Applying Sustainability Criteria for Chemical Leasing Business Cases at the Global Level

Final Report / TGLO-09012
## Content

<table>
<thead>
<tr>
<th>1</th>
<th>Introduction</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Executive Summary</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Background and Objectives</td>
<td>6</td>
</tr>
<tr>
<td>3.1</td>
<td>Background</td>
<td>6</td>
</tr>
<tr>
<td>3.2</td>
<td>Objectives</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Set of sustainability criteria – existing approaches and modifications due to application experiences</td>
<td>8</td>
</tr>
<tr>
<td>4.1</td>
<td>Set of sustainability criteria and their development</td>
<td>8</td>
</tr>
<tr>
<td>4.2</td>
<td>Arguments and discussion related to the modification of the criteria</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Application of the sustainability criteria to UNIDO´s international Chemical Leasing case studies</td>
<td>12</td>
</tr>
<tr>
<td>5.1</td>
<td>Case 1: Purification of water coming from mineral oil fields in Colombia</td>
<td>12</td>
</tr>
<tr>
<td>5.2</td>
<td>Case 2: Surface treatment and painting of washing machines and refrigerators in Egypt</td>
<td>17</td>
</tr>
<tr>
<td>5.3</td>
<td>Case 3: Water treatment and disinfection in Russia</td>
<td>22</td>
</tr>
<tr>
<td>5.4</td>
<td>Case 4: Lubrification of a conveyor in Serbia</td>
<td>27</td>
</tr>
<tr>
<td>5.5</td>
<td>Case 5: Newspaper Printing in Sri Lanka</td>
<td>32</td>
</tr>
<tr>
<td>5.6</td>
<td>Case 6: Dying of threads in Sri Lanka</td>
<td>36</td>
</tr>
<tr>
<td>5.7</td>
<td>Case 7: Cleaning of metal pieces in Serbia</td>
<td>38</td>
</tr>
<tr>
<td>5.8</td>
<td>Case 8: Powder coating of transformers in Egypt</td>
<td>40</td>
</tr>
<tr>
<td>5.9</td>
<td>Case 9: Galvanizing of metal pieces in Mexico</td>
<td>42</td>
</tr>
<tr>
<td>5.10</td>
<td>Case 10: Dying of textiles in Morocco</td>
<td>44</td>
</tr>
<tr>
<td>6</td>
<td>Certification, International Chemical Leasing Award and other opportunities to apply the sustainability criteria in the future</td>
<td>46</td>
</tr>
</tbody>
</table>
The present report outlines the activities and results obtained within the UNIDO project TGLO-09012. Main focus of the project was to globally apply, review and adapt sustainability criteria for Chemical Leasing business models. The report contains a detailed description of the application of sustainability criteria to 10 pilot cases in seven different countries. Based on the experience obtained, a final set of five main criteria was developed. These criteria have been included in UNIDO’s Chemical Leasing guidelines and will enable a systematic approach to the sustainable implementation of the global Chemical Leasing business models.
2 Executive Summary

Chemical Leasing (ChL) is a new business model for the sustainable management and application of chemicals where the economic benefit is achieved by selling chemical services instead of increasing the sales volume of chemicals. It provides adequate chemicals risk management coupled with environmental advantages and economic benefits for both the user and the producer. UNIDO actively supports the implementation of Chemical Leasing business models through its international network of Cleaner Production Centres.

It is UNIDO’s interest to ensure that all Chemical Leasing activities follow the principles of sustainability that are understood in the following way:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Within a German research project a set of sustainability criteria has been elaborated. This set of criteria has been further developed by UNIDO – as outlined below - in order to support its application to selected case studies at global level.

a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes

b) Improved handling and storage of chemicals to prevent and minimize risks

c) No substitution of chemicals by substances with a higher risk

d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

e) Monitoring of the improvements needs to be possible

Within the Global ChL Programme, these criteria were applied to 10 case studies/pilot projects in seven different countries. 5 successfully implemented cases fulfil each criteria. A detailed evaluation and description of these cases is provided in Part 4 of the present report. 2 pilot projects/cases are still in the planning and testing phase and it became obvious that the sustainability criteria are essential points in the negotiation phase between the partners. 3 pilot projects were terminated after successful implementation or could not be launched/
fully implemented. In the later case, it is interesting to note that the sustainability criteria were not completely fulfilled.

The set of sustainability criteria has proven to be very helpful not only for evaluating ChL projects but also in the negotiation and start-up phase. It is not recommended to establish a formal certification process for ChL projects and undertake corresponding audits to define compliance with the sustainability criteria. It is, however, suggested to apply the criteria as pre-requisite for companies aiming to obtain public promotion and/or funding and within the evaluation procedure for the international Chemical Leasing award.
3 Background and Objectives

3.1 Background

Chemical Leasing (ChL) is a new business model for the sustainable management use and production of chemicals where the economic benefit is achieved by selling chemical services instead of increasing the sales volume of chemicals. It provides adequate chemicals risk management coupled with environmental advantages and economic benefits for both the user and the producer.

Chemical Leasing forms part of UNIDO’s strategy to assist enterprises around the globe in all aspects related to greening of industry. During the last years, this innovative approach has been globally implemented in a number of different sectors and processes.

Experience has shown that it is best applied to processes that are not the core know-how of the chemical user, e.g. cleaning, de-greasing, painting, etc. Due to the adequate benefit sharing, which is an essential part of ChL, the concept stimulates technology innovation and knowledge sharing among participating companies.

The following definition has been developed and approved by the international Chemical Leasing working group under the leadership of UNIDO:

- Chemical Leasing is a service-oriented business model that shifts the focus from increasing sales volume of chemicals towards a value-added approach.
- The producer mainly sells the functions performed by the chemical and functional units are the main basis for payment.
- Within Chemical Leasing business models the responsibility of the producer and service provider is extended and may include the management of the entire life cycle.
- Chemical Leasing strives for a win-win situation. It aims at increasing the efficient use of chemicals while reducing the risks of chemicals and protecting human health. It improves the economic and environmental performance of participating companies and enhances their access to new markets.
- Key elements of successful Chemical Leasing business models are proper benefit sharing, high quality standards and mutual trust between participating companies.
Chemical Leasing business models are an essential element within UNIDO´s Resource Efficient and Cleaner Production (RECP) approach. RECP means the continuous application of an integrated preventive environmental strategy to processes, products and service to increase efficiency and reduce risks to humans and environment.

