business. The social dimension of sustainability concerns the impact of assets on the social systems in which it operates. SIG Sustainability focused on the indicators:

- Great place to work (good labor practice, healthy and safe workplace)
- Good relationships with local communities

"Profit" is the economic value created. It addresses the direct economic impact of assets and the added economic value of these activities. SIG Sustainability focused on the indicators:

- OPEX (Operational expenditures)
- CAPEX (Capital expenditures)

Quote: "You can never have an impact in society if you have not changed yourself". Nelson Mandela

Approach

In order to answer the general questions and meet the objective, the experiences of 12 NAP member companies are shared in the SIG Sustainability. It already became clear that NAP members wish to make their existing assets more sustainable. They have ambitious sustainability targets. For instance, they intend to reduce CO_2 emissions by 20% in 2020 and push down the amount of waste by 20% in 2020 (also due to governmental regulations). However, many members experience difficulties in translating sustainability improvements into practical tools and solutions for their existing assets.

Barriers when making your existing assets more sustainable have been discussed. It is evident that drastic changes are crucial when it comes to approaching sustainability in companies. Companies' culture and structure must be adjusted to be able to reach the sustainability targets. To find solutions for these barriers, sustainable solutions (best practices on sustainability) have been obtained in interviews with 18 NAP members. During these interviews possible solutions to these barriers have been discussed. Why was it possible to implement a sustainable solution in this case? How did they overcome these barriers? Can these solutions also help others overcome their barriers?

These sustainable solutions were also analyzed for applicability in other companies. This resulted in a set of practical examples of how to make existing assets more sustainable. These solutions are short examples that are meant to inspire your own company. These solutions show the specific example and how the general idea behind this solution can be made applicable in your company.

We recommend continuing this development in sharing sustainable solutions and combining them to inspire each other with new ideas in order make your existing assets more sustainable.

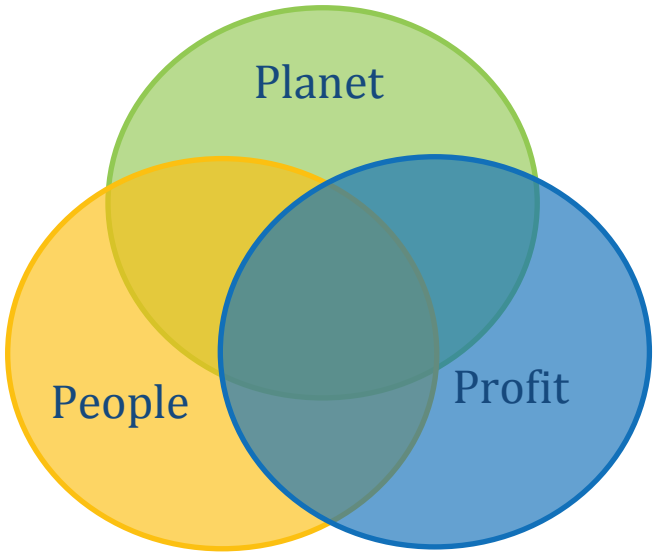


Figure 1: People, Planet, Profit

1. Introduction

Have you already set your targets on CO_2 emission reduction? Do you feel you should do something, but you have no idea where to start?

In this report several practical tools and solutions are given to make existing assets within the process industry more sustainable. It addresses both technical implementations of how to make your assets more sustainable as well as cultural and structural changes that can be made within your company to make the implementation of sustainable solutions easier.

The process industry is using a serious amount of energy, water and other raw materials. Otherwise all the products from paints, beer to aramids could not be manufactured. Most of the day-to-day consumer products originate from the process industry.

Resource revolution (meeting the world's energy, materials, food and water needs)

Until quite recently the prices of raw materials were relatively low. However as the New Scientist shows in their chart called '*How long will it last*?', we will be running out of some of the resources if we maintain this speed of consumption. The past few years have already revealed a price rise in some of the resources, as research conducted by McKinsey showed: *Resource revolution: Meeting the world's energy, materials, food, and water needs*. (www.mckinsey.com/mgi)

Therefore, the government has set up regulations like the Ecodesign Directive [1] and the energy and climate objectives.

Because the process industry is responsible for a large part of the Dutch CO_2 emissions, managing these emissions is increasingly important.

Dutch Energy and climate objectives:

- 20% CO_2 emission reduction in 2020 compared to 2005
- 20% share of renewable energy in energy consumption in 2016
- Average energy saving speed 2% annually from 2011 to 2020

Not only the governments, but also the consumers require companies to become more sustainable. They ask for Green Products, which is a growing (niche) market.

Endless consumption

If the industry maintains the current level of consumption of non-renewable energy, water and raw materials, it will not be possible to meet the future demand for food and products, as the population continues to grow. For your companies' business continuity, sustainable strategies must be embraced. Be prepared for the future and become competitive by closing loops and avoid spilling useful resources.

[1] (http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/index_en.htm)

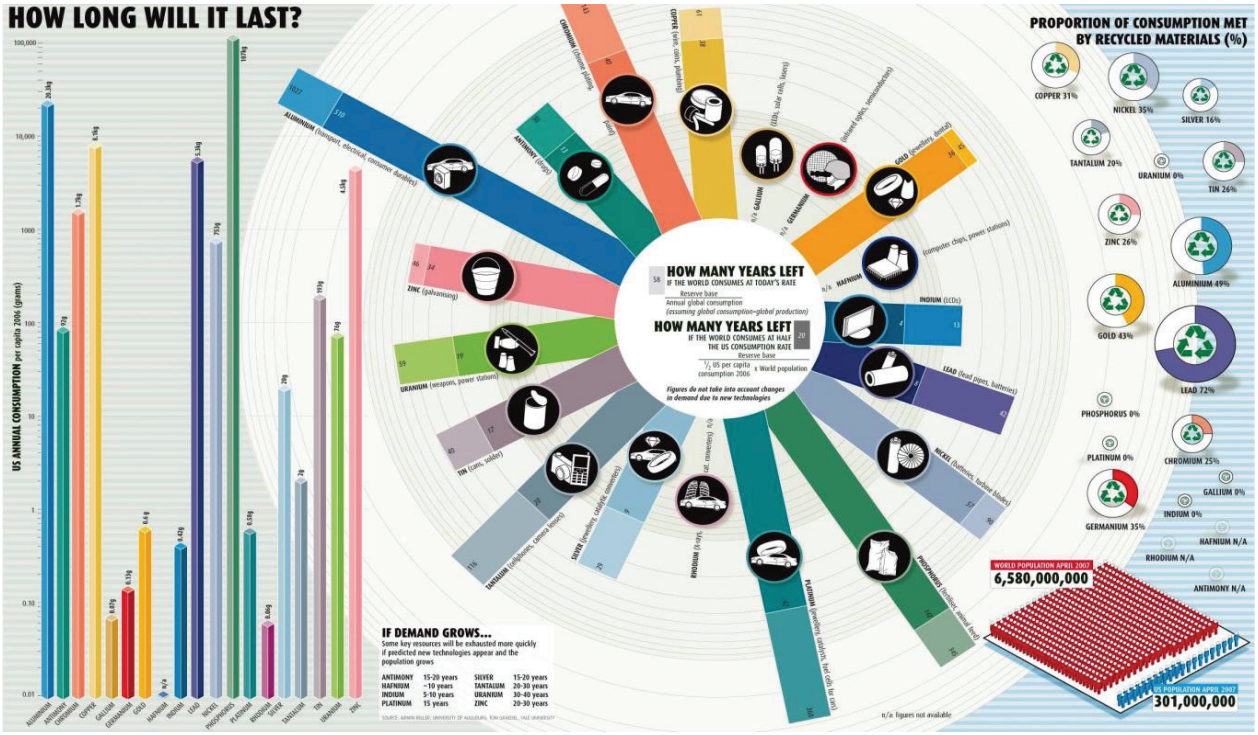


Figure 2: How long will it last? How many years are left before the resources will be exhausted when the world consumes at today's rate. Source: New scientist "www.newscientist.com/data/images/archive/2605/26051202.jpg"

How can you make your existing assets more sustainable?

The NAP Special Interest Group (SIG) Sustainability has studied this question and the experiences of 12 NAP member companies have been reviewed and discussed. Furthermore, sustainable solutions (best practices for sustainability) have been obtained from 18 different members and also from outside the SIG. All these companies have or had to overcome similar barriers to make their assets future-proof.

The first part of this report focuses on the drivers (chapter 2), followed by the barriers and solutions (chapter 3) and success factors for sustainable behavior (chapter 4). This is followed by the sustainable solutions (chapter 5), which is a list of practical examples about how to become more sustainable.

Start here

This report is a perfect guide to pro-actively start making your existing assets more sustainable. For business continuity, a cultural and structural change within your company is necessary.

Let us work together and continue to share our experiences, as we are all on the same journey.

2. Sustainability Drivers

Why would a company want to improve the sustainability of their existing assets? These are the main drivers found during our interviews:

The 4 main drivers for sustainable behavior:

- **Cost reduction**
- **Competitive advantage**
- **Image**
- **Governmental regulations**

Cost reduction

Reduced energy usage, water consumption and use of raw materials directly coincides with reduction in costs. This is interesting for all companies, especially for large-scale users of expensive materials, companies that must reduce costs in order to survive and companies that only have a small margin on their products.

Competitive advantage

Other members see opportunities within their market for sustainable or greener products. You can approach niche markets and differentiate your product. Sustainable products may have higher margins. This extra value brings you a competitive advantage on the market. Two options exist: finding a new market or providing green products based on consumers' or clients' demand.

Image

Sustainable solutions can help enhance your company's image. By showing that not only your products are sustainable, but also the way you operate, you underline that sustainability is an integral aspect of doing business. Hence, this also indirectly strengthens your competitive position on the market. Financial institutes increasingly often study companies' sustainability strategies prior to granting loans or making investments.

Governmental regulations

Due to governmental regulations, certain steps have already been made towards becoming more environmentally friendly. Examples include carbon emission trade, companies reducing their wastewater do not need a permit for wastewater emissions, the IPPC BAT is becoming stricter every time, etc.

Business and Sustainability

3. Barriers & Solutions

3.1 Barriers

The concept of sustainability is already widely known among members of the NAP. Many members have high ambitions and strive to integrate sustainability in their assets. However, in reality it often seems difficult to take steps and develop a plan to implement sustainable solutions within the existing assets.

During this study, we asked NAP members why sustainable solutions are not being applied. Based on discussions held between the SIG members and within their companies, the conclusion was made that for most members the barrier for sustainable solutions is not based on technical feasibility, but rather on the lack of knowledge, communication and existing procedures within the organization that do not support sustainability.

Below a summary of these barriers is given. They are divided into five categories: knowledge, risks, finances, governmental and organizational.

Knowledge

- There is not enough knowledge about the contribution of sustainable technologies. *What are the most optimal solutions?*
- The advantages and disadvantages for the different parties within the value or supply chain are unknown. *What's in it for me?*
- It is complicated to quantify the benefits of a sustainable solution. *What is the added value of the sustainable solution?*
- The knowledge is only limited to their own sites or facilities. It is not clear how other parties within the value or supply chain can contribute. *How can we collaborate?*

Financial

- Most investment decisions involve payback periods of < 2 or 3 years and do not consider the total benefits during the lifetime of the sustainable solution. *Why are we not looking at the long-term perspectives instead of the short-term ones?*
- The total cost of ownership is difficult to obtain. How can we *share knowledge of calculating the TCO?*
- The price paid for carbon credits and electricity is too low. *How about the certainty of supply in the long term, are you dependent on external sources?*
- The departments responsible for the investments do not reap the benefits of daily cost reduction. *Why do we still focus on personal reward for production capacity and not on energy reduction, material efficiency, etc.?*
- Due to the crisis only small investment budgets are released. *Can we find sustainable solutions that will help us increase production capacity and reduce energy costs?*

Risks

- Many companies dislike change and prefer to avoid risks. *Which sustainable solutions reduce risks?*
- Sustainable solutions are not always proven technology. *How can we be sure this solution really works?*
- It is often difficult to stand out, risk your own position and take the decision to embrace the new solution. *What is the benefit for employees who actively contribute to companies' sustainability targets ?*

Governmental

- Often incentives are too short-term, therefore it is difficult for companies to use these for their innovations, because the latter are often more long-term. *But what if we started an innovation route and next year we fail to acquire the incentive needed?*
- Incentives can hinder true innovations. *How can we stimulate green deals?*
- Procedures for incentives are often laborious and not transparent. *Why not make them more transparent and simple?*

Organizational

- Sustainable considerations often come in too late in the project. They are not a set part of the process. When boundary conditions and financial specifications are already known, it is difficult to bring in a sustainable solution. *When should we start thinking about sustainability?*
- There are too many existing regulations and procedures within the companies that get in the way of different solutions. *I have this perfect solution, which is proven, very efficient and meets our requirements. Why can it not meet our regulations?*
- Regularly, finding a sustainable solution takes more time to study. *Why would we spend time on other solutions if we already have one?*
- Collaboration with other companies is often needed for finding or implementing sustainable solutions. *Why is it so difficult to communicate with other companies?*
- Sustainability is not a high priority within the company. *Sustainability is mentioned in our sustainability report, but why is it not truly implemented within the company?*

3.2 Solutions

Instead of trying to find answers for the barriers by discussing the problems, this research was dedicated to sustainable solutions that are successfully implemented. Key question*: How was this solution successfully implemented?*

The first conclusion is that for most of the obtained sustainable solutions, the company interviewed did not actively have to overcome these barriers to implement this sustainable solution at that moment, because the barrier did not exist in these cases. The solutions fitted in the companies' structure and culture. Below are some examples of solutions that members have implemented to overcome barriers. These are again categorized into knowledge, financial, risks, governmental and organizational.

Knowledge

- **Sustainability drives innovation**. Companies that more easily introduce sustainable solutions often creates innovation. These companies have the resources or know how to obtain new knowledge. Usually, they are used to changes. They are not afraid of the unknown.
- **Quantify the environmental benefits** due to sustainability. Due to programs like the "*CO_2-prestatieladder*", (which literally means the *CO_2 performance ladder)* those companies are already used to calculating their CO_2 emissions or energy consumption level. But you can also quantify the added value of the sustainable solution yourself. For instance, Tebodin developed a sustainability process scan to benchmark existing assets.
- **Involve the suppliers and engineering companies at an early stage** to achieve the best results. Do not only ask them to find the optimal solution for a single device (e.g. a heat exchanger) or final design, but ask them to optimize the connecting installations. This is before the final design stage if all other parts of the installation are already chosen and specifications have been set up. Suppliers know best how to achieve the most optimal result and they can advise on reductions in material usage among other things.

Financial

- Several members are balancing long-term benefits. This for instance means calculating the benefits throughout the lifetime: **Compare the investment costs with the lifetime benefits**, instead of focusing on short-term payback periods. This shows the total gain of the solution during its lifetime.
- Members in the consumer products sector see market opportunities for sustainable products. **A more sustainable product adds value**. This extra value will enhance your competiveness.
- Energy reduction investments are financed by banks based on a payback period of e.g. seven years. Savings are guaranteed by approved contractors.
- Financing **co-siting operations** (a 'special project vehicle' takes care of the "co-siting activities"). Investing in co-siting operations can be enhanced, provided all parties involved guarantee exploitation during a number of years after commissioning.

Risks

- All solutions presented are **proven technology**. In some cases, extensive testing has been conducted, or suppliers have worked very hard to acquire test cases to prove the technology.
- **Spread the risks.** FrieslandCampina makes the existing installations more sustainable. In these modifications, combinations of proven/unproven or innovative solutions are used. To ensure the product quality and for example the required energy reduction, risks are spread. At several points within one facility, modifications are made. They can guarantee a certain energy reduction. By adding more (perhaps unproven) modifications, a possible range of extra energy reduction is achieved. If these steps do not work out properly, the system can easily be reset to the original setup.

Governmental

- It is difficult to affect the barriers due to governmental regulations and incentives. One way to ensure better revenues through **incentive systems** is to assign this task to an employee or engage an external specialist.

Organizational

Many companies, frontrunners in sustainability, **embedded** sustainability **in their projects or employee structures**. This for instance means that sustainability is a mandatory part of the projects, time is created for employees to analyze sustainable solutions or the employees are responsible for this. Below several examples are given of how this is implemented in different companies.

Project structure e.g.:

- Shell has a separate department called "Value Assurance" which **checks** the quality **in every project**. Sustainability is part of this quality check.
- **At the start of a project**, Tebodin addresses what the contribution can be for the sustainability goals of the client.
- In many companies one must defend why a sustainable solution should be implemented instead of an alternative. At Heineken it is the other way around. If there is a sustainable and a non-sustainable solution, **the sustainable solution is taken**, unless there is a very good reason not to do so.
- At AkzoNobel and for every large project (investment costs higher than EUR 500.000) **a sustainability report has to be written**, explaining why these solutions are chosen, whether they are sustainable enough and why other solutions were disregarded.