In 2004, the Austrian Ministry of Environment and the Austrian Ministry of Foreign Affairs decided to support UNIDO in the promotion of the Chemical Leasing business model. Five years later, the German Government also joint this global undertaken.

Since the year 2004 a number of Chemical Leasing projects were carried out in Egypt, Mexico and Russia in various industrial sectors. In 2007, Colombia, Morocco, Serbia and Sri Lanka also officially started and launched Chemical Leasing pilot activities.

Within the last 5 years more than 10 case studies have been implemented and/or are in progress. Experience shows that this model helped companies to reduce ineffective use and over-consumption of chemicals, develop a partnership with stakeholders and to enhance their economic performance

It is UNIDO´s interest to make sure that all Chemical Leasing activities follow the principles of sustainability that are understood in the following way:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Against this background UNIDO welcomes the German approach to develop sustainability criteria for Chemical Leasing and to support their application for international projects.

3.2 Objectives

The overall objective of this project is to apply sustainability criteria to UNIDO´s international Chemical Leasing case studies/projects in order to analyze if positive impacts for environment and health are obtained, taking into consideration the life cycle analysis.

In particular, negative side effects resulting from substitution of certain chemicals to increase efficiency of processes should be avoided. The existing set of criteria that has been developed for a research project in Germany is being tested to define if it should be further elaborated.
4 Set of sustainability criteria – existing approaches and modifications due to application experiences

4.1 Set of sustainability criteria and their development

Sustainability criteria for Chemical Leasing should help to ensure high standard of Chemical Leasing projects, taking into consideration the life cycle analysis.

In a German research project the following criteria have been developed and approved by a multi-stakeholder steering committee:

a) Continuous improvement of environmental and health impacts caused by chemicals and machines/equipment for chemicals application

b) Improved handling of chemicals related to risk prevention and risk minimization

c) No substitution of chemicals by substances with a higher risk

d) Improved energy efficiency concerning chemicals use

e) Transparent share of risks and economic improvements between the partners

f) Monitoring/measurement of the modifications/improvements need to be possible

These criteria have to be considered as a voluntary framework that is justified by its acceptance. During the German research project acceptance was achieved by companies involved in pilot projects as well as the participants of the steering committee.

An important aim of the project was to also achieve international acceptance of these sustainability criteria and modify them in the course of the international application, if required.

Based on the project findings, some modifications have been suggested and discussed with several experts (such as the participants of the German steering committee for chemical leasing):
This results in the following final version of the sustainability criteria:

a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes

b) Improved handling and storage of chemicals to prevent and minimize risks

c) No substitution of chemicals by substances with a higher risk

d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

e) Monitoring of the improvements needs to be possible

The approval of the criteria was again achieved during the collaboration with companies and National Cleaner Production Centres. In addition, the UNIDO Chemical Leasing Focal Points from seven countries accepted in its latest discussion at the Asian Pacific Round Table in Sri Lanka the elaborated criteria. However, all approvals are so far informal as there is no official mandate and no institutional framework for a formal acceptance procedure.

The set of criteria differentiates between “high, low and no sustainability rate” of a specific Chemical Leasing project. As a consequence, its application allows the involved business partners and other stakeholder to define if the services and efforts are provided in a sustainable manner and to avoid misleading approaches.

To summarize, the following targets related to Chemical Leasing are addressed under sustainability:

1. Concrete and lasting environmental and health improvements as a key component of sustainability

2. Concrete economic and/or social improvements as a motivation for the involved companies to continue their projects

3. Protection of the positive image of the term “Chemical Leasing” from misuse, e.g. if activities that do not lead to acceptable environmental and health protection results would be called “Chemical Leasing” and benefit from the positive image and the expectations of the markets.
4.2 Arguments and discussion related to the modification of the criteria

The sustainability criteria were been first applied within a German pilot project. At that time, most of the cases in Germany were in a planning phase and/or had just started when the criteria were discussed. Some of the international projects, however, were more mature and during discussions with the involved NCPCs and companies the following suggestions for improvement arose.

Criterion a) **Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes**

It was suggested to delete the word “continuous” of the previous version and address the important aspect of continuous improvements within a target under criterion d).

Typically a significant process optimization takes place when supplier and user identify gaps and shortcomings of a production process at the beginning of a project, exchange know how on improvements and implement appropriate measures. The impacts of these measures define a sustainable approach if they lead to environmental and health benefits from an overall life cycle point of view. Missing follow-up measures should not affect the sustainable character of the project, as they might not be possible and/or might make no sense from an economic or social point of view. On the other side, as it seems essential to the experts to keep the challenge of a continuous improvement in the criteria, criterion was modified accordingly.

Criterion b) **Improved handling and storage of chemicals to prevent and minimize risks**

It was suggested to add “storage” as also failures related to an appropriate storage of chemicals can define risks. Typically the assistance of the supplier in a Chemical Leasing business model that addresses improved risk prevention and risk minimization should include the proper storage of chemicals.

Criterion d) **Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners**
It was suggested to add the phrase: “economic and social benefits. Within the analysis of several Chemical Leasing pilot projects it became clear that without economic and social benefits partners will not continue the implementation of the business model. This would, thus, put in danger the required long lasting partnership and would negatively affect the sustainability.
5 Application of the sustainability criteria to UNIDO’s international Chemical Leasing case studies

In the following the criteria are applied to various pilot projects in developing countries and countries with economy in transition. The first 5 examples show Chemical Leasing case studies which are fully implemented and where all sustainability criteria are met. The analysis is then extended to 5 additional cases that are either in the planning stage and/or have been stopped. Not all sustainability criteria could be examined and/or are fulfilled for these cases..

5.1 Case 1: Purification of water coming from mineral oil fields in Colombia

Overview:

- All sustainability criteria are fulfilled
- Project is fully implemented and will be further disseminated
- Sector: oil and gas industry
- Process: Water purification and oil dehydration
- Partnership of two big companies (Ecopetrol SA – Nalco SA)
- Main environmental and health benefits: significant less chemicals are emitted to rivers that serve as drinking water source

Background information:

The Chemical Leasing project was planned and developed by Ecopetrol S.A. and Nalco de Colombia, and implemented at the Castilla oil field in Colombia. It focuses on oil dehydration and water purification processes which involve many variables regarding the quantity, quality and efficiency of the chemicals used. The chemicals applied in these treatments represent an important part of the operation costs and the environmental impact of the resulting waste water depends on them. In addition, environmental accidents can occur if the system variables are not sufficiently monitored, which would cause considerable costs.

The following variables are measured in the process of monitoring the efficiency of the chemicals treatment:

- Water content in oil (BS&W): The water content in oil may vary from 0% to 0.8%. If this parameter is exceeded, it is possible that the customers will not accept the oil.
Oil content in waste water (G&A): This parameter measures the oil contained in the waste water. The tolerance range in this case is between 0 and 3 ppm. If this parameter is exceeded, the regional environmental authorities can impose fines or even close the oil field.

Suspended solids in waste water (SST): This indicator measures the content of suspended solids in waste water. The tolerance range is between 0 and 3 ppm. As in the case of G&A, the authorities may impose sanctions if this parameter is exceeded.

Furthermore, the consumption of all chemicals for water treatment is measured.

The following partners were involved in the implementation of the project:

- Ecopetrol S.A: It is the country’s largest company and the main producer of petrol in Colombia. It ranges among the top 40 oil companies in the world and the five largest oil companies in Latin America. Ecopetrol exploits hydrocarbon extraction fields all over Colombia and operates two refineries and a pipeline network of 8,500 km. In 2003 it became a publicly traded company and initiated a transformation process to achieve higher financial autonomy and competitiveness.

- Nalco SA: It is the chemicals supplier, one of the world leaders in water treatment and process improvement applications, providing services, chemicals and equipment to industrial and institutional customers. The global corporate and research headquarters are located in Sugarland, Texas. Nalco’s approximately 10,500 employees work with more than 60,000 customers in around 130 countries.

- The Chemical Leasing business model was implemented with the technical and operative support from the Colombian National Cleaner Production Centre (CNPML).

**Situation before Chemical Leasing:**

In 2006, Ecopetrol’s purchasing strategy was based on the lowest cost, and savings could only be achieved by reducing the volume of the chemicals used. The company recognised that this model did not correspond to the global vision of their activities and started to look for new strategies in order to not only work at the lowest possible cost but also to consider the total economic balance of the crude oil drilling and water treatment operations.

Ecopetrol then started their first project, which focused on the dosage of the chemicals applied. In 2008, they recognised the potential environmental and economic benefits that can be achieved by implementing best practices in the chemical process. In this respect,
Chemical Leasing appeared to be the most comprehensive and global strategy and therefore cooperation with the NCPC was started.

Before Chemical Leasing, 352 KBBL\(^1\) of oil and water were extracted and treated at the Castilla Plant with 15.14 bls\(^2\) of chemicals consisting of 7.95 bls of emulsion breaker, 1.63 bls of antifoam treatment, 3.18 bls of inverse breaker and 2.38 bls of water purifier. Since the evaporation of water caused a loss of 1718 bls, the plant produced a total of 72 KBBL of oil, 279 KBBL of water and 107 bls of solid waste.

The basis for the payment of all chemicals was USD per gallons or kg of chemicals used.

**Changes due to the implementation of Chemical Leasing**

After Chemical Leasing, 434 KBBL of oil and water were extracted and treated at the Castilla Plant with 14.88 bls of chemicals consisting of 7.6 bls of emulsion breaker, 1.9 bls of antifoam treatment, 3.79 bls of inverse breaker and 1.59 bls of water purifier. As water evaporation accounted for a loss of 1785 bls, the plant produced a total of 91 KBBL of oil, 343 KBBL of water and 106 bls of solid waste. This data shows that more oil and water is treated while at the same time, the consumption of certain chemicals is reduced (emulsion breaker, water purifier). The amount of inverse breaker and antifoam products increased slightly to fulfill water quality standards. Moreover, less solid waste was generated.

The unit of payment under Chemical Leasing is benefit oriented as USD have to be paid per kilo barrels (KBBL) of oil with a specified quality.

Among others the following measures were implemented:

- Training of workers on accurate handling of chemicals
- New dosing equipment
- Regular maintenance of equipment
- Simplifying operations and logistics by injecting just one product, an emulsion breaker in two oil fields

\(^1\) KBBL = kilo barrels
\(^2\) bls = barrels
- Diluting the purifier, thus cutting costs by approximately 20%, and reducing the oil and grease deposited in the cooling towers

- Measuring the water quality parameters in real time by installing flowmeters and introducing mobile laboratories

**Results of the sustainability criteria analysis:**

*Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes*

- Criterion fulfilled

Justification: The following picture shows the reduction of chemicals that was achieved. The saved chemicals do no longer enter the river that serves as a drinking water source for various villages downstream. This is a clear benefit. The continuous measurement of the water quality further ensures that oil contamination of the river is always below the legal limit value. Further benefits can be seen in the fact that less raw materials and in this way less resources are consumed for the production of the water treatment chemicals.

There is no measurable difference in the plants energy consumption before and after implementation of Chemical Leasing. However, the chemicals that are no longer used do no longer need to be produced what counts for significant savings of energy. A quantification was not done so far, but is easily possible via a life cycle analysis of the chemicals production process.

*Criterion b) Improved handling and storage of chemicals to prevent and minimize risks*

- Criterion fulfilled

Justification: A regular training of workers by experts of the chemicals supplier takes place. There is an intensified presence of the supplier on site, experienced engineers provide advice in case of questions related to chemicals. An increased degree of dosing equipment and a control stand for the chemical processes further reduces risks of accidents due to handling mistakes.
Criterion c) No substitution of chemicals by substances with a higher risk

Criterion fulfilled

Justification: A substitution took place. The partners provided material safety data sheets of all chemicals applied before and after Chemical Leasing. The properties of the new chemicals have been investigated by the international expert and no higher risk in comparison to the formerly used chemicals could be identified.

Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

Criterion fulfilled

Justification: The partners follow a policy of “open books”. This means that revenues, costs and resulting earnings are disclosed to the other partner. The savings of applying Chemical Leasing are distributed in a way that follows the relation between the efforts of each partner. A two years evaluation shows economic benefits of more than 1 million USD. Social benefits are achieved in particular as regards working conditions.

Criterion e) Monitoring of the improvements needs to be possible

Criterion fulfilled

Justification: A continuous measurement is established. Furthermore, authorities have the possibilities to check the parameters related to water quality and chemicals consumption any time.
5.2 Case 2: Surface treatment and painting of washing machines and refrigerators in Egypt

Overview

- All sustainability criteria are (or will be) fulfilled
- Project is fully implemented and will be further disseminated
- Sector: Manufacture of electrical domestic appliances
- Process: Surface treatment, painting, powder coating
- Partnership of three big companies (Delta – Akzo – Chemetall)
- Main environmental and health benefits: less waste, less waste water, reduced exposure for workers

Background information

The integrated process of painting washing machines and refrigerators at the company Delta Electrical Equipment (DEA) Egypt has considerable economic and environmental impacts. The process includes metal pre-treatment (degreasing and phosphating), cathodic deposition (E-coating) and electrostatic powder coating.

This integrated process is essential to ensure the high quality and durability of the final product (washing machines and refrigerators). This activity, however, is categorised as a non-core business process for DEA, since the company focuses on the electrical technology of domestic appliances and not on metal surface pre-treatment processes or coating technologies.

The following partners were involved in the implementation of the project

- **Akzo Nobel Powder Coating SAE** (leading supplier) is part of the international group Akzo Nobel and has a share of around 60% of the Egyptian powder coating market. It is a joint venture with an Egyptian company and operates mainly in the sectors of domestic appliances, electrical equipment and air-conditioners.

- **Chemetall Italy** (sub-contractor supplier and co-partner) is a global company in the field of specialty chemistry. The group's activities focus on products and processes for the chemical treatment of metal surfaces and plastics, as well as on selected fields of fine chemistry, e.g. lithium and caesium compounds. The company is
represented in Egypt by its authorised agent Obegi Chemicals Egypt. Chemetall operates in a wide range of industrial sectors (e.g. the automotive industry, domestic electrical appliances, and the aluminium and galvanisation sectors).

- **Delta Electrical Appliances** is the leading Egyptian manufacturer of electrical equipment. It is part of the Olympic Group, one of the foremost Egyptian companies. DEA mainly produces electrical appliances, refrigerators, and washing machines.

- **The Egypt National Cleaner Production Centre** was established by UNIDO in close cooperation with the Ministry of Trade and Industry (MTI) as a service provider to Egyptian industry in the field of Cleaner Production. It is an integral part of the programme Egypt Technology Transfer and Innovation Centres (ETTIC) for the modernisation of Egyptian industry.

**Situation before Chemical Leasing**

The high thickness of coating and non-optimised processes lead to a high consumption of chemicals and consequently to high costs per washing machine or refrigerator (unit of payment). In addition, the amount of reworks and rejects was high (up to 9%).

Before Chemical Leasing, the sludge waste generated during the phosphating process amounted to 0.021 grammes per unit (about 6 tonnes in 2008) and was deposited at a nearby landfill site. In addition, 30 m³ of waste water were generated and 10% of fine powder was wasted and dumped every day.

The workers had only limited information on chemicals management and risk management and there was also no full compliance with REACH and RoHS.

**Chemicals applied**

The following chemicals are used in this integrated process:

- Surface pre-treatment (degreasing chemicals, conditioning and activation chemicals, zinc phosphate)

- Electro-deposition chemicals

- Electrostatic powder coating
The unit of payment was **Egyptian pounds (EGP) per unit (kg, etc.) of chemicals**

*Changes due to the implementation of Chemical Leasing*

Figure 4 shows the scope of the Chemical Leasing model applied to the integrated process of washing machine painting, which includes the following sub-processes: surface treatment, electro-deposition and electrostatic powder coating.

![Surface Treatment](image1)
![Electro-deposition](image2)
![Electro-static Powder Coating](image3)

**Figure 4**: Integrated process of washing machine painting at DEA (Source DEA Egypt, 2009)

The new basis of payment is **Egyptian pounds (EGP) per washing machine produced**

The optimization of the pre-treatment and electrostatic powder coating process resulted in a more efficient use of chemicals. This brought significant cost reduction per unit produced and allowed to reduce the amount of chemicals waste. In addition the recycling of chemicals waste was enhanced.

*Results of the sustainability criteria analysis:*

*Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes*

⇒ Criterion fulfilled

Justification: The consumption of pre-treatment chemicals could be reduced by 15-20%. This counts as an advantage without any environmental negative impacts as less hazardous chemicals (non-cyanide and nickel-free phosphating technologies) have been applied. The same solely positive impacts are valid for the powder coating where a reduction in
consumption of 50% could be realized. Further environmental benefits have been created by a re-use of waste water and a partial recycling of waste.

There is no measurable difference due to process modification. However, the chemicals that are no longer used do no longer need to be produced what counts for significant savings of energy. Quantification was not done so far, but is easily possible via a life cycle analysis of the chemicals production process.

Criterion b) Improved handling and storage of chemicals to prevent and minimize risks

⇒ Criterion fulfilled

Justification: A regular training of workers by experts of the chemicals supplier is done. Risks are reduced as less hazardous chemicals are applied.

Criterion c) No substitution of chemicals by substances with a higher risk

⇒ Criterion fulfilled

Justification: A substitution took place. The partners provided material safety data sheets of all chemicals applied before and after Chemical Leasing. The properties of the new chemicals have been investigated by the international expert and no higher risk in comparison to the formerly used chemicals could be identified.

Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

⇒ Criterion will be fulfilled in future

Justification: This criterion is a weak point as a fair sharing of benefits is doubted by one partner. There was no complete openness to disclose economic relations for the analysis related to sustainability criteria. The overall economic benefits are indicated with 10-15% of the original costs. Partners agree to share future savings and readjust potential economic benefits.
Criterion e) Monitoring of the improvements needs to be possible

⇒ Criterion fulfilled

Justification: A continuous measurement has been established. In the first phase of the project monitoring was done by the ENCPC as an external accepted partner.
5.3 Case 3: Water treatment and disinfection in Russia

Overview:

- All sustainability criteria are fulfilled
- Project is fully implemented and will be further disseminated
- Sector: drinking water supply
- Process: Water treatment and disinfection
- Partnership of one big and one medium sized company (Vodokanal – Aquatech Services Ltd.)
- Main environmental and health benefits: risk reduction as storage and handling of liquid chlorine became obsolete; reduced chemicals in drinking water

Background information

The sector of industry covered by this case study is the treatment of drinking water for households and companies. The State Unitary Enterprise (SUE) Vodokanal of St. Petersburg supplies drinking water to almost 4,568,000 persons and to 17,500 corporate customers and organisations.

In July 2007, a framework agreement regarding cooperation on a Chemical Leasing project was signed between the NWICPC (North-Western International Cleaner Production Centre) and Vodokanal. In February 2008, the Chemical Leasing contract between the Southern Water Supply Station of Vodokanal of St. Petersburg (SWSS), Aquatechservice and the NWICPC was signed. The unit of payment for this contract was the quantity of sodium hypochlorite (NaOCl) solution and powdered charcoal pulp (measured in cubic meters or tonnes). This cooperation resulted in a Chemical Leasing contract on water purification with cubic metres of purified water as new unit of payment, which was signed on 31 December 2009.

Information on partners (user(s), supplier(s) and other parties involved)

- Aquatechservice Ltd: is the chemicals supplier, a company specialising in the development and implementation of innovative water purification processes as well as in the exploration and maintenance of equipment.
- **Vodokanal of St. Petersburg**: is the user of the chemicals, specialised in the treatment and disinfection of water. Vodokanal of St. Petersburg provides drinking water and waste water services to over 4.5 million people in private households. Moreover, the company has more than 17,500 customers including both industrial consumers and providers of municipal services.

![Image](image.png)

**Figure 5: Electrolytic installation and sodium chloride storage**

### Situation before Chemical Leasing

For over a hundred years, water was disinfected with chlorine in St. Petersburg. It was an effective way of fighting epidemics at the beginning of the 19th century, but caused serious problems as chlorine is an extremely poisonous substance. Chlorine storage and transportation used to be a permanent source of potential danger. Chlorine had to be transported through the city on a regular basis with all necessary precautions. In 2006, Vodokanal of St. Petersburg began to replace liquid chlorine by sodium hypochlorite. This substance is as effective as chlorine for disinfecting, but is safe for transportation and storage.

### Chemicals applied

In the Chemical Leasing project, the safe NaCl is used instead of chlorine for the disinfection of drinking water at water treatment stations. In general, the water disinfection process comprises the following stages and chemicals:

- Water ammonation (ammonium sulphate)
- Water disinfection (sodium hypochlorite)
- Coagulation of pollutants (aluminium sulphate)
- Flocculation (cationic flocculant)
- Sand filtration
- Sedimentation and sand filtration in rapid filters
- UV disinfection

**Changes due to the implementation of Chemical Leasing**

The initial implementation of the Chemical Leasing business model was based on the following approaches:

1) Replacement of the environmentally hazardous and toxic chlorine as water decontaminating reagent by a significantly less harmful diluted sodium hypochlorite solution at the water treatment stations.

2) Due to the participation of service companies in the production of sodium hypochlorite and in the maintenance of the equipment used, the water disinfection process was optimised. The basis of payment is the volume of processed water.

By introducing the new process based on the in situ production of diluted hypochlorite solution, water disinfection costs could be reduced by almost 33% compared to the conventional technology which used concentrated sodium hypochlorite solutions. This reduction could be achieved because the prepared diluted reagent is highly stable and its synthesis is more efficient. Aquatechservice Ltd produce sodium hypochlorite for water treatment from a 3% sodium chloride (NaCl) solution, provide the innovative water purification processes and maintain the equipment.

**The new basis of payment is cubic metres of purified water (RUB per 1000 cubic metres)**

The water used for the preparation of the NaCl solution is preliminarily softened by ion-exchange purification. The concentrated salt solution is prepared in dissolving containers and subsequently diluted with softened water to a concentration of 3%. The water has to be softened to avoid the deposition of salts onto the electrodes which would diminish the electric discharge gap and impair the functioning of the electrolyser.
In the electrolytic unit, the salt solution is heated to working temperature by titanium heat exchangers. During electrolysis, the solution passes through two parallel lines in the electrolysers and the concentration of the yielded sodium hypochlorite gradually increases. In the process, hydrogen is generated and removed from each electrolytic cell through a ventilation pipe. It is then diluted with air to a concentration of below 1% by powerful ventilators.

**Results of the sustainability criteria analysis:**

*Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes*

⇒ Criterion fulfilled

Justification: The main improvement address handling, transport and storage of chemicals and the corresponding risk reduction for workers and the public. Liquid chlorine was replaced – as concerns the handling, transport and storage – by ordinary salt (NaCl). The establishment of a UV treatment unit could further reduce chemicals consumption. This can be assessed to be a clear environmental and health benefit, as correspondingly less chemicals are contained in the drinking water, the elimination of viruses is improved and health problems in the population - due to water contamination – could be reduced.

Significant more energy is consumed in the process itself. This concerns the operation of UV treatment and the on-site generation of NaOCl. On the other side – under a life cycle perspective – the generation of liquid chlorine is no longer necessary and this means significant energy savings. A balance has just roughly been calculated and shows that in total energy is saved; Further quantifications can be done on request.

*Criterion b) Improved handling and storage of chemicals to prevent and minimize risks*

⇒ Criterion fulfilled

Justification: see explanation to criterion a)
**Criterion c) No substitution of chemicals by substances with a higher risk**

- Criterion fulfilled

Justification: A substitution took place. The partners provided material safety data sheets of all chemicals applied before and after Chemical Leasing. The properties of the new chemicals have been investigated by the international expert and no higher risk in comparison to the formerly used chemicals could be identified.

**Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners**

- Criterion fulfilled

Justification: The partners follow a policy of “open books”. This means that revenues, costs and resulting earnings are disclosed to the other partner and a fair sharing of benefits is realized. The total cost reduction (economic benefit) is quantified with 33% of the original disinfection costs.

**Criterion e) Monitoring of the improvements needs to be possible**

- Criterion fulfilled

Justification: A continuous measurement is established. Furthermore, authorities have the possibilities to check the parameters related to water quality and chemicals consumption any time.
5.4 Case 4: Lubrification of a conveyor in Serbia

Overview:

- All sustainability criteria are fulfilled
- Project is fully implemented and will be further disseminated
- Sector: beverage industry
- Process: Lubrication of a conveyor for mineral water bottles
- Partnership of two big companies (Knjaz Milos – Ecolab)
- Main environmental and health benefits: significant less chemicals are emitted to waste water; less waste from waste water treatment

Background information

Serbia is home to 30 producers of mineral water. In 2008, 640 million litres of mineral water were manufactured and 560 million litres were packed in PET bottles. One third of this quantity is produced by Knjaz Milos. All of the companies have old packaging lines, which means that the process of conveyor lubrication is based on wet lubrication with extremely high consumption of water.

Information on partners (user(s), supplier(s) and other parties involved)

- **Knjaz Milos** is the biggest producer of mineral water and beverages in the Republic of Serbia and was founded in 1811. The annual production capacity amounts to 300 million litres of beverages. In 2008, 220 million litres of mineral water and beverages were produced. The company has about 900 employees and is certified according to ISO 9001, ISO 14001 and ISO 22000.

- **Ecolab** is the global leader in cleaning, sanitising, food safety and infection prevention products and services with sales of USD 6 billion and more than 26,000 associates. They deliver comprehensive programmes and services to foodservice, food and beverage processing, healthcare, and hospitality markets in more than 160 countries. The company is certified according to ISO 9001/14001 and EN 46001 (for medical devices).
**Situation before Chemical Leasing**

To ensure the smooth movement of the bottles down a packaging conveyor, the conveyor belt has to be lubricated. Before Chemical Leasing, Knjaz Milos used a lubricant which was dissolved in water. It had to be microbiologically effective to prevent the natural growth of microbes in this favourable environment and was sprayed onto the conveyor through nozzles.

The chemical used as a lubricant has hazardous properties. It causes eye and skin irritation and is toxic to aquatic organisms. It may cause long-term adverse effects in the aquatic environment. The annual consumption for the lubrication of one conveyor (which is now the subject of the Chemical Leasing contract) amounted to 6,000 kg of lubricant.

For water pre-treatment sodium hypochlorite is used. This chemical also has hazardous properties. In contact with acids it releases toxic gas, causes burns and is very toxic to aquatic organisms. Every year, 270 litres of sodium hypochlorite were used for water pre-treatment on this packaging line. As the chemical had to be dissolved in water, waste water (1,500 m3 per year) was contaminated with hazardous chemicals.

Due to foam overflow (the lubricant is surface active), potential problems with occupational safety arose because the floor was slippery (Figure 7)

**Chemicals applied**

For the lubrication of the packaging conveyors, a lubricant containing alkyl amines and acetic acid was used. This chemical has an adverse impact on human health and the environment. It causes irritation to the eyes and skin, is corrosive and toxic to aquatic organisms and may have long-term adverse effects on the aquatic environment. The chemical was substituted by an alternative one with better characteristics.

The chemicals were paid per unit of chemicals (litres, kilograms)
Changes due to the implementation of Chemical Leasing

In this case, the process was modified and the chemical was substituted by a non-hazardous one\(^3\). In addition, new equipment was installed (dosage system, spraying nozzles). Due to these changes, the process has been significantly improved, since almost no bottles fall off the conveyor belt any more.

The efficiency of the line has been increased (which is one of the key performance indicators in Knjaz Milos) and the working life of the conveyor has been significantly extended. The downtime which was about 15 minutes per shift before the implementation of the ChL model was eliminated and the costs of packaging can now be precisely calculated and predicted.

The health and safety of workers significantly improved due to reduced quantity of aerosols in the air, cleaner working environment and less risk of injuries as the floor is no longer slippery.

The unit of payment is the number of working hours of the conveyor

\(^3\) According to the Material Safety Data Sheet no significant effects or critical hazards on human health are known and no information on ecotoxicity is available.
The cost savings were achieved because water and chemicals for pre-treatment and waste water treatment were eliminated from the process.

**Results of the sustainability criteria analysis:**

*Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes*

- Criterion fulfilled

Justification: The quantity of chemicals used for lubrication is three times less compared to the situation before Chemical Leasing. However, the chemicals do not enter the wastewater but are attached to the bottles and finally remain at waste. Therefore the exposure situation related in particular to dermal exposure needs to be examined from a health benefits point of view. Tests and examinations of the dermal suitability of the new chemical, however, show that no disadvantages occur. It should also be mentioned for this criterion.

There is no measurable difference in the plants energy consumption before and after implementation of Chemical Leasing. However, the chemicals that are no longer used do no longer need to be produced what counts for significant savings of energy. A quantification was not done so far, but is easily possible via a life cycle analysis of the chemicals production process.
Criterion b) Improved handling and storage of chemicals to prevent and minimize risks

\(\Rightarrow\) Criterion fulfilled

Justification: The criterion is addressed to chemicals but real improvements as concerns the handling are the result of a significant improved process. As a result working floors are no longer slippery and there is much less broken glass on the ground.

Criterion c) No substitution of chemicals by substances with a higher risk

\(\Rightarrow\) Criterion fulfilled

Justification: A substitution took place. The partners provided material safety data sheets of all chemicals applied before and after Chemical Leasing. The properties of the new chemicals have been investigated by the international expert and no higher risk in comparison to the formerly used chemicals could be identified.

Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

\(\Rightarrow\) Criterion fulfilled

Justification: The partners follow clear agreements. This means that revenues, costs and resulting earnings are discussed between the partners with the possibility of re-adjustments if necessary. This is done due to an understanding of an intended long lasting partnership. For the first year cost savings of 5,700 € could be realized.

Criterion e) Monitoring of the improvements needs to be possible

\(\Rightarrow\) Criterion fulfilled

Justification: A continuous measurement is established.
5.5 Case 5: Newspaper Printing in Sri Lanka

Overview:

- All sustainability criteria are fulfilled
- Project is fully implemented and will be further disseminated
- Sector: newspaper printing
- Process: printing
- Partnership of two medium sized companies: Wijeya Newspapers Ltd – General Ink Ltd
- Main environmental and health benefits: significant less chemicals are emitted to the work floor and improve the occupational exposure of workers; reduced waste of inks

Background information

Newspaper printing requires several types of ink consisting of volatile organic compounds which can lead to environmental problems as well as to occupational health issues. The optimisation of ink usage in the newspaper printing process is highly complex. The common belief is that ink consumption per m2 cannot be standardised or even quantified. This case study has attempted to look at optimising ink usage in the newspaper printing process by the application of the Chemical Leasing concept. The information below clearly demonstrates that both ink suppliers and printers can benefit from optimised ink usage in newspaper printing. In addition, it demonstrates the environmental and the occupational health benefits achieved.

Information on partners (user(s), supplier(s) and other parties involved)

- **Wijeya Newspapers Ltd** is the user of newspaper printing. It is a medium-sized factory with about 80 employees owned by the leading Sri Lankan newspaper printing company. The main company has 1,500 employees. The company has a large market share in newspaper sales and is making efforts to increase its share in the sale of advertising space. The Lankadeepa is the leading national Sinhala daily. The newspaper is published in seven editions daily catering to the various geographical areas of the country.
• **General Ink Ltd** is the ink supplier General Ink Ltd. It is a medium-sized Sri Lankan company with about 50 employees. The supplier has a strong market share, especially in newspaper printing.

**Situation before Chemical Leasing:**

Ink is wasted through penetration, spills and residues in containers and trays and other machinery, which leads to poor housekeeping. The ink is lost in the printing process itself through excessive usage (darker than normal impressions). Ink (and also white paper) is also lost by printing the initial copies (400 copies) of the run until the print image is corrected, thus increasing energy costs (due to waste printed paper) and costs for waste water treatment. The waste printed paper increases solid waste.

Since the printing area is closed and air-conditioned, the evaporation of solvents contained in the ink causes health risks to the employees as well. Finally, hazardous ink waste enters the environment. This leads to the contamination of ground and runoff water and causes water pollution. In addition, due to the hard working conditions a certain level of demotivation of the staff could be observed.

- The company prints about 15 million newspapers per month.
- The ink consumption amounts to 14,000 kg per month.
- Ink waste amounts to about 15%.
- The ink for the initial copies of the run (400 copies) is wasted until the print image is corrected.
- The floors have to be cleaned once or twice every day (ink penetration).

**Chemicals applied**

The inks are water-based/solvent-based. The chemicals used in the process are:

- phenolic resins
- hydrocarbon resins
- alkyd resins
- linseed oil
- aromatic rubber process oil
- petroleum distillate
- pigments
- carbon black

The former unit of payment was **costs per kilogram of ink**

**Changes due to the implementation of Chemical Leasing**

The ink waste streams occurring during spraying, drum spillation and duct cleaning were identified and analysed. Improvements were implemented, e.g. a drum rubber beading wiper was installed to stop drum spillation and the supplier material was adjusted in order to deal with spraying issues. Good housekeeping concepts and Cleaner Production activities were introduced to reduce ink waste during the process.

The ChL business model fosters the long-term business relationship between the partners leading to process improvement and innovation.

The new unit of payment is **ink costs per printed copies of newspaper**

**Results of the sustainability criteria analysis:**

**Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes**

⇒ Criterion fulfilled

Justification: An ink reduction of 7% could be achieved. This is solely an environmental advantage (less waste, less resource consumption). It is also a health benefit as the exposure of workers to solvents could be reduced as well.

There is no measurable difference in the plants energy consumption before and after implementation of Chemical Leasing. However, the chemicals that are no longer used do no longer need to be produced what counts for significant savings of energy. A quantification was not done so far, but is easily possible via a life cycle analysis of the chemicals production process.
Criterion b) Improved handling and storage of chemicals to prevent and minimize risks

Criterion fulfilled

Justification: A regular training of workers by experts of the chemicals supplier takes place. Although the effect is visible it does not play a major role in this case.

Criterion c) No substitution of chemicals by substances with a higher risk

Criterion fulfilled

Justification: No substitution of chemicals took place.

Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

Criterion fulfilled

Justification: The partners follow a policy of “open books”. This means that revenues, costs and resulting earnings are disclosed to the other partner. The savings of applying Chemical Leasing are distributed in a way that follows the relation between the efforts of each partner. The annual cost savings amount to 50,000 USD per year.

Criterion e) Monitoring of the improvements needs to be possible

Criterion fulfilled

Justification: A continuous measurement is established.
5.6 Case 6: Dying of threads in Sri Lanka

Overview:

- Not all sustainability criteria could be checked
- Project is in testing phase, sustainability criteria defined a major point in negotiations between the partners
- Sector: textile industry
- Process: Dying of threads
- Partnership of two big companies (A&E/Brandix – Huntsman)
- Expected main environmental and health benefits: less chemicals are emitted to waste water, reduced waste

Chemical Leasing approach:

This project is currently in a testing phase. The original payment (Rupees per t of dyes) will be changed to Rupees per m of thread. The supplier will provide assistance and know how exchange on the optimization of the dying process. The sustainability criteria defined important topics in the negotiation phase.

Results of the sustainability criteria analysis:

Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes

⇒ It is expected that the criterion will be fulfilled

Justification: The amount of dyes consumed will be reduced. No substitution is expected. There will be no measurable difference in the plants energy consumption before and after implementation of Chemical Leasing. However, the chemicals that are no longer used will no longer be produced what counts for significant savings of energy.
Criterion b) Improved handling of chemicals related to risk prevention and risk minimization

⇒ It is expected that the criterion will be fulfilled

Justification: A regular training of workers is foreseen. An increased degree of dosing equipment will further reduce risks of accidents due to handling mistakes.