Employee structure e.g.:

- Create **project group sustainability**. For example, at Bronswerk the ideas of the sustainability project group make both the company and its products more sustainable. Employees may join this group voluntarily. This means creating the time, space and finances for these projects.
- At Shell, every year employees receive their **performance evaluation reports**, in which their targets for the next year are determined. There are five important main topics sustainability being one of them. The following year employees can be held accountable for their targets.
- Hire employees with **sustainability subjects being their job** or part of their job. For example, many large companies have an employee who is responsible for sustainability within their company. This can also be divided in the subjects: energy, water and raw materials: Teijin has a (part-time) energy road map manager, who is responsible for energy consumption at the site.
- AkzoNobel has **energy auditors** whose job is to visit different sites and find out how energy consumption levels can be pushed down. This starts by making the employees aware of this. These examples can also be used for water and raw materials, where someone is responsible for (improved) use.

Another organizational characteristic is:

- Having **a CEO who sees the necessity of the sustainable approach** within the company and puts pressure on making the company more sustainable, not only on paper.
- **Communicating the importance of sustainability** within the company. Creating subject awareness.

4. Success factors

In Chapter 2 the main drivers, why a company would want to be sustainable, were given. But, **how to trigger sustainable behavior within your company?** Some of the triggers found during the interviews can help overcome barriers. These are summarized in the following five triggers:

5 triggers for sustainable behavior

- **Find the financial benefits** of becoming more sustainable, for example energy reduction equals cost reduction. Or adding value to your product to be more competitive.
- **The right leadership**: the CEO understands the necessity of sustainable behavior for the company's long-term existence and proactively acts within the company. 'Walk the Talk'.
- **Customers or clients need** sustainable products.
- **Create time/budget/opportunity** for improving project sustainability and define responsibility for sustainable topics.

These triggers are part of the success factors that help make companies more sustainable. During the interviews many different success factors for implementing sustainable solutions, overcoming barriers and in the next chapter the sustainable solutions themselves, are presented.

5. Sustainable Solutions

During interviews with 18 different companies, sustainable solutions (best practices in sustainability) were obtained. These examples can be seen as practical tools for implementing sustainability within your company. They are divided by different subjects and the given examples are mentioned. Study the examples with an open mind. Often the ideas behind sustainable solutions for energy for instance, can also be applied for water and materials.

5.1 Overall

- Make it tangible
  - Fluor Sustainability Solution Manual
  - Plan-do-check-act at Teijin
  - SISCAN: The sustainability index scan by Tebodin

5.2 Energy

- Maintenance
  - Survey compressed air at AkzoNobel
  - Restore basic conditions at Heineken
- Efficient equipment
  - 'Sweat the asset': increasing capacity evaporator at Teijin
  - LED lamps at Heineken
  - High Efficiency Cooling at Bronswerk
- Heat recovery
  - General usage heat exchanger by Kapp
  - Heat exchanger suggestions by Kapp
  - Compact header heat exchanger by Bronswerk
  - Heating reductions at FrieslandCampina
- Chain efficiency
  - Transport without drying by Tebodin
- Renewables
  - CSP (Concentrated Solar Power) by NEM Energy B.V.
- Co-siting
  - Co-siting: Steam pipe by Visser&Smit Hanab
  - OCAP by Visser&Smit Hanab

5.3 Water

- Reduction of portable water
  - Reuse of process water at AkzoNobel
- Water purification
  - Joint water purification installation
- Efficient equipment
  - Reduce freshwater consumption at Bronswerk

5.4 Materials

- Quantify material use
  - 'Why create waste if you are throwing it away?' By Tebodin
- Reuse/waste management
  - Goal: zero waste aramid production at Teijin
  - Reuse waste at AkzoNobel
- Reduce harmful materials
  - Self-cleaning heat exchanger: reduce chemical use by Bronswerk
- Reduce leakages
  - Bypass Pigging at Shell

5.5 Surrounding site

- Materials
  - Low temperature asphalt by Heijmans
- Efficient equipment
  - Intelligent lighting system by Heijmans
- Green
  - Low maintenance green/green roofs by Heijmans

5.6 Sustainable products

- Light conveyor belt by Teijin
- LCA sustainable lifecycle assessment by Tebodin

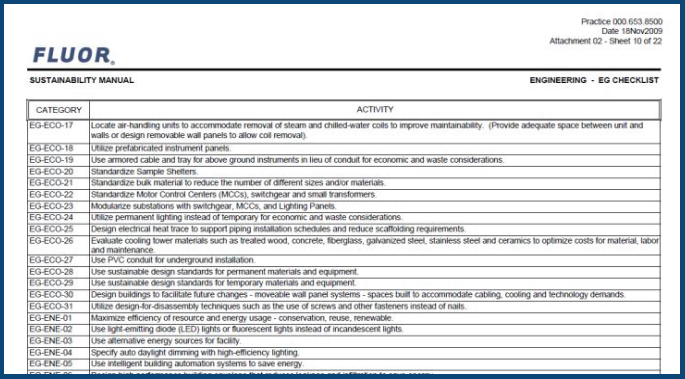
5.7 Policy

- Financial focus
  - Sustainable solution: ESCo financing
  - Change focus on finances by Tebodin
  - Examples of incentives
- Programs
  - Energy assessment tool by Antea
  - CO2-prestatieladder (performance ladder)
  - APGS by Tebodin
  - Continuous Improvement Plans by SIG 2x2 OPEX
- Evolution
  - Evolution in sustainability by Ecoawareness

5.1 Overall

To find out where the main gains can be achieved, you need to know what you are using. This approach prevails for energy, water and raw materials. Set up a measuring plan and find out more about your footprint. Then you seek to push down the consumption level. This can easily be achieved by comparing the usage results with the prescribed feasible values, to see whether equipment should be cleaned, repaired, revamped or renewed. This approach will provide an overview of high users and indicate where high gains can be made through recycling or by developing new equipment or processes to reduce your usage.

Furthermore energy, water and raw materials are usually seen as separate topics. The highest gains can be made by combining them and being aware of their synergy.



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Attachment 02 - Sheet 10 of 22

FLUOR

SUSTAINABILITY MANUAL — ENGINEERING - EG CHECKLIST

CATEGORY	ACTIVITY
EG-ECO-17	Locate air-handling units to accommodate removal of steam and chilled-water coils to improve maintainability. (Provide adequate space between unit and walls or design removable wall panels to allow coil removal).
EG-ECO-18	Utilize prefabricated instrument panels.
EG-ECO-19	Use armored cable and tray for above ground instruments in lieu of conduit for economic and waste considerations.
EG-ECO-20	Standardize Sample Shelters.
EG-ECO-21	Standardize bulk material to reduce the number of different sizes and/or materials.
EG-ECO-22	Standardize Motor Control Centers (MCCs), switchgear and small transformers.
EG-ECO-23	Modularize substations with switchgear, MCCs, and Lighting Panels.
EG-ECO-24	Utilize permanent lighting instead of temporary for economic and waste considerations.
EG-ECO-25	Design electrical heat trace to support piping installation schedules and reduce scaffolding requirements.
EG-ECO-26	Evaluate cooling tower materials such as treated wood, concrete, fiberglass, galvanized steel, stainless steel and ceramics to optimize costs for material, labor and maintenance.
EG-ECO-27	Use PVC conduit for underground installation.
EG-ECO-28	Use sustainable design standards for permanent materials and equipment.
EG-ECO-29	Use sustainable design standards for temporary materials and equipment.
EG-ECO-30	Design buildings to facilitate future changes - moveable wall panel systems - spaces built to accommodate cabling, cooling and technology demands.
EG-ECO-31	Utilize design-for-disassembly techniques such as the use of screws and other fasteners instead of nails.
EG-ENE-01	Maximize efficiency of resource and energy usage - conservation, reuse, renewable.
EG-ENE-02	Use light-emitting diode (LED) lights or fluorescent lights instead of incandescent lights.
EG-ENE-03	Use alternative energy sources for facility.
EG-ENE-04	Specify auto daylight dimming with high-efficiency lighting.
EG-ENE-05	Use intelligent building automation systems to save energy.

Benefits:

Systematic approach and early identification of sustainability in plant design and project execution.

Application:

Fluor's Sustainability Manual can be applied for any project that involves addition or modification of process equipment.

Fluor.com/sustainability
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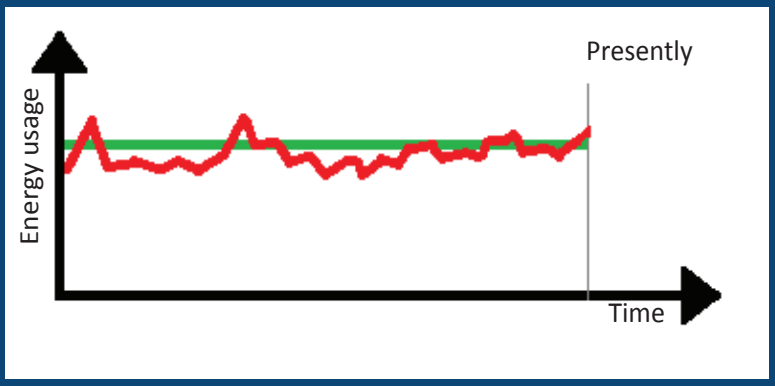
Fluor's Sustainability Solutions Manual

Fluor executes engineering, procurement and construction projects for many clients in the process industry. In today's business environment, asset owners are looking for solutions that incorporate sustainability. In order to address this topic in our projects in a systematic manner, Fluor has developed a Sustainability Manual to identify sustainable options in all phases, from feasibility to start-up.

The Sustainability Manual brings together Fluor Sustainable Solutions from Fluor's vast project experience through a structured process. This process is based on project requirements and is always fit-for-purpose. The Manual enables the project team to select target areas for sustainability and plan and implement sustainability options in an appropriate manner.

The manual includes a global Sustainability Initiatives Tracking Register, which provides access to initiatives that were considered or implemented in the execution of Fluor's projects around the globe. These initiatives range from sustainable solutions in plant design options to reduce home office paper usage to implementing sustainability in subcontractor selection or material transport.

The Manual contains an eight-step work process that can be used to facilitate the brainstorming on and implementation of sustainable solutions in project execution. In addition, the Manual includes checklists that provide ideas and stimulates thoughts on the evaluation and selection of sustainability opportunities at the various stages of the project or the area of interest.



Presently at this installation:

Exceeding energy: 120.000 W

Extra costs: 12 €/hour

Benefits:

Energy reduction

Creating awareness of energy costs

Application:

This method can be introduced at every site to gain:

- Insight into energy use

- Insight into where to reduce

Plan-do-check-act at Teijin

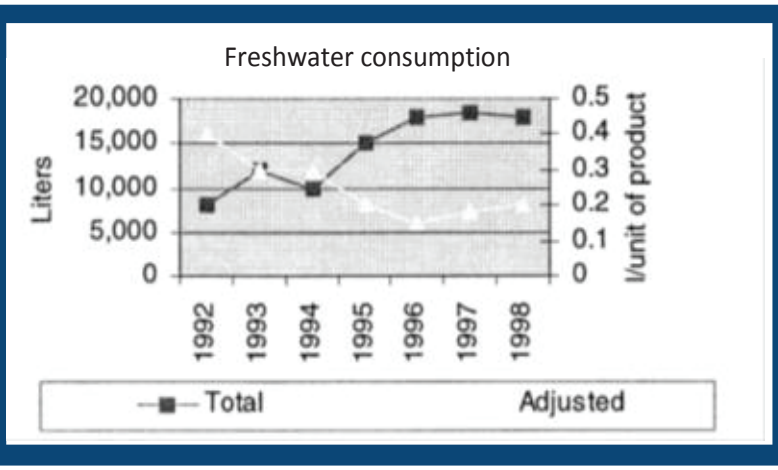
In Emmen a system is created that makes the energy use of different sections comprehensible for the employees.

Online, in graphs, both the present consumption and the norm (target) are visible. Next to the graphs it is clearly indicated how strongly the norm is exceeded (if exceeded). This is given both in energy use and costs. Every employee can access these and therefore have more insight into the usage of the sections they are responsible for.

These graphs are part of the **plan-do-check-act** roadmap:

Plan:	Measuring is key ("Meten is weten"). Set up a well-constructed measurement plan, such that all energy flows can be calculated. It is an investment in money and time, but it pays off later on.
Do:	Determine the specific energy use based on registration for a set period of time and thereby fixing the norm.
Check:	Calculate the norm deviation.
Act:	Communicate this deviation and take action if the current usage exceeds the norm.

In the short term: if installations do not work properly, action can be taken immediately. This can give quick wins. In the long term smaller flaws and inefficient use can be detected.



Benefits:

Insight into the current level of sustainability of existing assets.

Benchmark

Insight into the improvement potential

Application:

Measure the sustainability level of your production process

Analyze local differences

http://www.tebodin.com/countries/netherlands/Pages/default.aspx

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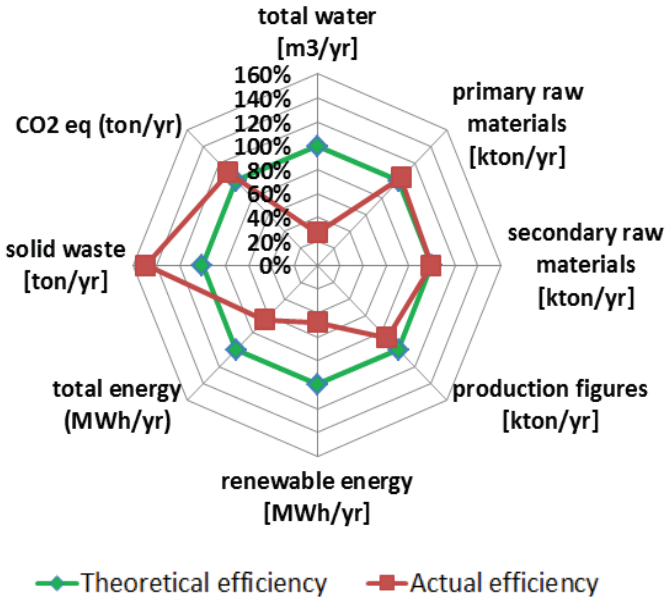
SISCAN: The sustainability index scan by Tebodin

To measure the sustainability level of a production location, Tebodin designed a tool with eight indicators. This scan provides insight into the current design performance of a plant. The scan can also be used to benchmark production facilities. The scan has been successfully tested for one of our international operational clients in Asia. The scan will be available online in 2013.

The scan provides insight into current performances and provides useful information if you are benchmarking your facilities. As local conditions differ, it can also be used as a strategic tool for future expansion plans.



5.2 Energy

You can study the reduction of your energy consumption level and how to use renewable energy sources. There are several items which you can focus on:

- **Maintenance**

Often, reduction is feasible by checking your equipment's effectiveness. This can be done for example by measuring the energy usage and comparing that to the prescribed feasible values. High energy consumption could mean cleaning or repairing is required. These are often the quick wins.

- **Efficient equipment**

Make your existing equipment more efficient for example by adding insulation, changing process settings or investing in low-energy equipment like LED lamps and energy-efficient fans.

- **Heat recovery**

Check your cooling and heating locations. Where can a heat exchanger be installed? The payback period can be very short. New developments are made every day and even at difficult locations heat exchange or recovery may now be possible.

- **Chain efficiency**

Sometimes your process will consist of certain steps, simply because you are used to them. But maybe these steps are not necessary. For example, you dry your product first and then the customer adds water to it. This product can also be transported in wet condition. Other energy consuming steps might be skipped as well.

- **Renewables**

Your carbon footprint can be reduced by buying electricity based on renewable energy sources. Or you could produce your own renewable energy by using e.g. PV-panels, windmills or biomass. You can also create these solutions in another country and you may receive carbon credits.

- **Co-siting**

For example, your excess heat can be used at other companies or your clean CO_2 can be used in greenhouses. The two examples given are at a large scale. But co-siting can also be started at a small scale. It means you need to collaborate with your neighbors.

Calculating tool:
(Energy cost savings/year) = (Energy price) x (0.1) x (Energy usage/year)
(Energy usage/year) = (Compressor power) x (Hours of service/year)

Benefits:

Energy reduction: 10%

Creating awareness

Costs little time

No in-house knowledge needed

Costs KDS are € 1,200 for a day

If your energy costs for compressed air exceed € 12,000/year, your payback period is less than a year

Reduced costs: 25,000€/year

Application:

This is especially useful for intensive users of compressed air

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Survey compressed air at AkzoNobel

The compressed air network at one of AkzoNobel's sites was traced for leaks. By measuring and repairing the leaks in one of their existing assets, the energy costs for that year were reduced by € 25,000, with minimum effort from their people by hiring the compressed air survey company KDS.

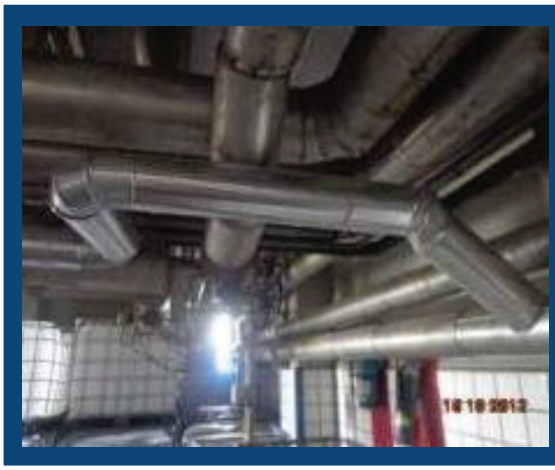
The average leakage in compressed air systems is 35%. KDS repairs 80% of the leaks themselves and thereby they can reduce the energy usage for compressed air by 10%. The remaining leaks have to be repaired by specialists and they are tagged.

KDS costs about € 1,200 for a day. To roughly calculate the energy reduction potential, the formula above can be used. If the energy consumption is unknown, the rough estimate mentioned above can also be used. For more information see the calculating tool.

Due to these checks, awareness is created among the employees to take care of the leaks during the year or even perform general maintenance.

Alternative

Conduct the survey within the company yourself. For this the commitment of the employees at their workplace is required. By creating awareness the employees can find a leak during their work, report it and have it fixed. For this one must understand how to conduct such a survey (knowledge) and employees are needed to perform the survey and the repairs (time).



Calculating tool :
Heat remaining in condensate (%)
$= (h_c - h_m) / (h_s - h_m) \times 100$

h_c = enthalpy of condensate
h_m = enthalpy of make-up water
h_s = enthalpy of steam

Benefits:

Energy reduction by:
-Less heat is needed for heating freshwater
-Less heat is lost due to insulation
-Less steam is lost
-Insulation

Increase operational safety

Payback period: a few months up to 2 years

Application:

This method is applicable to all your installations. Compare what the situation should be to the current situation (for example by measuring the energy usage). Then take action.

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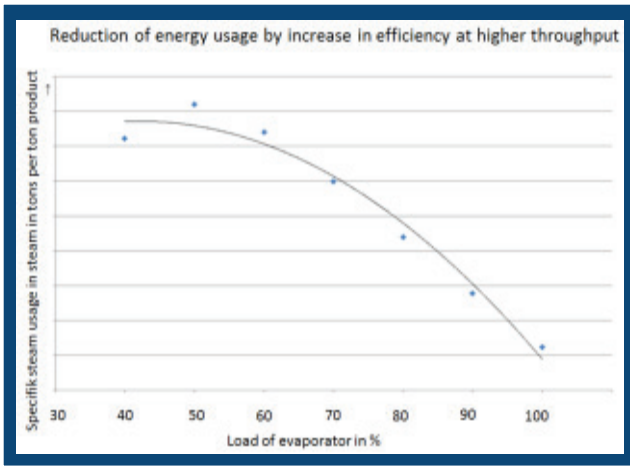
Restore basic conditions at Heineken

When steam transfers heat to the process in, for example, a heat exchanger, it reverts to a liquid phase called condensate. Energy can be reduced by increasing the amount of condensate which returns to the boiler.

When more condensate is returned, less make-up water is required, saving heating energy and make-up water and less condensate is discharged into a sewer. The energy that remains in the condensate can be 10%, depending on the temperatures and pressures. This can be calculated for your company using the equation above. For more information see the calculation tool in the Annex.

But do you still achieve this 10% reduction?

Even though you have the right equipment, this still has to be maintained to ensure a 10% energy reduction. In an audit on one of Heineken's sites the basic conditions were restored for steam distribution and condensate return among other things. Often basic things like insulation are not properly placed, due to e.g. other maintenance, or they are even not present at all. By applying insulation, the operational safety is increased as well. Another issue are the stream traps that were not working properly and therefore, energy was wasted. The payback period for restoring these to their basic condition is one to two years, but often just a few months.



Benefits:

At Teijin Emmen, the evaporators determine much of the energy costs.

This adaptation ensured a reduction of 1 to 2% on the total energy consumption.

Application:

The 'Sweat the asset' concept can be applied to all constructions where several installations perform the same task but not at full capacity.

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"Sweat the asset" at Teijin

On Stream Efficiency (OSE) was performed for the sulphuric acid evaporator installations at Teijin Emmen.

After the sulphuric acid is used in the production process of Twaron, it has to be concentrated in three stages. Every stage involves multiple evaporators.

Inside the evaporator the dependence of steam consumption on the capacity of the evaporator is not linear. This can be seen in the graph above. One of the reasons for this non-linearity is the following: the heating of the installations and the pumps, which relatively consume more energy.

At Teijin they 'sweat the asset': increase intensity of use. Instead of having for example nine evaporators at 50% capacity, they use five evaporators at 80% and four are switched off temporarily.

Benefits:

70% energy reduction

Less maintenance = longer lifespan: over 50.000 hours

Enhance safety

Enhance working quality

Application:

Inside and outside

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www.sustainabilityreport.heineken.com/2010/best-practices/

LED there be light at Heineken

When at the Heineken manufacturer Vrumona 1.750 fluorescent lamps needed to be replaced in a large distribution hall, they switched to LED lights.

LED lights:
- last longer. Lifespan is at least 50.000 hours.
- do not contain dangerous chemicals.
- are more efficient: 70% less energy consumption compared to fluorescent lamps.
- produce better quality lighting for safe working at the hall, e.g.: moving parts do not seem to be stationary anymore. Small prints on crates and instruments are easier to read.

Testing skepticism

Even a company which is so progressive towards sustainability, was skeptic:

Is the light quality high enough?

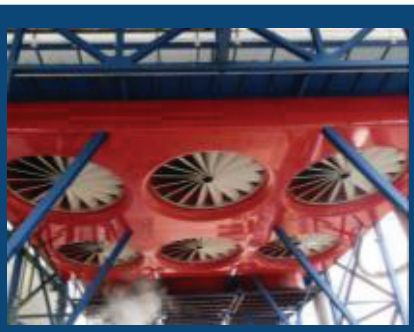
Due to a test facility with two types of LED lights (one could not handle the vibrations), workers became even more enthusiastic about the lighting.

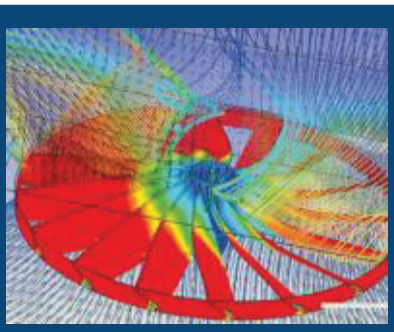
Are they too expensive?

The financial consideration: even though LEDs are more expensive, they last longer and save money.

Are they rugged enough?

Some LEDs shine less brightly over time. By negotiating strong guarantees with the supplier, they were willing to take the risk.





(Cost savings) = (Lifetime) x (Energy costs) x (Energy saving) x (Power per fan) x (Amount of fans) x (Hours of service)
For a 10-year period for 100 fans of originally 120 kW and an electricity price of €0.10/kWh this gives:
(Cost savings) = 10 years x €0.10/kWh x 0.5 x 60 kW/fan x 100 fans x 8.000 hours/year = € 24.000.000

Benefits:

Energy reduction up to 50%

Noise reduction of 6 dB(A)

Raw material reduction: The casing is made of plastic instead of steel. Therefore it is lighter.

Investment costs:
1.15 x conventional

Pays back in 2-3 years

Energy cost reduction from example: € 24.000.000/lifetime

Application:

Often your equipment suppliers have an integrated solution for the installation. Generally, the most optimal result is not achieved if only the separate device is delivered.

Ask your suppliers for new developments in the area of the equipment, which can ensure more sustainable results.

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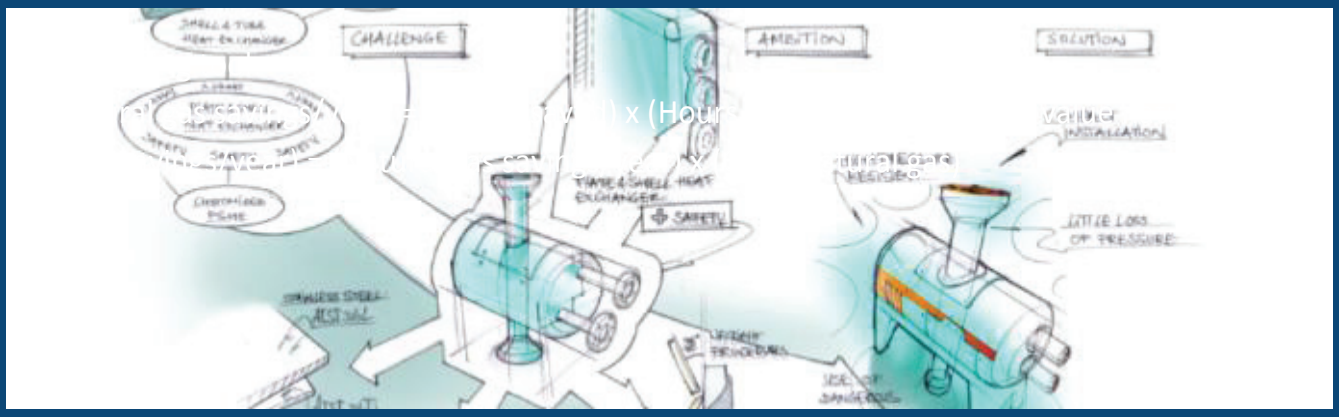
High-efficiency cooling by Bronswerk

Efficient equipment is not just about using your equipment as optimally as possible, but also about choosing energy-efficient equipment in the first place. New innovations are developed every day. One example is the Whizz-Wheel® by Bronswerk for air-cooled heat exchangers. It is a very energy-efficient, low-noise intensity fan and in production it uses less raw materials. The high efficiency and low noise is acquired by using optimised blades.

The fans are implemented in air-cooled heat exchangers, but also wherever fans are required, e.g. for air-conditioning units, data centres and air treatment. Bronswerk does not only deliver these fans, but it also provide the complete optimised cooling system. They offer a solution for your needs, like reduced energy in existing processes.

The feasible energy saving is up to 50%. For the feasible energy cost savings over the lifetime within your company, see the formula above. For more information see in annex 2.3.



Benefits:

Energy reduction

Cost reduction

Application:

For almost any application where heat can be transferred from one medium to another.

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General usage of heat exchangers at Kapp

Kapp Nederland, Consultants in Heat Transfer, still sees many opportunities when it comes to using heat exchangers in smarter ways. Payback period can be less than a year.

Especially in existing plants, there are opportunities due to recent changes in the process. It is worth taking a good look at the total energy balance. A proper check can generate cost reductions resulting from energy optimization:

If currently you can save 1,500kW to heat your flow, operate 8.000 h/year and your gas costs are 0.30/m^3 your saving can be:

(Natural gas savings) = 1.500 kW **X** 8.000 h/year **/** 9,769 kWh/Nm^3

= 1,228,320 Nm^3/year

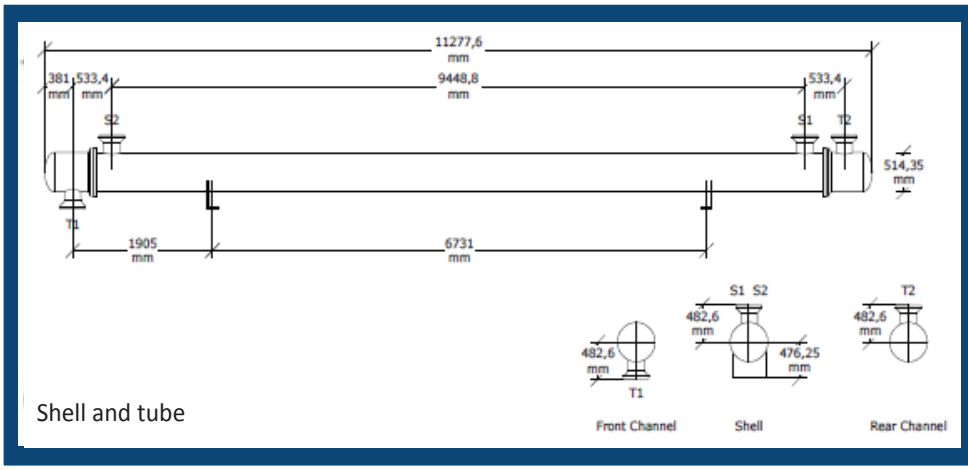
(Cost savings) = 1.228.320 Nm^3/year **X** €0.30/m^3 = € 368,496/year

For more information about the equation see the calculation tool in Annex 2.4.

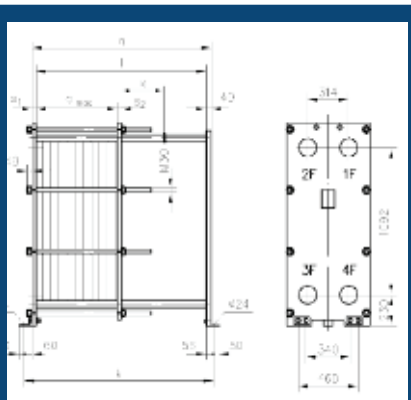
How do I get the maximum result in energy reduction?

Achieve more optimal results by involving suppliers and engineering companies at an earlier stage. Innovative solutions for your application result based on cross experiences.

Check the energy balance of your site and use these data to optimize your plant.



Shell and tube



GEO Ecoflex Plate Heat Exchanger

Benefits:

Energy reduction

Material reduction

Weight reduction

Cost reduction

Application:

Discuss alternatives with your supplier. Smart solutions can be available.

Be open-minded to other/new suggestions

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Heat exchangers suggestions by Kapp

Kapp Nederland, Consultants in Heat Transfer, specializes in engineering solutions for heat transfer requests. Two examples:

1. Two airflows at a distance from each other: Gas drying unit

Although the airflows are at a distance from each other, the required heat can be transferred from one flow to the other by using a twin-coil system. The latter consists of two separate air/liquid heat exchangers. Loop 1 consists of the wet gasses from the dryer, the heat is transferred to the cold water/glycol liquid. In loop 2 the warm water/glycol liquid delivers the heat to the cold air.

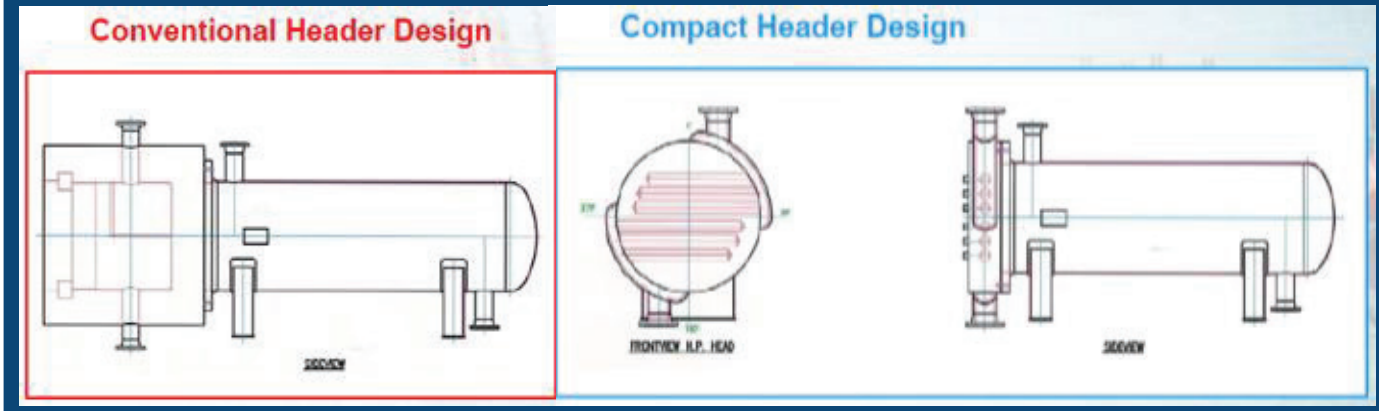
The investment costs, including HE, piping and appendages are approx. € 50.000. Energy reduction = 470 kW. Pays off in less than five months.

2. Be open-minded to alternatives

What you think you want, is not always your best solution. A waste-to-energy client requested a shell and tube heat exchanger for a Cooling Water Cooler application. However, Kapp saw the benefits of an alternative: the plate heat exchanger. The solution offered instead contained a high alloy plate material (better resistant to the chlorides in the river water, using less space and material).

The main benefits are the gigantic size and weight differences:
Shell & tube : 11mx0.5m and 6000 kg
Plate heat exchanger : 1.3mx1.5m and 1300 kg

The investment costs for PHE compared to the S&T are 60% lower. Civil works are also reduced – space savings, less foundation works, less piping. In order to realize the savings it is important to investigate alternatives at an early stage.



Benefits:

For heat exchanger p>200bar:

Material reduction 30%

CO_2 emission reduction

Weight reduction 15 tons of steel

Investment cost reduction

Application:

This heat exchanger is especially beneficial for high - pressure heat exchangers.

Ask your suppliers for new developments in the area of your equipment, which could ensure more sustainable results.

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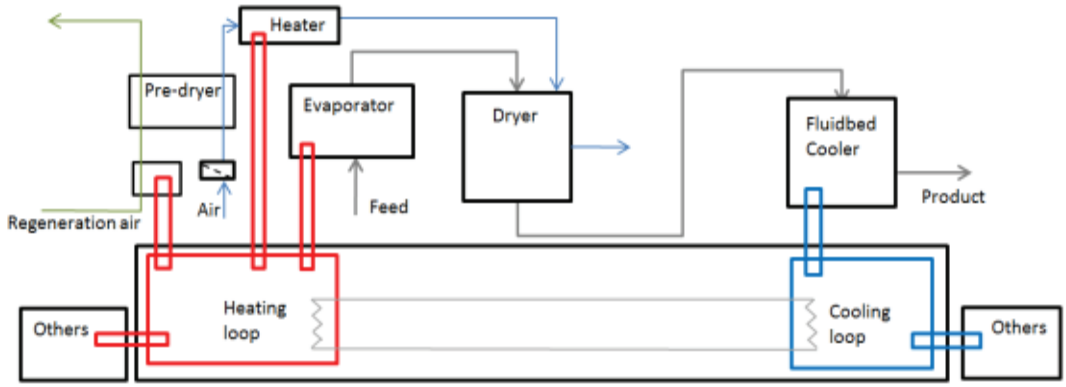
Compact header heat exchanger by Bronswerk

Shell and Tube Heat Exchangers with (extremely) high pressure on the tube side, normally require a solid and exceptionally strong and heavy construction. The higher the pressure the more material is needed. This dependence is quadratic, resulting in constructions which require plenty of material.

To reduce the amount of material needed, Bronswerk developed the Compact Header Design, which only needs a fraction of the material normally required for a similar heat exchanger. This difference is due to the structure of the head. Instead of leading the flow through a large tube the flow is led through many small tubes. These smaller holes can better withstand the high pressure and therefore less material is needed.

Due to this material reduction the heat exchanger is lighter and requires less space. Using less material also means a cost reduction. For a heat exchanger with a > 200 bar pressure a weight reduction of 30% can be achieved. This equals about 15 tons of steel and an equivalent CO_2 emission reduction, due to material reduction.



Benefits:

Energy reduction

Cost reduction

Application:

Study your own heat and cold loops:

Where can heat be reused?

Where can the heat and cold loops be combined?

What adaptations can be made to reduce the amount of energy used for heating and cooling purposes (e.g. pre-dryer)?

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Heating reductions at FrieslandCampina

At the Beilen Production facility, milk powder is produced during a process where liquid is first concentrated through evaporation inside an evaporator. It is then dried using a spray dryer to become milk powder. Afterwards the product is cooled down.

These existing installations are now being revamped. To reduce the energy use two different systems were introduced:

1. Heat recovery system

By using heat pumps the cooling and heating loops are combined. For example, heat is needed to increase the temperature in the air heater and heat the regeneration air. Further ahead cold is required to cool the milk powder, milk and milk concentrates. With the heat pumps the necessary heat is taken from the cooling loop and less energy is needed for producing the heat and cold.

2. Pre-drying the air

As the drying agent for the milk powder, the outside air is used. The air characteristics differ in summer and winter. The humidity is higher in summer. To overcome this difference a pre-dryer is installed to reduce humidity. In winter the air is already less humid. By using air with a lower humidity, less heat is needed to increase the temperature.

$W = |\Delta E_P - \Delta E_T|$

$\Delta E_T = |E_{T1} - E_{T2}|$

The energy savings (W) can be calculated by finding the difference between the production energy (ΔE_P) and the transport energy (ΔE_T). The difference in transport energy is the present transport energy (E_{T1}) and the new transport costs (E_{T2}).

Benefits:

Energy reduction of 2 to 3% of the total energy use

Turning point: 4.000 -5.000 km

Adaptation investment: 200 k€

Pays back in 10 years

Application:

This is especially usable with a thermal drying step (high energy consumption)

If the energy usage is known, the energetic and financial benefits can be calculated.

The investment costs depend on the adaptations that are needed within the process.

AgentschapNL subsidises many chain crossing feasibility studies.

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Transporting without drying by Tebodin

Some companies dry their products before transportation. Customers' first step is adding water. By removing the drying step, at what distance can the wet product be transported to be energetic and financially beneficial?

Zeolyst C.V. in Delfzijl produces zeolites, which are the building materials for catalysts. One of the last steps in the production process of zeolites is drying the slurry. After that the dried zeolite powder is transported to the customer, who adds water once again. Together with AgentschapNL and Tebodin a feasibility study has been conducted on the energetic and financial effects of delivering the product in slurry to the customer.

The last step of the drying process involves thermal heating, a flash dryer, which uses high amounts of energy. In the new setup the flash dryer is skipped. The process does require other adaptations:

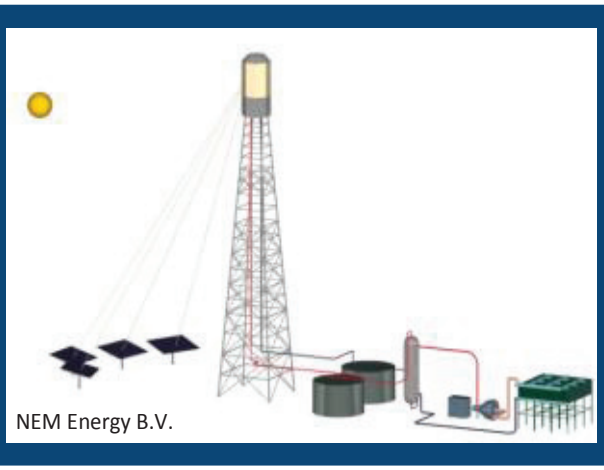
- Storage, packaging and transport of the liquid product
- Method of adding the liquid product at the client's

Due to these adaptations, the investment costs for Zeolyst B.V. will be about € 200.000. Payback period: 10 years.

The feasibility study showed a reduction of 2 to 3% of the total energy use in the plant. This is significant because the process comprises 10% of the total plant production.

Zeolites can be transported from an energetic and financial point of view for several thousands of kilometers: the turning point of (energy cost savings dryer)- (transport cost) at 4.000 to 5.000 km.

To calculate the energy savings by transporting your product in liquid condition instead of a dry condition. For more



NEM Energy B.V.

NEM energy b.v.

Benefits:

Use of renewable energy during day and night time.

Application:

This setup is interesting for companies with sites in sunny areas.

If your company carries out CO_2 reducing programs in other parts of the world, they are rewarded with carbon-credits.

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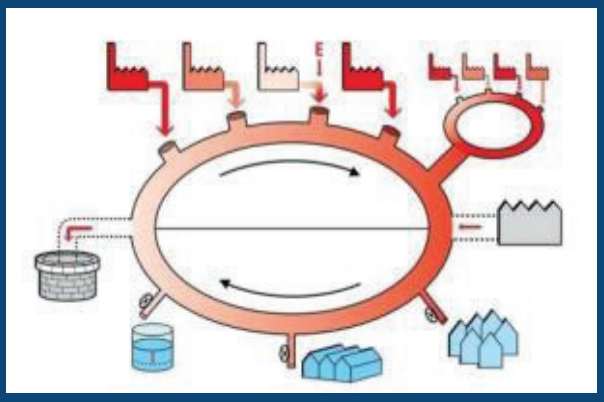
Concentrated Solar Power by NEM Energy B.V.

In the search for renewable energy sources, the sun is an attractive example. Its energy can be harvested using for example concentrated solar power. NEM Energy B.V. developed both the thermal and optical equipment. They supply the thermal equipment and have extensive knowledge of the optical equipment for a Power Tower plant.

The Power Tower is based on a field of heliostats (large parabolic shaped mirrors) which reflect and concentrate sunlight onto a central receiver, placed on top of a tower. Each individual heliostat tracks the movement of the sun during the day and aims the reflected sunlight onto the receiver. The receiver collects the solar energy and transfers this to a heat transfer fluid. This thermal energy can be used to directly drive a steam turbine for electrical power generation. Excess thermal energy can be stored in a Thermal Energy Storage (TES) system for extended power generation during cloud coverage or during the evening or night.

The solar fields can be created for any size: from small hybrids or solar add-ons to large utility scale solar power plants.

For the Netherlands the possibilities lie in creating concentrated solar power plants in Spain or North Africa and transferring the electricity to Western Europe using electricity cables. In the short run the Netherlands could make use of the locally produced renewable energy to reduce CO_2 emissions and increase the amount of renewable energy produced. Investments in such projects are compensated by carbon credits.



Benefits:

Companies are now producing steam by using fossil fuels. The entire network will reduce CO_2 emissions by 2.000 tons a year.

Steam at 40 bars and 400°C

Application:

Companies with excess or need for heat in the Botlek area.

This is a large-scale co-siting project, but it can also be applied at small scale. Your process excess heat can be applied for a neighboring process.

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www.rotterdamclimateinitiative.nl/en/english_2011_design/50_reduction/projecten/steam_pipe?portfolio_id=65

Co-siting: Steam Pipe by Visser&Smit Hanab

A large quantity of residual heat exists within the Rotterdam Rijnmond area. It is often discharged into the air and water. While other businesses require heat and therefore burn fossil fuels. Why not combine these?

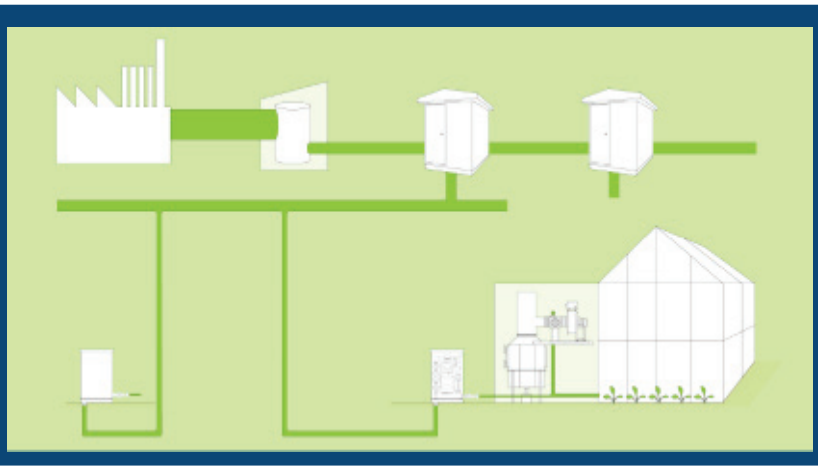
To connect demand and supply and use each other's residual heat, a transport system has been set up in the Botlek area: Steam Pipe. Here, steam is delivered from the supplier to the consumer.

This project has been set up by Visser&Smit Hanab, Stedin and is supported by Havenbedrijf Rotterdam and Rotterdam Climate Initiative. Steam Pipe will be the common carrier, while the dispatcher (Stedin) manages the infrastructure.

Steam is delivered at 40 bars and 400°C. If your steam is not of this quality an extra stage will be required. How to achieve this can be discussed with Stedin or Visser&Smit Hanab.

At the moment there are two steam suppliers and consumers but the system is expendable with more suppliers and consumers who are using the steam directly from the system. Steam can be directly supplied to or consumed from the system or a heat exchanger can be used to transfer the heat.

The Steam Pipe will be available in May 2013. The first part of the network will be built in Botlek West. The objective is to extend the network in the whole Botlek area within the foreseeable future. The design allows for multiple suppliers and consumers of steam.



Benefits:

Reduction of natural gas consumption at the greenhouses.

Greenhouses are a sink for industrial CO_2.

Application:

Companies along the network who produce or need clean CO_2.

On a smaller scale your clean excess CO_2 can be transported to a neighbouring company.

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www.warmco.nl

OCAP by Visser&Smit Hanab Organic Carbon dioxide for Assimilation of Plants

This co-siting program captures clean CO_2 from the industry and transports it to greenhouses, and in the future possibly also to underground storage areas.

The transport system is based on the existing underground crude oil pipeline ranging from the industrial area in Rotterdam to the harbor area in Amsterdam (85 km), which is used for transport and buffer. Besides this pipeline a wide distribution network is constructed to link the greenhouses to the network.

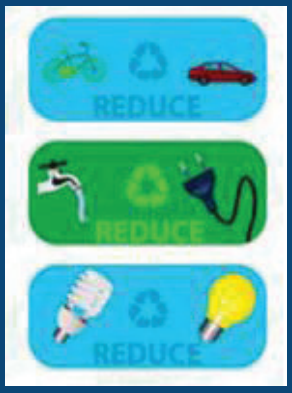
The positive effect for the greenhouses is that growth is enhanced due to the concentration and dose of CO_2. Furthermore, greenhouses' self-produced CO_2 still may contain contaminations.

At the moment the clean CO_2 is captured from two companies in Pernis and the Botlek and is transported to three greenhouse areas: Westland, B-driehoek and Zuidplaspolder. OCAP is investigating for other areas along this network to join. The condition is that the companies must be able to produce pure CO_2. For example, pure CO_2 is produced during the process or a cleaning step is added.

A similar program is implemented in Zeeland: WARMCO2. This is done at a smaller scale. However at WARMCO2, both CO_2 and heat are co-sited.

5.3 Water

How can you tackle your water consumption? Investigate the incoming and outgoing water flows and where water is used. Try using the water within the process as efficiently as possible, reduce your fresh water intake and your water disposal by reusing as much water as possible. Try using closed water loops.



Benefits:

Reducing drinking water intake by reusing evaporated process water.

A side effect is that this water is often warmer than drinking water. Therefore energy reduction is also possible.

Application:

Evaluate both outflows of quality process water and inflows of water within your assets or even collaborate with other companies.

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Reusing process water at AkzoNobel

In the salt plant in Delfzijl, salt is produced by evaporating salty water. The evaporated process water is of good quality. Previously, this clean pure water was discharged into the sea.

To reduce the tap water consumption at AkzoNobel, the latter evaluated the users within their own assets and also at the surrounding companies. The process water is reused in the chloride plant in Delfzijl, thus reducing the tap water intake significantly.

Checking whether their evaporated water is good enough is easy (pH and density).

The main costs for reusing the water are the costs paid to install the pipeline. The payback period of this installation was 10 years. To make this a business case AkzoNobel received a subsidy, which highly reduced this period.

Benefits:

Enabling users to better understand the true costs of water use.

Application:

This tool is developed in order to help different industries calculate their water costs. Especially this will help with the financial justification of water efficiency projects.

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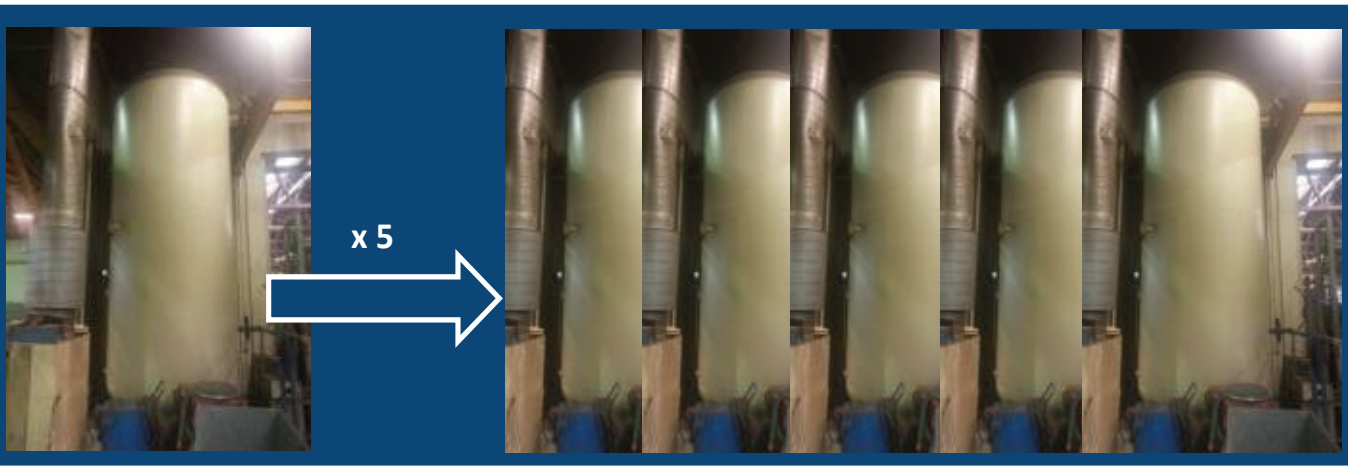
True cost analysis

Getting insights in the true costs of water

Antea developed for one of their clients a tool to calculate the true cost of water. Based on the price of water and water treatment not all water efficiency projects may be feasible.

But not only water price and waste water treatment costs are important. Also chemical treatment of the water, energy use of pumps, heating and cooling of the water, operator costs and other, are important cost factors to consider as well. Other important costs that may be important for a ROI calculation, are permits, costs of production stops or production continuity problems (e.g. due to exceeding BOD/COD values of waste water treatment plant) and the costs for reputation damage when water issues occur.

The tool provides the user guidance and calculations on how to calculate the true costs of water. This enables to user to better justify water efficiency projects.



Benefits:

Reducing drinking water intake

Reducing wastewater discharge

Using fewer anti-corrosion agents

Enhancing working quality for employees

Application:

This example is not only applicable to hydro test water, but wherever water is used. Find the solution, to reduce the amount of tab water used and the wastewater discharged.

Create closed loops as much as possible.

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Reduce freshwater consumption at Bronswerk

Previously, Bronswerk would only use one water tank for hydro-testing. This tank is often too small for larger equipment. In those cases, fresh tab water was used and discharged into the sewage system afterwards.

The water is used to test the new equipment for leaks and strength. Because it is not possible to completely dry the equipment afterwards, anti-corrosion agents are added. The water used passes through a filter and is then stored inside the water tank. This is a closed system. Lately more often tab water (or even a tank car) is used to suffice demand. Wastewater is discharged including the added (biodegradable) anti-corrosion agents into the sewage system.

To reduce the tab water usage four more tanks are added. Having several tanks also has a practical benefit for the employees: more hoses are available at different locations. These do not have to be unrolled far, enhancing safety and comfort for the employees.

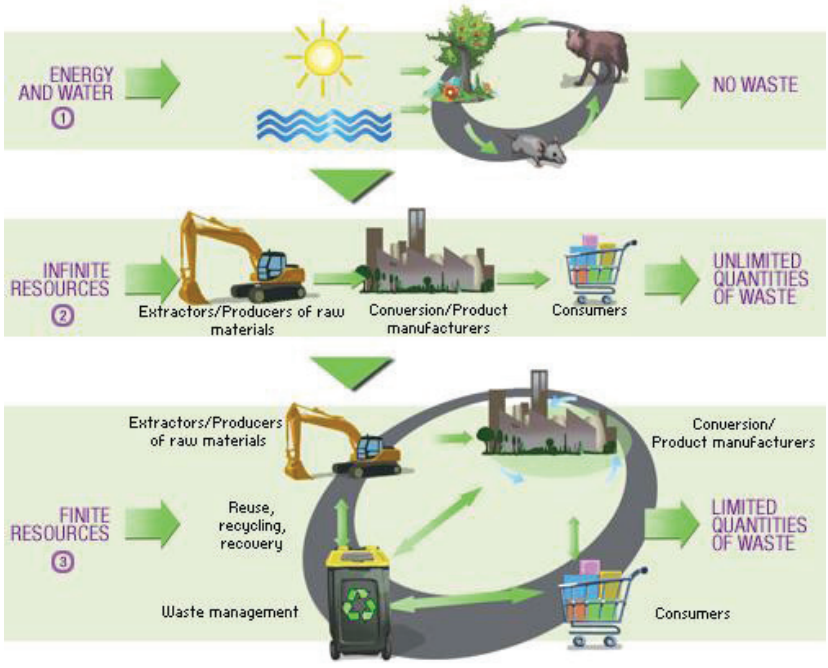
Another adaption is the implemented filter, which filters steel particles among other things.

This sustainable adaptation does not give direct financial benefits. This is more of a long-term approach. If your company is on the market to sell sustainable products, making a difference within your company as well is convincing.

5.4 Materials

Reducing your material usage is again about checking your incoming and outgoing flows and where these are used. Questions that can be asked are: Can I reduce the amount of raw materials I use (incoming flows)? Can I reduce the amount of toxic materials used and are there any alternatives? Can I reduce the amount of waste disposed by using fewer raw materials or by reusing materials?

Some have an ambitious zero waste goal by using their materials as efficiently as possible and also by reusing materials. Others use the concept of industrial symbiosis: I have this “waste flow”, is there another company that can use it?



① Operation of natural ecosystems
② Linear operation of "conventional" industrial systems
③ Circular operation of eco-industrial systems

Benefits:

Material usage reduction

Waste reduction

Energy reduction

Cost reduction

Application:

If you have a neat overview of all your incoming and outgoing material flows, it is easier to calculate the improvement potentials.

Calculate the financial benefits of waste reduction not only by reducing the waste disposal costs, but also by pushing down the raw material purchase costs.

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Why create waste if you are throwing it away? By Tebodin

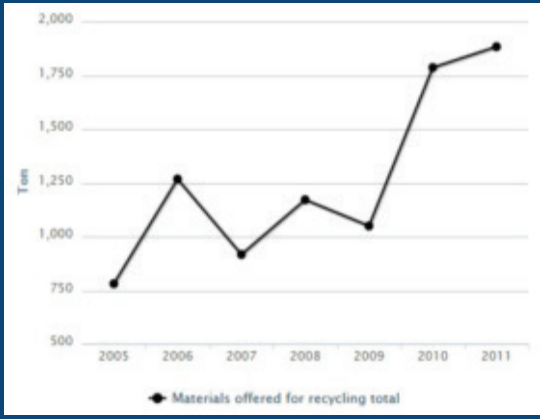
Tebodin performs Value Improving Practices, where feasible improvement potentials are determined. For one of the clients the focus was on waste minimization. They have a very neat and clear administration of their incoming and outgoing flows of materials: how much material they buy, where it is used and how much they wash away. This knowledge is a fantastic start to reduce waste.

With such an overview the improvement potential can be calculated relatively easily.

If you can reuse waste, you will be able to reduce the amount of new purchased materials. The eye-opener is that previously, the client would calculate the financial benefits of reducing waste by the reduced disposal costs. **However, the financial benefits should also be appraised based on the purchase costs of the product.**

In this case the company calculated the financial benefits by the disposal costs of the material at €0,20/L and now by the purchase costs at €10,-/L.

By reusing waste as a raw material, costs were pushed down including the energy reduction and manpower costs. The manpower time can now be used for profitable production.



Benefits:

Less CO_2 emission

Less toxicity

Fewer waste products

Reuse materials

Application:

Check all your company's your incoming and outgoing flows:

Which of these can be reused at your company?

Which of these can be reused at other companies?

Can your customers' used products be collected and recycled?

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Goal: zero waste aramid production at Teijin

To reduce the carbon footprint, all the incoming and outgoing flows have been analyzed for possible material recovery and recycling. Next a few examples are given:

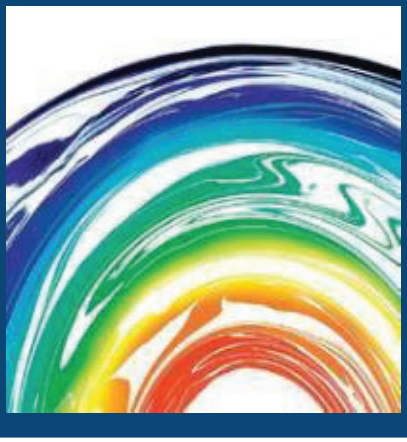
1. Recovery Sulfuric Acid

In the production process of Twaron-yarn, the PPTA-polymer is dissolved in sulfuric acid to produce a liquid crystalline solution, which is then spun into a fine filament yarn. The sulfuric acid is washed out of the yarns. This dilution (10-15 % acid) can be neutralized or sold for example to the lime or fertilizer industry. Then new concentrated sulfuric acid can be bought again. It is about reusing your waste products at a down-graded level.

At Teijin Emmen the dilution is concentrated in three evaporator phases. The resulting 96% concentrated sulfuric acid is then mixed with oleum (125% concentrated sulfuric acid) to give 100% sulfuric acid. This can be used as solvent again.

2. Waste becomes feedstock

Used products are collected from many different sites in the market: ballistic vests, fabric scrap, yarn leftovers, cut-protective gloves, optical fiber cables. These are sorted, tested for quality and processed into new products. The graph above provides an overview of the recycled materials used. The recycled products are pulp, which can be used as asbestos replacement and recycled spurn yarn.



Benefits:

Fewer waste materials

Disposal cost reduction

Application:

Look at all your incoming and outgoing flows:

Which waste products can be reused as product or raw material?

Which waste products of other companies can you use as your raw material?

Look into Industrial symbiosis: start the conversation with nearby companies, what you can mean to each other?

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Reusing waste at AkzoNobel

AkzoNobel has an overview of their incoming and outgoing material flows. They evaluated waste for reuse as product or raw material.

Is there a market for obsolete paint and coating materials?

In the production of paints & coatings, there are certain yield losses. These i0nvolve e.g. expired pints, QC samples, powder coatings fines, obsolete raw material and wash solvents.

All these materials can be reworked into low tier paints & coatings. They do not need to be disposed as waste.

Is there a market for woodchip boiler waste?

A woodchip boiler is used as a sustainable solution to produce steam. However it also generates fly-ash. Can this be reused?

They evaluated the local market for reusing the product as a raw material. It is now being reused at a nearby company where they use the fly-ash for the production of insulation materials. Fly-ash does not need to be stored and secondly disposed as waste. It is a win-win situation for both.

Reusing chemicals?

AkzoNobel supplies and consumes chemicals wastewater purification. Can this be combined?

Hydrochloric acid is produced at a nearby company and is bought cheaper than before by AkzoNobel. The producer does not have to neutralize it any more. It is again a win-win situation. This idea is also being implemented at other facilities.

Benefits:

Energy reduction due to not cleaning heat exchanger by heating or implementing the

heat exchanger where it was at first impossible

Using fewer anti-fouling chemicals

Less maintenance

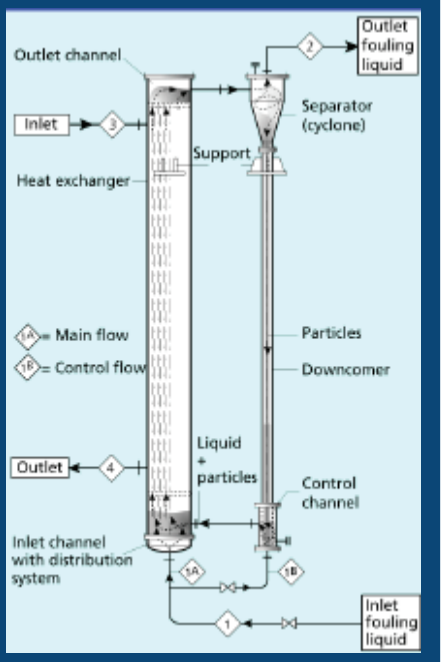
No more production stops

Application:

For fouling liquids in e.g.: forced circulation evaporators, polymerization, concentration of wastewater, pulp & paper industries, raw juice heating and seawater desalination.

Ask companies for new developments for situations where a heat exchanger could not be used in the past.

Ask them as well whether they can optimize or revamp the current installation



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Self-cleaning heat exchanger by Bronswerk

Due to its self-cleaning characteristics the Klarex heat can be used for fouling liquids which can be corrosive, hazardous or blockage materials.

The technology is as follows: extra solid particles are added to the fouling liquid. The upward flow of liquid transports the particles through the heat exchanger and creates a mild scraping effect on the wall and thereby removes any deposit at an early stage. At the top, the particles are separated from the liquid and are re-added to the feed by a side loop. These particles can be made of cut metal wire, glass or ceramic balls. Examples of where it can be used:

Tar sands

The oil is being exploited by injecting steam into the sands. To clean the water for reuse, chemicals are added. By using the self-cleaning heat exchanger, these chemicals are not needed anymore.

Food-processing plant

The heat exchanger is installed as an evaporator for wastewater concentration. The Klarex heat exchanger could be used, because the severely fouling liquid would not cause blocking anymore.

Crystallization

Crystals' deposits can cause fouling. Shutdown every 16 hours for melting out these deposits is common. Using the self-cleaning technology to revamp the installation, this melting is no longer needed. The payback period of the investments of the modification can be nine months.

Benefits:

Smaller risk of pollution due to leakages

Checking is less invasive

Higher production rates are possible

Less chance of surges, reducing slug catcher costs

Application:

Shell shows that preventing leakages is important. Every day new equipment is developed, which can be used to inspect your installations. It can examine less invasive equipment which could not be examined before or more often.

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Bypass pigging at Shell

Preventing leakages of polluting materials in their pipelines is pivotal as far as Shell is concerned. Therefore, pipes are examined on a regular basis. Pigs move through pipelines, for example to measure the thickness of the pipe and the amount of corrosion. By using these devices the condition of the pipe can be inspected and action can be taken to reduce the hazard of leakages.

However, they do not want to use these pigs very often because of the decrease in production: the pig has to move through the pipeline at a certain velocity. Thus the production through this pipeline needs to be slowed down or sometimes even stopped up to three weeks, during the check.

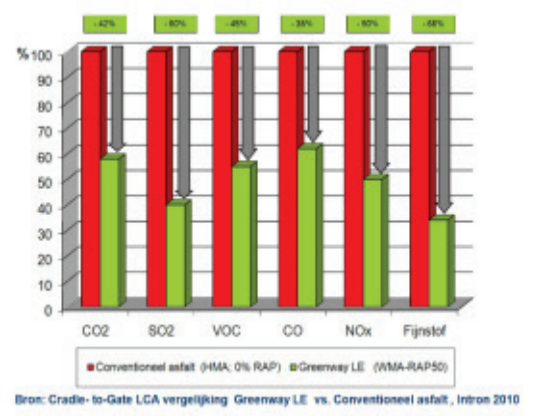
As a solution for this problem, the bypass pig has been developed. The technology already existed, but so far it has been used in innovative applications. A diaphragm has been implemented in the pig which can open and close allowing flow through the pig. This can also adjust the speed (even to a standstill) to inspect the pipes more carefully.

Besides the benefit of reducing leakage hazards, this method means little or no reduction in the production levels. Furthermore the possible liquid surge is smoothed, which means that the slug catcher size may be reduced and therefore considerable savings are ensured.

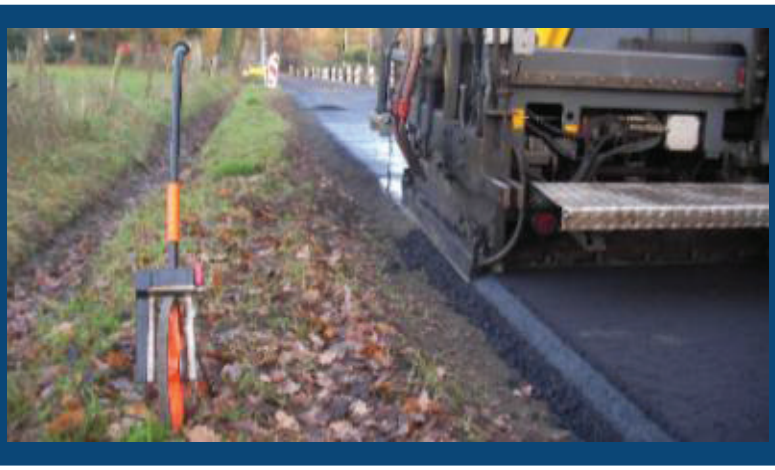
5.5 Surrounding site

When you are making your existing assets more sustainable, you can study energy, water and materials separately. However, you can also study part of your assets and how the benefits of these subjects can be combined. For example, look at your surrounding site: green landscaping, lighting and pavement.

Introducing sustainable adaptations to your site can be quite an investment. But, by combining solutions you can find benefits (e.g. lower maintenance costs).



Bron: Cradle- to-Gate LCA vergelijking Greenway LE vs. Conventioneel asfalt , Intron 2010



Benefits:

Using 50% recycled asphalt and decreasing the production temperature to 105 °C means:

Reducing CO_2 emissions by 42% (w.r.t. conventional asphalt)

Reducing the amount of particulates, NO_X, CO, VOC and SO_2

Quality, costs, lifetime are the same as with conventional asphalt

Application:

Lower, middle and top layers, cycling paths and all types of roads: from side roads to highways.

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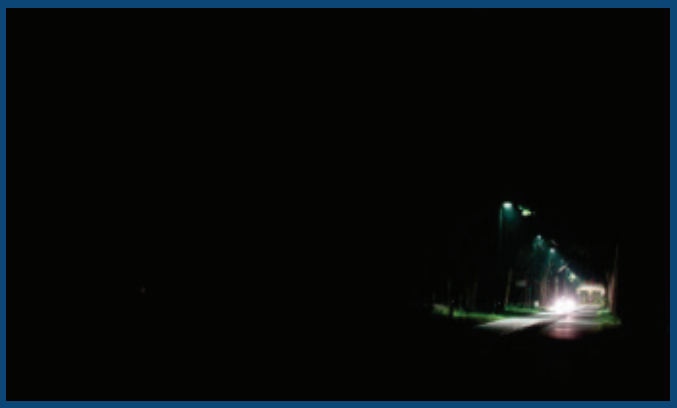
Low-temperature asphalt by Heijmans

To make asphalt production more sustainable, the energy use and the associated CO_2 emissions can be pushed down. This can be achieved by reducing the production temperature and increasing the reuse of old asphalt. At first these two could not be combined as the physical processes are contradicting. Heijmans, in collaboration with Shell, has created '*Greenway LE'* (Low Emission), which is produced at a lower temperature of 105°C instead of 150 to 170°C and can contain more than 50% of reused asphalt.

By combining the foamed bitumen technology and Shell's WAM Foam technology, old asphalt can be mixed homogeneously with the new materials. Thus the hardness, quality, and other characteristics are comparable with conventionally produced hot asphalt.

Furthermore the costs, lifetime and ease of use are also the same as with conventional asphalt. The latter is already being used on the A2 ring road between Eindhoven and Den Bosch. Using it for a highway means it meets the strict quality requirements of Rijkswaterstaat (Directorate-General for Public Works and Water Management).



Benefits:

Consuming 40% less energy by using dynamical LED instead of conventional LED

Energy reduced by 60% w.r.t. conventional lightning systems

Payback period of 7 years provided 'old' fixtures are replaced

Application:

Outdoor or indoor lighting

The optimal solution is achieved by creating a smart design for the lighting system

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Intelligent lighting system by Heijmans

LED installations have evolved dramatically in recent years. The quality is as good as that of conventional lighting, the investment costs are lower and the light output is increased. Especially when this low energy lighting is combined with a smart design. By combining some or all of these steps, lower energy consumption, safe and longer lifetime, less maintenance and less light pollution lighting system can be achieved.

Dynamical system

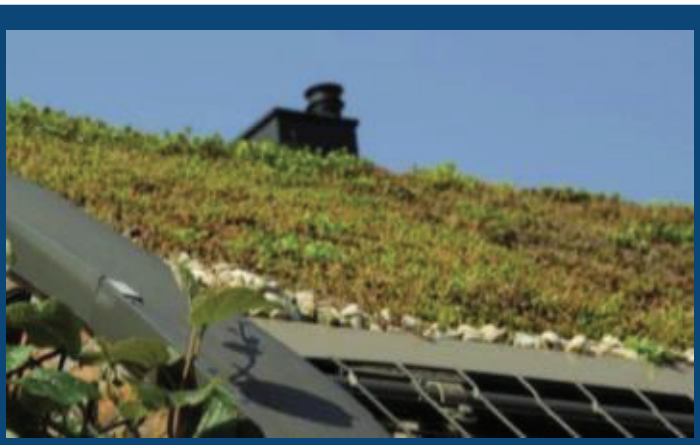
Several lighting scenarios can be programmed, which can depend on time and movement. LED, compared with conventional systems, has no startup time when switched on or off. Furthermore, LED can be dimmed: the lighting becomes brighter when people pass by and then dims again for a more energy-efficient level. Thus, this combines energy reduction with guaranteed sufficient light.

Smart planning

Every location is unique and has a different optimal lighting scheme. Looking into the requirements, different types of lampposts, distances and different areas (maybe only reflectors can be used), and the optimal scheme can be designed using the least amount of lampposts.

The next step: coloring

This is usually interesting nearby an ecological network. By adapting the light color it will have less impact on wildlife. For example, reddish light does not repel bats and greenish light has less effect on birds.



Benefits:

Increasing:
-Employee life quality
-Biodiversity
-Green looks
-Image
-insulation

Reducing:
-Drainage
-Maintenance
-Energy usage

Application:

Outside terrain
Roofs
Parking spaces

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Green areas by Heijmans

Industrial sites have the image of being boring, ugly and a nuisance to their surroundings. It is because of the odors and noise among other things. Introducing green areas will contribute to the green image of the company. Furthermore, it will support biodiversity and influence the contentment and attitude of the employees. There are positive effects on costs due to the reduced need for sewerage, because of natural drainage, and the energy reduction, because of insulation.

Maintenance-free greenery

It is a simple method with the aim of having as little maintenance as possible and creating a cheap yet charismatic solution. You can have different color sets throughout the year using plants which have been chosen to support the biodiversity in the area.

Green roofs

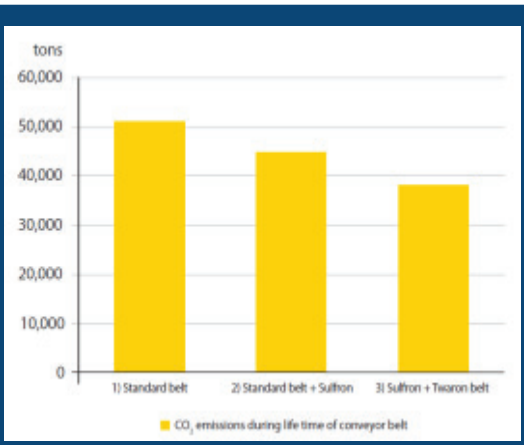
Value can be added to roofs which just “lie fallow”, by giving them a green function. The vegetation can absorb almost all of the rainwater and have a strong insulating effect. Furthermore, the vegetation increases the lifetime of the roof because the weather has less impact on it.

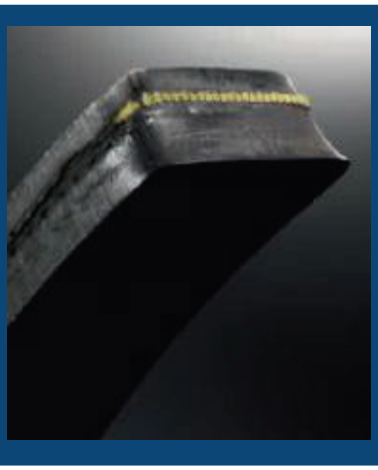
Parking spaces with open pavement

By using a half-open parking site the rainwater can seep directly into the ground and therefore less drainage is needed. In addition, the area has a greener appearance and is still low in maintenance.

5.6 Sustainable products

A more sustainable product will add value to your product and enhance your competitive position on the market. It is a growing niche market. Another benefit is that when you are responsible for reducing your customers' footprint, the sustainability measure can be accounted for your company. Cradle to Cradle products seek to become "more good" rather than simply "less bad." Each of the five categories spell out the steps necessary for transforming products, The result: the industry will achieve new levels of environmental and human health and safety for all products sold to consumers. Products that meet the criteria of the Cradle to Cradle Products rating system will receive the Cradle to Cradle certification^{CM} mark.





Benefits:

Energy reduction

Less CO_2 emission

Competitive market position

Application:

How can sustainability add value to your product?

Which (new) clients in the market can you address with these products?

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Lighter conveyor belts by Teijin

Teijin realized that it had to look at the market from a different angle. Stronger and cheaper competition with lower quality products arrives from Asia. Therefore the company has chosen to increase the quality of the products. Value is added by making products more sustainable. This also led to other positive benefits for clients. Furthermore, Teijin realized that part of the CO_2 reduction at their clients' can be granted to Teijin's products.

More sustainable products

Mining companies are increasingly looking for solutions to cut down on energy consumption and CO_2 emissions, also due to governmental legislations. Large and heavy conveyor belts can be replaced by lighter alternatives. Clients can enjoy the following benefits:

- Energy reduction
- Less CO_2 emission
- High strength, low elongation
- Easier and faster installation
- Lower investment and operating costs
- Resistance to corrosion, heat and flame

Teijin's Twaron is five times stronger and lighter than steel. Their Sulfron product lowers the hysteresis of the belt. Therefore, less energy is required to drive the belt. Also, Twaron is thinner which means it can be installed in longer and fewer pieces, reducing capital expenditure.

Benefits:

Understanding the impact of your product on the entire life cycle.

Application:

All products from cradle to gate

http://www.mosa.nl/en/algemeen-1/sustainable-production-process.aspx

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LCA Sustainable Lifecycle Assessment by Tebodin

To provide insight in the sustainability of a product during the entire lifecycle, an LCA model can be made.

More and more consumers and clients ask for information on product sustainability.

This can be used to show your clients the effects of the measures you took in the past. Besides, it is a perfect tool to use for potential investments to understand the environmental impact.

With an environmental product declaration (EPD) the info of an LCA can be easily communicated.

For the sales people it provides specific information and insight into the products score. Tebodin has the software and expertise.

5.7 Policy

Tackling the subject of sustainability within your company is not only about finding the right technical implementations. Sustainability has to be embedded in the culture and structure of the company.

The NAP members also have sustainable solutions concerning the company's policy. Like changing your financial focus, being aware of the sustainability level of your company, embedding sustainable approaches in your organizational structure, quality improvement plans that also concern sustainability and how far do you want to evolve when it comes to sustainability?

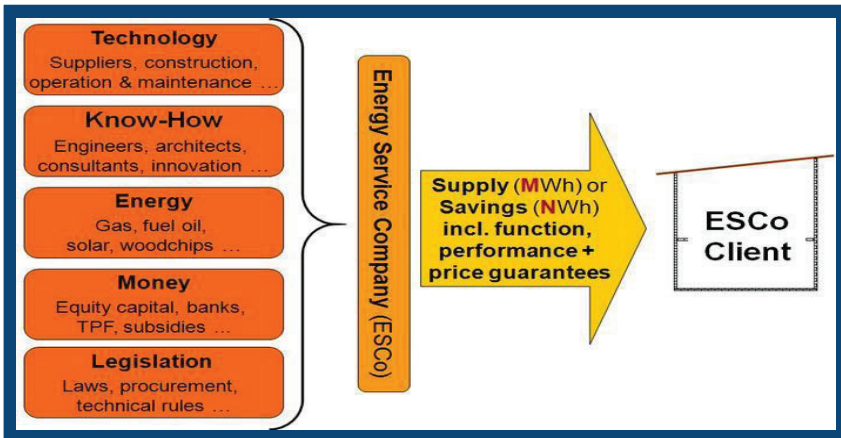


Figure 1: source: Bleyl (2009)

Benefits:

Making sustainable solutions more accessible

More long-term cost benefits

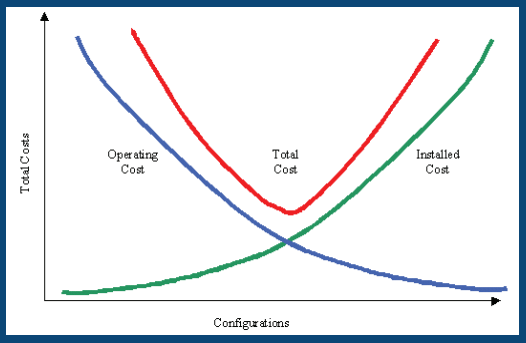
Avoiding initial investment costs

Application:

Energy investment projects

Sustainable Solution: ESCo financing

Currently ABN Amro is offering clients the opportunity to finance energy reduction projects. For this ABN Amro selected a number of preferred suppliers. These suppliers will implement the energy reduction projects at the client's facility. The capital needed for these investments is supplied by ABN Amro through a so-called 'Energy Efficiency Credit'. Suppliers are paid for their efforts from the savings generated through the reduction projects. The client is guaranteed savings on the selected projects. ABN Amro benefits because of the lower operating costs for its client thus ensuring a stronger financial position. The credit is marked as a special credit and will not influence the client's balance sheet.



Benefits:

Making sustainable solutions more accessible

More long-term cost benefits

Application:

Apply this method to all company projects

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Change focus of finances by Tebodin

It is difficult to find finances for investments aimed at making projects more sustainable. Even though often there are different requirements for the payback period of non-sustainable (e.g. 2 years) and sustainable projects (e.g. 5 years) and even if the benefits are vast.

This is because usually the investment costs are set against the payback period. Whatever the yearly cost reductions might bring in is not highlighted. The operational expenditures are not enough part of the financial decision-making process. This short-term perspective needs to change.

Make the operational expenditures and especially the reduction on these expenditures transparent. Multiply this reduction by the lifetime and lay this next to the investment costs, to show the major difference.

Investment costs:	**540.000 €**
Payback period:	6 years
Reduced operating expenditures:	90.000 €
Lifetime:	20 years
Lifetime benefit:	**1.800.000 €**

It sounds logical, but in practice this is not usual in financial business. Companies need to get used to this. Tebodin has tried this method successfully with several clients. It has been an eye-opener.

MIA\Vamil

Benefits:

Cost reduction

Application:

Environmental technologies

Energy-efficient technologies

Producing sustainable energy

www.agentschapnl.nl/programmas-regelingen/positieve-lijsten-miavamil

www.agentschapnl.nl/programmas-regelingen/energie-investeringsaftrek-eia

www.agentschapnl.nl/programmas-regelingen/stimulering-duurzame-energieproductie-sde

Examples of Incentives

MIA/Vamil

The Environmental Investment Allowance (in Dutch: MIA or Milieu Investeringsaftrek) and the Random Depreciation of Environmental Investments (in Dutch: VAMIL, willekeurige afschrijving milieu-investeringen) represent two incentives (which can be combined).

The MIA incentive is a tax deduction tool, allowing a partial write-off of an investment in environmental technology against tax. Up to 36% of the investment costs can be subtracted from the fiscal profit, on top of your usual write-off. With Vamil you can decide for yourself when the investment costs will be written off.

You can use the MAI and/or VAMIL incentive if your environmental technology appears on the “Environmental Technology List”.

EIA

Using the Energy Investment Allowance (in Dutch: EIA, Energie investering aftrek) companies can invest in energy-efficient techniques and sustainable energy fiscally lucratively. Up to 41.5% of the investment costs can be subtracted from the fiscal profit, on top of your usual write-off.

SDE+

Using the Stimulating Sustainable Energy Production (in Dutch: SDE+, Stimulating duurzame energieproductie) you can apply for subsidies for the production of sustainable electricity, heat or for combined production.

Benefits:

Logical and structured approach to assess energy reduction opportunities

Setting priorities; which items need further investigation?

Can be part of an initial energy management strategy

Application:

Manufacturing Facilities

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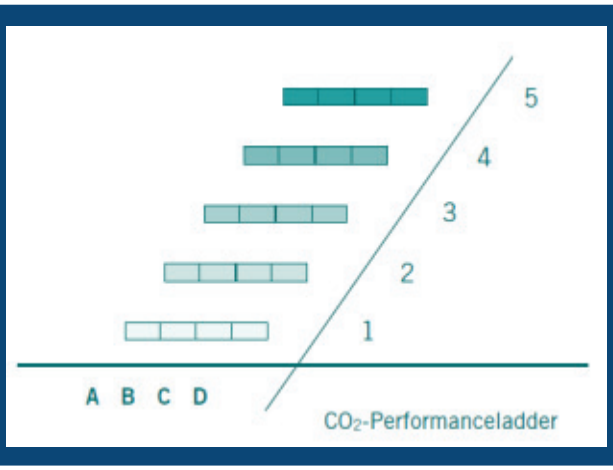
Energy Assessment tool by Antea

To be able to assess your facility for energy reduction potential, Antea has prepared a checklist or assessment tool. With this elaborate checklist the different processes, utilities, and other energy parameters (e.g. energy management) can be analysed. It allows users to come up with a list of possible opportunities and priorities to be further investigated.

User advantages:

- Logical and structured approach to assess energy reduction opportunities.
- Setting priorities; which items need further investigation?
- Can be part of an initial energy management strategy.



Benefits:

Insight into your own CO_2 emissions

Reducing CO_2 emissions

Insight into the CO_2 emission of your suppliers

Application:

It rewards positive effort, even if your company is in a 'poor' starting position.

Ask your suppliers for the CO_2 emissions of their products.

Use CO_2 emissions as a part of your tendering process.

www.skao.nl

'CO2-prestatieladder' (performance ladder)

This performance requirement has been developed to challenge and stimulate companies to be aware of and reduce their own CO_2 emissions and those of their suppliers. It is an innovative tool for sustainable procurement that can be used by every major commissioning party. It has been developed and is mostly used by ProRail.

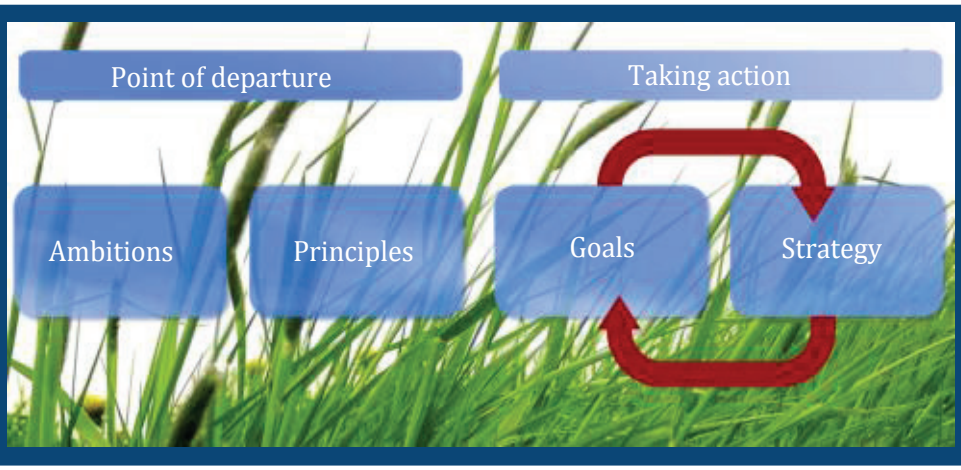
It stimulates energy reduction, material reduction and renewable energy consumption. It focuses on two starting points:
- Own initiative, practical results and innovation.
- Minimum obstruction of the process due to regulations.

The principle behind the ladder is that efforts are rewarded: a higher score on the ladder means a concrete advantage in the tendering process. The level of CO_2 emission reduction is referred to as the *award advantage*.

The performance ladder has five levels. The next level can be reached by incrementally improving the existing processes and through innovation. These requirements are based on four aspects:

The starting position is to have insight into your own and your suppliers' CO_2 emissions (A). To this the reduction targets can be connected (B) and communicated (C) and initiatives about CO_2 emissions reduction can be joined within or outside the sector (D).

The ladder is fully compatible with the European regulations and Public Procurement Directives.



Benefits:

Translate CSR ambitions into engineering projects

Make sustainability SMART

Provide insight

Application:

Engineering projects

m.vandalen@tebodin.com

APGS by Tebodin

To achieve the sustainability objectives of your company, it is important that CSR values are embedded in projects.

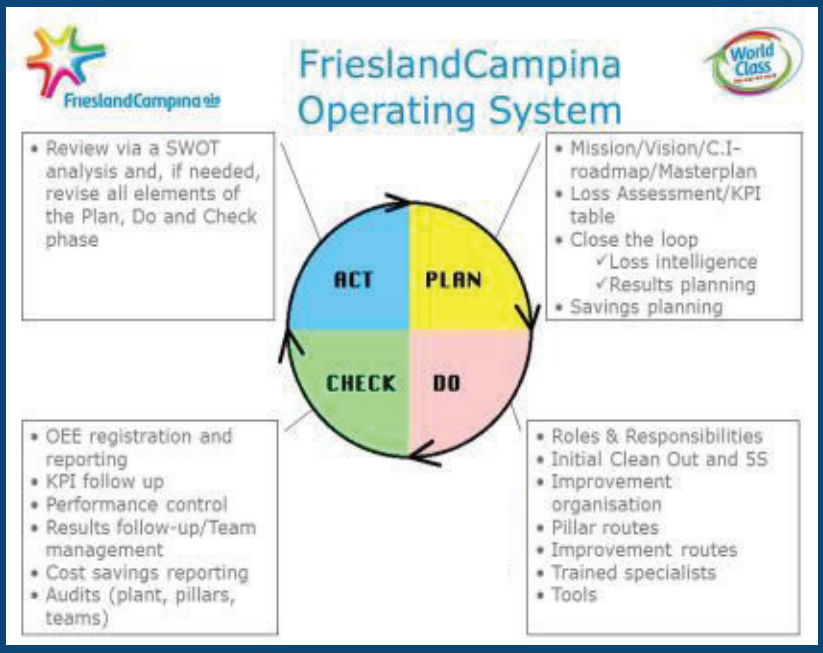
Working towards a sustainable company is a challenge. First of all, the meaning of sustainability is context-dependent and can be ambiguous. Therefore, it is important to align stakeholders' interests and encourage uniformity among them. Projects are often complicated due to multidisciplinary, budgetary and time constrains.

Tebodin developed an approach to effectively embed sustainability values of our clients in engineering projects. We encourage clients to design industrial facilities and installations that are fit for a sustainable future.

APGS: Ambitions, Principles, Goals and Strategies

APGS is based on two design paradigms: 'Value Engineering' and 'Front End Loading'. With APGS we ensure that:

- Sustainable ambitions are clarified and translated into project principles.
- SMART goals are determined to enable effective decision-making processes during projects.
- Strategies are coupled to goals, achieving cost-effective measures.
- Transparency about sustainable strategies, making it possible to share best practices within your company.
- A fundament is created to embed sustainability in all your projects.



Benefits:

Cost reduction

Energy reduction

Material usage reduction

Complaint reduction

Application:

Quality management in an organisation is about assuring and improving the quality of a product, production process, service or organisation in a systematic way. Sustainability is often a part of that.

SIG 2x2 OPEX
p.hettema@tebodin.com

Continuous Improvement Plans by SIG 2x2 OPEX

Objective: Significantly reduce operating expenditures (by double-digit percentages) and extend the remaining economic life of aging assets by factor 2 across the NAP value chain.

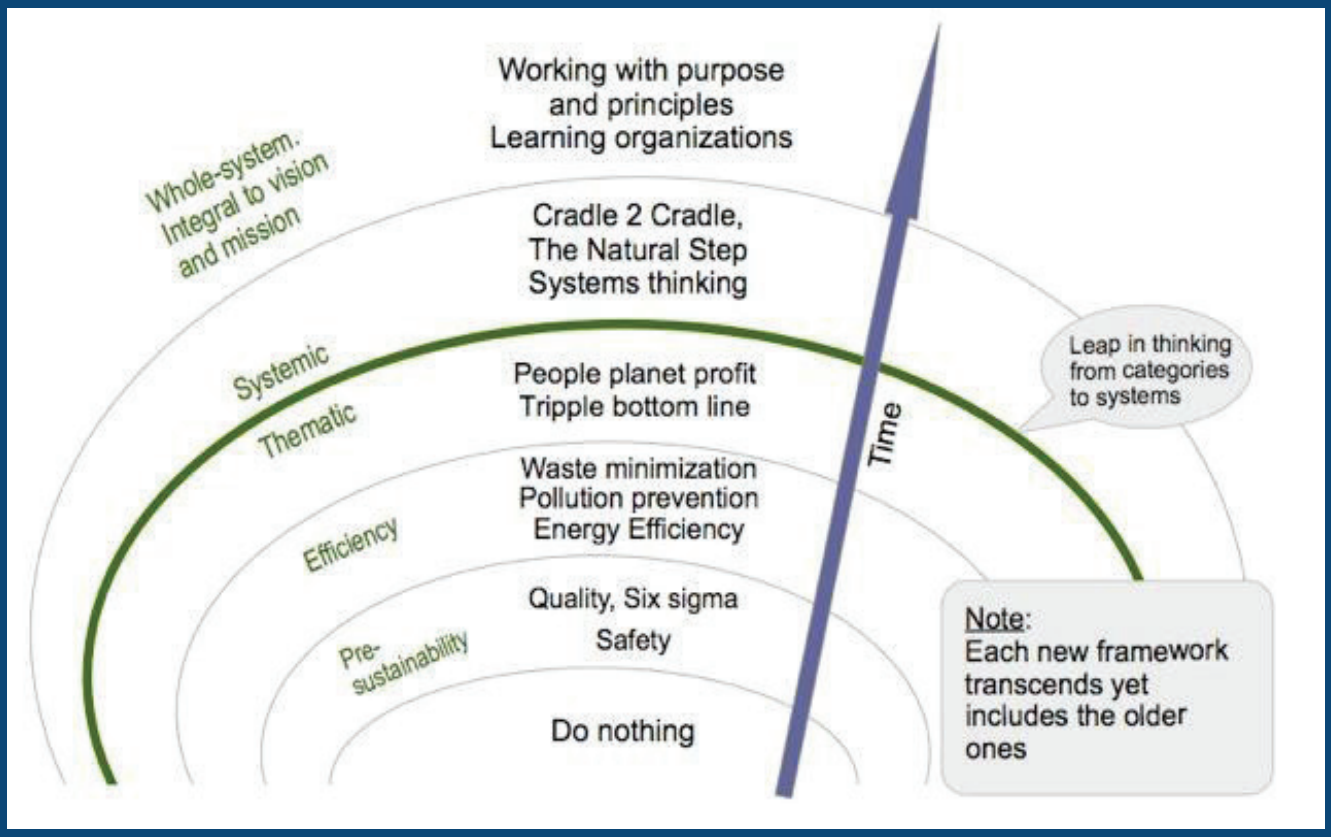
Continuous Improvement Plans is one of their subjects. Lean, TOC, QRM, Six Sigma, TPM, RCM, WCM, there are many approaches. Here is one example. For more information see the NAP SIG 2x2 OPEX results.

World Class Operations Management at FrieslandCampina

Their so-called WCOM maintains a plan-do-check-act approach. The goal is to produce products in safe working conditions, with care for the environment at the agreed quality and service level, at the then lowest possible costs.

Some of their KPIs includes output, consumer complaints, material losses and energy consumption.

It resulted in OEE increase, productivity improvement, elimination of sources of product loss and packaging material loss, elimination of sources of failure costs and becoming more competitive through reduced conversion costs. They found out that WCOM is very cost-efficient. Payback periods of less than four months are no exception.



Benefits:

Creating a positive carbon footprint

Cost reduction

Increase competitive position

Application:

Integral sustainable approach towards energy, water and materials

How much do you want to evolve?

Evolution in sustainability by Ecoawareness

Both in the concept and framework of sustainability there is evolution.

Within the process industry there is no company in the 'do nothing' zone due to governmental pressure. The scope of this report is to aim at bringing the existing assets further towards the 'people, planet, profit' balance. But most companies are still in the 'pre-sustainability' or the 'efficiency' zone.

Some companies in our country, however, have already undertaken a leap in their thinking towards sustainability. Instead of seeing sustainability as a separate subject (thematic), understand the synergy. Think in systems. For example, Cradle-2-Cradle is not about creating a less bad footprint (like PPP), but rather about creating a positive footprint and creating a circular economy.

Companies like DESSO (industrial carpet) and Trespa (façade panels) already apply the C2C ideas to their products. They realized it adds value to their products within the market.

Additional Best Practices

In this chapter a list of sustainable solutions from several NAP members was given. We do not claim that this is a complete list. Let us work together and continue to share our experiences as we are all on the same journey.

Other lists of best practices on sustainability can also be found online.

Energy innovation catalogue

More than 1000 innovative research and practice projects have received a subsidy from energy-innovative programs: EOS (energy research subsidy) and IAE (innovation agenda energy). As an inspiration for research and products a catalogue is prepared by AgentschapNL which includes 700 projects.

www.agentschapnl.nl/programmas-regelingen/energie-innovatiecatalogus-0

Best Available Techniques (BAT)

In the BAT Reference (BREF) documents, the available and most environmentally friendly techniques are described which can be implemented within your company and which have been adopted under the Industrial Emissions Directive (IED).

http://eippcb.jrc.es/reference/

List of energy reduction measures

AgentschapNL, in collaboration with sector organizations, has created a list of energy reduction measures to give inspiration. Both a sector-specific and a generic list are available.

http://www.agentschapnl.nl/content/maatregellijst-generieke-maatregelen-mja

Towards Sustainable Growth Business Models

The Dutch Sustainable Growth Coalition is formed by Jan Peter Balkenende and 10 large Dutch companies. They pro-actively promote sustainable growth. In this document several examples for sustainable growth business models are given.

http://gpr.turnpages.nl/publicaties/DSGC/201209/

6. Communication about Sustainable Solutions

How should you communicate about sustainable solutions within your company? People often see reality through a certain lens, their worldview. The people at your company have different worldviews. Research has shown distinct worldviews may be identified. These represent what people believe is important – i.e. their values. These different worldviews matter to how large companies function. Convincing people of other values, like sustainability, can be quite a challenge.

Therefore, when communicating with others, it is useful to understand their worldviews and tailor your communication accordingly. Below, the most common worldviews are described broadly. The worldviews overlap to a certain degree. Furthermore, people respond to cold buttons more than they do to hot buttons.

Worldview	Main values	Most suited definition of sustainability	Most appropriate source	Best-fit approach (Hot Buttons)	Communication to be avoided (Cold Buttons)
Autonomy	Self-assertion. Power to be free	None. Relate to autonomy, doing it yourself.	Person with power. Straight-talking boss. Celebrity	Point out - What's in it for me, now. Appeal to machismo and strength. *Strong, straight, fiery language.*	Challenge power or courage. Move to take over. Be derisive or laugh. Show weakness, make excuses. Use extensive numbers.
Traditional	Maintain order and follow the rules. Stability	Stewardship Sustainability is akin to quality assurance.	Director, person with proper authority and rank	Refer to directives, company rules and (national) regulations. Build on how we've always done our work with pride. Tradition, duty. Show how sustainable practices will bring future rewards. *Use calm, authoritative language.*	Attack pride, tradition, or religion, authority, hierarchy. "There are many ways that lead to Rome" Differentiate from the proven method. Come across as messy, unreliable, chaotic.
Engineer	Technical challenge. Analytical skills, logic and factual knowledge.	Efficiency. Project improvement. Reducing energy, water, resources waste.	One's own cleverness and analytical skills. Toolkits, best practices. Successful mentors, professionals that appeal to self-image.	Point out advantages, cleverness, success. Proven experience. Quote scientific and technological advances and facts. Increased efficiency, results, staying ahead of the game and of government regulations. Use challenges, targets, competition and bonuses. *Strong, clever, motivational language*	Put down profit or entrepreneurship. Talk about collectivization, being one of the herd. Deny rewards for success. Impose too many rules and procedures. Show inflexibility. Non-objective assessments
Career maker	Success, Progress, prosperity. Competition Innovation	Profit, People Planet. Triple bottom line.			

World view	Main values	Most suited definition of sustainability	Most appropriate source	Best-fit approach (Hot Buttons)	Communication to be avoided (Cold Buttons)
Green	Save the Earth and humans from abuse and greed. Global commons. Consensus	Taking care of the needs of all beings, now and in the future. Cradle 2 Cradle	Consensus, outcome of a group process. Emotional appeals	Teamwork, participation. Belonging, bonding, harmony. Self-exploration and understanding. Show real people and situations. Openness, fairness, equality. Taking care of the weak. *Emotional yet inclusive language.*	Assault the group. Try to take charge and get centralized control. Reject the collective for individual accountability. Put profit over quality of life for all beings. Deny feelings. Rely on "hard facts."
Holistic	Life is exciting and sustainability is intrinsic. Learning and evolving is more important than material wealth.	Sustainability is and inner drive the awareness of multiple inter-linked ecological, economical, and socio-cultural systems and we just do what's needed.	Inner drive, enthusiasm, learning and experimenting in multiple systems and disciplines. Inspiration from peers, science and intuition.	Sustainability is an intrinsic drive. Solutions are holistic and functional. Use of vision and principles. Accepting and working with subjectivity, uncertainty and chaos. *Holistic language, using psychological, cultural, and technological themes, expressing excitement for novel solutions.*	Dogmatism. Too much of any of the above value systems, especially green, post-modern groupthink. Denying subjective realities and interconnectedness. Rigid planning and measuring. Denying fun and excitement to be alive.

Table 1. How to communicate about sustainability to different worldviews. (Adapted from work by Barret Brown PhD. Integral Sustainability Center and supplied by Ecoawareness, michiel@ecoawareness.org)

Tips on communication instruments

Together with the SIG Sustainability and the communication departments of Tebodin and Heijmans, several ideas have been discussed which you can use to discuss sustainable solutions (intern/external):

- **Movies**
  The members create their own movie about their sustainable solutions (e.g. TED talks, “short and pure”, it should not be clear advertisement). An intern from Media Studies can be hired to oversee the process and make sure output is in the same format and encourage the members to produce the movie (to enthuse the members to spend time). This does concern confidential information and time of the NAP members. “Stichting DOEN” might give incentives for these kinds of projects.
- **Board game**
  In a board game the barriers and their solutions can be discussed. The questions from chapter 3 can be included in the game.

- **Website**
  It is interactive and always attainable. Display the sustainable solutions online. The users can chose which information they want to see. Add links to extra background information in case their interest for that subject has been triggered.
- **Tabloid**
  Several times a year publish a “tabloid format” which contains some of the sustainable solutions to repeatedly trigger curiosity. Because of the brevity of a tabloid the interest is maintained. This can be an online or a paper version.
- **Poster**
  Create posters with only short slogans about the sustainable solutions, their pictures and the company names to trigger interest in reading the report/workshop/etc.
- **Hand-outs with do’s&don’ts or tips&tricks**
  People are easily distracted. Keep information brief and interesting. During the NAP contact meetings and other meetings as well hand-outs can be distributed which contain a short list of do’s&don’ts or tips&tricks with cartoons to trigger interest.
- **Workshops**
  The best way to get through to people is by personal contact. In these workshops a few TED talks can be given by members about sustainable solutions in their company. Also, discuss how their company can implement more and easier sustainable solutions, based on how to overcome the barriers and the ideas behind sustainable solutions. The questions from chapters 3 and 5 can be used. Emphasize the benefits for the company.
- **Calendar**
  Every month can stress one particular subject: for example month of reusing materials or restoring basic conditions. You can use cartoons to trigger interest. Besides the calendar, other communication methods can be used that month to support the subject.
- **Database**
  Continue sharing sustainable solutions so more members enter their sustainable solution and ask members what kind of solutions they are interested in.

  In general, it is advised to combine different communication methods to address all stakeholders. Different communication methods have different strengths, like maintaining interest, using current events or providing depth and background information.

7. Interview experiences

For obtaining sustainable solutions and their background information (e.g. about barriers and success factors) a structured interview was held among several companies. A list of these companies can be found in Annex 1. To help companies prepare for the interview a questionnaire was sent to them in advance, which is displayed in Annex 3.

Remarks about the interview process:

- The process industry has many kinds of companies and there is a wide range of different sustainable solutions. Therefore, a general list with a wide range of questions is needed. Both the interviewer and the interviewee should understand that not every question is of interest for every sustainable solution.
- The questionnaire is not often completed by the members themselves. It is important to conduct a personal interview, to acquire more detailed information. The questionnaire from Annex 2, Sheet 2, which contains the technical background information, is easier to complete than Sheet 3, which contains the barriers. For obtaining more detailed information about how they overcame the barriers, deeper questions are needed to be asked. Especially for understanding why in this situation it is not a barrier for them.
- At first a longer questionnaire was used. This scared some of the members off. Hence, the questionnaire which is sent beforehand was shortened, see Annex 1. The questions during the interview were still based on the extended version.
- Everyone is very busy. Obtaining detailed information that members need to look up is not always very easy. Completing the questionnaire takes a considerable amount of time. The interviewee often does not want to spend too much time on this.

General findings from the interviews:

- Many sustainable solutions are of interest to the company for their strategic position. It was not easy to obtain detailed information about the technical implementation and financial background. This is because of the confidentiality of the information. It is difficult for members to share information.
- The larger part of the obtained sustainable solutions have a short payback period. Mainly, during the crisis, the investments in sustainability still need short payback periods.
- Most of the sustainable solutions obtained are proven technologies. Companies want to innovate on paper, but first solutions must be tested properly.
- Most of the ideas behind the acquired sustainable solutions are applicable for other NAP members. Even though the NAP members have different backgrounds, their specific solutions are good examples for general application of the idea behind the sustainable solution (which is written next to the sustainable solution in chapter 5).
- Most sustainable solutions acquired are about making the existing assets more sustainable. Only a few examples involve the entire value chain.

ANNEX 1: SIG Sustainability Members

NAP Special Interest Group Sustainability:

Company	Member
Heijmans	Eelco Linnert
	Frank Hoekemeijer
Fluor	Oscar Schot
AkzoNobel	Cindy te Boome
	Johan Ike
Kapp Nederland B.V.	Amy Triesscheijn
Tebodin Engineers & Consultants	Mariska van Dalen
	Richard Horvath
	Sinta de Wildt
Technip	Iek Risseeuw
Antea Group	Steven Meun
Tejin Aramids	Teun Boer
	Harrie Bosman
CB&I Lummus	Suvad Memetovic
Heineken	Hayco Bloemen

NAP Program Production Assets support:

Company	Member
AkzoNobel	Ren Jansse
Heineken	Bert Adam
Siemens	Koen Bogers

Interviews outside SIG members:

Company	Member
Bronswerk Heat Transfer	Remco Kruit
Shell	Bert Christoffels
NEM	John Franssen
FrieslandCampina	Frank Jeurissen
Visser&Smit Hanab	Henk van der Werff
Ecoawareness	Michiel Doorn

Bureau NAP:

Esther Faber
Petra Termaat
Julius Freutel

ANNEX 2: Calculation tools

In chapter 5, in some of the sustainable solutions calculations are displayed. In this appendix their background information is given.

ANNEX 2.1: Survey compressed air costs at AkzoNobel

AkzoNobel hired KDS to perform a survey on leakages in their compressed air system. On average they pushed down energy consumption by 10% using compressing air. To calculate your energy cost savings, first the total usage needs to be known. If this is not directly measured an approximation can be made using the equation shown below. The energy consumption per year [kWh/year] is the compressor power to compress the air in the system [kW] times the hours of service per year [h/year].

Calculating tool:
(Energy cost savings/year) = (Energy price) x (0.1) x (Energy usage/year)
(Energy usage/year) = (Compressor power) x (Hours of service/year)

Your energy cost savings per year [€/year] are the energy price [€/kWh] times the 10 percent energy reduction times the energy usage per year.

Example:

If currently you can use a compressor of 200 kW and you operate 5.000 h/year and your electricity costs are € 0,10/kWh your saving can be:

(Energy usage/year) = 200 kW x 5.000 h/year = 1.000.000 kWh/year

(Cost savings/year) = € 0,10/kWh x 0.1 x 1.000.000 kWh/year = €10.000/year

The costs for hiring KDS for a day are about € 1200. This gives a payback period of 44 days.

ANNEX 2.2 Restoring basic conditions at Heineken

Energy reduction can be achieved by returning your condensate to the boiler. To calculate the percentage of heat that remains in the condensate this calculating tool can be used, in which h_c is the enthalpy of the condensate, h_m is the enthalpy of the make-up water and h_s is the enthalpy of the steam. The values of the enthalpies of the condensate and the make-up water depend on the temperature. The enthalpy of the steam depends on the pressure.

Calculating tool:
Heat remaining in condensate (%) = $(h_c - h_m) / (h_s - h_m) \times 100\%$

Example:

If your condensate is 82 °C and your make-up water 13 °C and your steam at 6.9 bar
h_c = 344 kJ/kg
h_m = 53,5 kJ/kg
h_s = 2765 kJ/kg

Heat remaining in condensate = (344 kJ/kg - 53 kJ/kg) / (2765 kJ/kg - 53 kJ/kg) x 100 = 11%

This calculation tool is based on the best practices of the U.S. department of energy. For more information see
www1.eere.energy.gov/industry/bestpractices/pdfs/steam8_boiler.pdf

ANNEX 2.3: Energy-efficient cooling by Bronswerk

Bronswerk has developed a low-noise, low-energy usage fan for air-cooled heat-exchagers. It ensures 50% energy reduction. To calculate the cost savings in its lifetime [€]: the lifetime [years] times the energy costs [€/kWh] times the feasible energy reduction due to the new technology [0.5] times the power per fan that the current fans are using [kW/#] times amount of fans [#] times the hours of service [h/year].

Calculating tool:
(Cost savings) = (Lifetime) x (Energy costs) x (Energy saving) x (Power per fan) x (Amount of fans) x (Hours of service)

As an example:

If the lifetime is 10 years and you use 100 fans of originally 120 kW and the electricity price is € 0.10/kWh this means:

(Cost savings) = 10 years x € 0.10/kWh x 0.5 x 120 kW/fan x 100 fans x 8.000 hours/year
= € 48.000.000

ANNEX 2.4: Heat exchanger savings by Kapp

When a heat exchanger is applied instead of heating the flow by burning natural gas, a certain amount of natural gas can be saved, pushing down costs.

Calculating tool:
(Natural gas savings/year) = (Power saved) **x** (Hours of service) / (Calorific value natural gas)
(Cost savings/year) = (Natural gas savings/year) x (Costs natural gas)

The natural gas savings per year [m^3/year] can be calculated by multiplying the power saved [kW] times the hours of service per year [h/year] divided by the calorific value of natural gas [kWh/Nm^3].

The power saved depends on the amount of power that is needed to heat the flow. The calorific value of natural gas is 9.769 kWh/Nm^3.

The cost savings per year (€/year) are the natural gas savings per year times the cost of natural gas (€/m^3).

Example:

If currently you can save 1500 kW to heat your flow, operate 8.000 h/year and your gas costs are € 0,30/m^3 your saving can be:

(Natural gas savings) = 1.500 kW x 8.000 h/year / 9.769 kWh/Nm^3

= 1.228.320 Nm^3/year

(Cost savings) = 1.228.320 Nm^3/year x € 0,30/m^3 = € 368.496/year

An example of investment cost for such an installation is € 550.000. This results in a payback period of 1,49 years.

ANNEX 2.4: Removing drying step by Tebodin

Calculation method of energy savings transport

In this Annex the energy savings are calculated that can be achieved by changing the production processes in the value chain. It shows the possibility of transporting less or more and a change in the energy usage. The calculation method is larger based on the STREAM research used in a feasibility study of Tebodin, subsidized by AgentschapNL and published in a public report.

Step 1

The energy gain *W* is the difference between the change in production energy, ΔE_P, and the change in transport energy, ΔE_T. The turning point is when $W = 0$.

$$W = |\Delta E_P - \Delta E_T|$$

Step 2

The difference in transport energy use by subtracting the transport energies of two different scenarios.

$$\Delta E_T = \Delta E_{T2} - \Delta E_{T1}$$

Step 3

The transport energy can be calculated by multiplying the amount of transport kilometers, *A*, by the transport energy per kilometer, β.

$$E_T = A \times \beta$$

Step 4

The transport kilometers are calculated by multiplying the amount of transport movements, *N*, times de distance *L*. The transport energy per kilometer with maximum load (25 tons per truck) is 15 MJ per kilometer. If the load is less than 25 tons, the next equation can be used, where *G* is the amount of load in tons.

$$A = N \times L$$

$$\beta = \left(\frac{G}{25} - 0{,}44\right) \times 0{,}061 + 11{,}6 \text{ MJ/km}$$

ANNEX 3 Questionnaire

For obtaining sustainable solutions and their background information from different companies, a structured interview was set up. It is shown in Dutch on the next three pages.

Sheet 1

Beschrijving Sustainable Solutions

nap

De beschrijving van de sustainable solutions bestaat uit twee onderdelen: De technische beschrijving van de sustainable solution (Sheet 2) en de beschrijving van de barrières met bijbehorende oplossingen (Sheet 3). Voor het analyseren van de sustainable solution ligt de focus op de bruikbaarheid van de informatie. Daarom deze uitgebreide vragenlijst. Er wordt zowel gekeken naar het technische succes als het organisatorische succes om te analyseren wat toepasbaar is bij andere NAP-leden.

Let op: het gaat dus niet om proces gerelateerde vertrouwelijke data, maar om de redenen van succes die mogelijk voor andere NAP-leden toepasbaar zijn. Als het om vertrouwelijke informatie gaat, kunnen we samen een manier bedenken om deze onherkenbaar te delen.

De analyse van de sustainable solutions wordt uitgevoerd als onderdeel van de Special Interest Group (SIG) Sustainability van de NAP. Deze SIG is opgezet met als doel om te onderzoeken hoe de NAP-keten kan bijdragen aan een verduurzaming van de bestaande Production Assets in Nederland

Het eindproduct is in het Engels. Deze vragenlijst kan in het Nederlands of in het Engels ingevuld worden.

Focus

De sustainable solutions zijn gebaseerd op het verduurzamen van **bestaande production assets**. Dit kan inhouden zowel dat de toepassing het doel heeft de bestaande asset te verduurzamen, maar ook indien een onderdeel van de bestaande asset aangepast wordt voor een duurzaam alternatief te kiezen. De focus voor de verduurzaming is:

- Energie (besparing, hernieuwde energie, CO_2 uitstoot)
- Water (besparing watergebruik, besparing drinkwatergebruik, besparing afvalwater, hergebruik)
- Grondstoffen (besparing grondstoffen, minder afvalstoffen, hergebruik)

Daarnaast wordt ook gelet op:

- Mens
    - Gezondheid (voldoende daglicht, temperatuur, schadelijke stoffen)
    - Veiligheid
    - Gekwalificeerd personeel/vakmanschap
- Rendement
    - Opex (operational expenditures)
    - Capex (capital expenditures)

Hieronder is een lijst met voorbeelden waar binnen het bedrijf naar gekeken kan worden:

- Energie programma's
- Aanvoer grondstoffen, grondstoffen opslag
- Productieproces optimalisatie
- Bestaande apparaten/processen: aangepast of nieuwe onderdelen
- Onderhoud
- Installaties reinigen
- Kantoren/gebouwen op site
- Hergebruik afvalstoffen
- Transport (Intern, producten, afval)
- Utilities (verlichting, verwarming, koude, watervoorziening, waterzuivering)
- Ook keten overlappende handeling voor de production asset keten

Vragenlijst Sustainable Solution	
Bedrijf ingediende Sustainable Solution	
Titel Sustainable Solution	

Technische beschrijving		
	Beschrijving toepassing	Geef een beschrijving van de sustainable solution. Hoe werkt het precies? Wat zijn de fysische processen? Wat zijn de (technische) veranderingen t.o.v. oorspronkelijke situatie?
	Doel	Wat is het doel? (bijv. energiebesparing)
	Foto's/tekeningen	Hebben jullie foto's/illustraties?
	Bewezen techniek	Was deze toepassing bewezen techniek?
	Toepasbaarheid	In welke situaties is deze oplossing ook bij andere bedrijven toepasbaar?
	Vertrouwelijke informatie	In hoeverre is deze kennis deelbaar met andere bedrijven?
Verduurzaming		
	Reductie milieubelasting	Wat is de vermindering in energie/water/grondstoffen/afvalstoffen/CO_2 uitstoot (totaal of relatief)?
Financiën		
	Kosten capex, opex	Wat zijn de investeringskosten en jaarlijkse kosten?
		Wat zijn de meer kosten hierin t.o.v. een niet-duurzame oplossing
	Besparing jaarlijks	Wat is de jaarlijkse besparingen en kosten?
		Zijn er besparingen op belastingen en vergunningen?
		CO_2 emissierechten?
	Terugverdientijd	Wat is de terugverdientijd van de techniek?
Tijd		
	Tijdens gebruiksduur	Moet er grotere/kleinere hoeveelheid tijd besteed worden aan de oplossing tijdens zijn levensduur t.o.v. de oorspronkelijke situatie (bijv. onderhoud)?

Organisatorisch		
	Driver duurzame oplossing	Wat was de driver voor de (goedkeuring) duurzame oplossing? Bijvoorbeeld: - marktwerking - imago - geldbesparing - wetgeving - ...
Risico's		
	Risico's duurzame oplossing	Wat waren de risico's t.o.v. bestaande situatie/andere oplossingen?
Factoren		
	Succesfactoren	Wat waren de succesfactoren dat een duurzame oplossing werkte? Wat zijn de triggers geweest dat er duurzaam gekozen is?

Barrière tabel

In dit onderdeel worden de barrières voor duurzame oplossingen samengevat. De lijst is opgedeeld in verschillende onderwerpen die al bekende barrières bevatten.
Voeg hieraan ook andere barrières toe waar jullie tegenop gelopen zijn.
Geef vervolgens een cijfer aan deze barrière. Een 1 voor als het geen barrière vormde en een 6 als het een onoverkoombare barrière was. (of een 0 als n.v.t)
Hoe hebben jullie deze barrière opgelost. Als er een 1 aan een barrière is gegeven, geef dan aan waarom dit geen barrière is in jullie situatie (misschien door aanpak bedrijf).
Geef een korte beschrijving van de barrière in jullie situatie en hoe deze is opgelost.

Barrière voorbeelden:	**Cijfer tussen 0 en 6** **0 = n.v.t.** **1 = geen barrière** **6 = onoverkoombaar**	**Beschrijving barrière en hoe deze is opgelost.** **Als het barrièrecijfer 1 was, beschrijf dan waarom dit in jullie situatie/bedrijf dit geen barrière is.**
Kennis:		
Hoeveelheid kennis binnen bedrijf		
Verkrijgen nieuwe kennis		
Waarborging haalbaarheid duurzame oplossing		
Waarborging operational safety duurzame oplossing		
Angst voor het onbekende		
Financiën:		
Interne financiële goedkeuringsprocedures		
Investeringskosten		
Terugverdientijd		
Kwantificeerbaarheid duurzaamheid		
CO_2 emissierechten		
Tijdsbesteding:		
Vooronderzoek duurzame oplossing		
Implementatietijd		
Gebruiksduur		
Organisatorisch:		
Aandragen duurzame oplossing in chain of commands		
Aandragen duurzame oplossing in tijdsproces		
Communicatie		
Leverancier		
Wetgeving/vergunningsprocedures		
Subsidies		
Samenwerking in de keten		
Risico's:		
Extra risico's door duurzame oplossing		
Onduidelijkheid risico's		
Duurzaamheid:		
Positie duurzaamheid in bedrijf		
Acceptatie duurzaamheid op de werkvloer		
Onduidelijkheid over meerwaarde duurzaamheid		
Ontbreken motivatie/kennis eindgebruiker voor duurzaamheid		
Andere barrières waar jullie tegenaan zijn gelopen:		

Over welke barrière hebben jullie het meest gediscussieerd? Waarom juist deze barrière? Wat waren de verschillende kanten? Hoe is het opgelost?	