Criterion c) No substitution of chemicals by substances with a higher risk

⇒ Criterion fulfilled

Justification: No substitution is expected.

Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

⇒ Criterion cannot yet be evaluated, difficulties occurred during negotiations

Justification: The partners agreed on a testing phase. Several contractual details still need to be negotiated.

Criterion e) Monitoring of the improvements needs to be possible

⇒ It is expected that the criterion will be fulfilled

Justification: A continuous measurement will be established.
5.7 Case 7: Cleaning of metal pieces in Serbia

*Overview:*

- Not all sustainability criteria could be checked
- Project is in design phase, sustainability criteria defined a major point in negotiations between the partners
- Sector: metal industry
- Process: cleaning of metal pieces; general management of solvents
- Partnership of two medium sized companies (FKL – Safechem)
- Expected main environmental and health benefits: less chemicals are disposed, reduced exposure to workers, improved risk situation

*Chemical Leasing approach:*

The project is planned since several months, samples have been taken and analysed and the optimisation potential is clear. It is foreseen that full implementation starts in the coming weeks. The basic idea is that the payment of solvents (Dinar/kg) is replaced by a payment for a full service as concerns the supply, handling and recycling of solvents (Dinar / basket or Dinar / working hours). The supplier is committed to bring in engineering know how to optimize the process.

*Results of the sustainability criteria analysis:*

*Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes*

⇒ It is expected that the criterion will be fulfilled

Justification: The current disposal does not meet sustainability criteria and will be significantly improved (recycling instead of dumping). The amount of solvents used will be reduced. A substitution of trichloroethylene by perchloroethylene is foreseen.

*Criterion b) Improved handling and storage of chemicals to prevent and minimize risks*

⇒ Criterion fulfilled
Justification: A regular training of workers by experts of the chemicals supplier will take place. The equipment used within the Chemical Leasing business model will provide significant risk prevention and risk reduction.

*Criterion c) No substitution of chemicals by substances with a higher risk*

⇒ Criterion fulfilled

Justification: A substitution is planned. The new solvent will have less toxic properties than the original one.

*Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners*

⇒ Criterion cannot yet be evaluated;

Justification: Data for the evaluation of this criterion are currently missing.

*Criterion e) Monitoring of the improvements needs to be possible*

⇒ Criterion will be fulfilled

Justification: A continuous measurement will be established.
5.8 Case 8: Powder coating of transformers in Egypt

Overview:

- Not all sustainability criteria were fulfilled
- Project has been stopped; supplier will continue with dissemination activities
- Sector: manufacture of electrical equipment
- Process: Powder coating
- Partnership of two big companies (ABB – Akzo)
- Main environmental and health benefits: less chemicals waste, improved occupational exposure

Chemical Leasing approach:

The project was successfully implemented over a period of three years. The original payment (EGP per kg powder coating) was replaced by a payment EGP per m² of coated surface. The process was optimized by joint efforts of supplier and user of the chemicals. However, economic aspects and fair sharing of benefits as well as handling of problems (such as quality issues) caused difficulties. Therefore the partners decided not to continue with Chemical Leasing.

Results of the sustainability criteria analysis:

Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes

Criterion fulfilled

Justification: The consumption of powder coating was reduced, less waste was produced. The occupational exposure of workers could be improved. There is no measurable difference in the plants energy consumption before and after implementation of Chemical Leasing. However, the chemicals that were no longer used did not need to be produced what counts for significant savings of energy. Quantification was not done so far.
Criterion b) Improved handling and storage of chemicals to prevent and minimize risks

→ Criterion fulfilled

Justification: A regular training of workers by experts of the chemicals supplier took place.

Criterion c) No substitution of chemicals by substances with a higher risk

→ Criterion fulfilled

Justification: No substitution took place.

Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

→ Criterion not fulfilled

Justification: The partners could not agree on sufficient transparency and fair sharing of risks and benefits. This deficit caused troubles and finally led to the termination of the Chemical Leasing contract.

Criterion e) Monitoring of the improvements needs to be possible

→ Criterion not sufficiently fulfilled

Justification: A continuous measurement was established but both partners did not disclose all relevant data in a transparent way.
5.9 Case 9: Galvanizing of metal pieces in Mexico

Overview:

- Not all sustainability criteria were fulfilled
- Project has been stopped
- Sector: metal treatment
- Process: galvanisation
- Partnership of two small companies (Cromadora Delgado - Mardi)
- Main environmental and health benefits: less nickel emissions to waste water, improved occupational exposure

Chemical Leasing approach:

The project was successfully implemented over a period of more than one year. The original payment (Pesos per kg Nickel, Pesos per kg brightener) was replaced by a payment Pesos per Amperehour what corresponds to the m² galvanised surface. The process was optimized by joint efforts of supplier and user of the chemicals. However, economic aspects and fair sharing of benefits as well as handling of problems (such as quality issues) caused difficulties. Therefore the partners decided not to continue with Chemical Leasing.

Results of the sustainability criteria analysis:

Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes

\[ \Rightarrow \text{Criterion fulfilled} \]

Justification: Due to process modification a significant decrease of the nickel consumption could be achieved. The Ni freight to waste water was reduced with clear environmental benefits.

Justification: There is no measurable difference in the plants energy consumption before and after implementation of Chemical Leasing. However, the chemicals that are no longer used do no longer need to be produced what counts for significant savings of energy.
**Criterion b) Improved handling and storage of chemicals to prevent and minimize risks**

⇒ Criterion fulfilled

Justification: Workers of the galvanizing plant received special training and instruction of the supplier.

**Criterion c) No substitution of chemicals by substances with a higher risk**

⇒ Criterion fulfilled

Justification: A substitution took place. The partners provided material safety data sheets of all chemicals applied before and after Chemical Leasing. The properties of the new chemicals have been investigated by the international expert and no higher risk in comparison to the formerly used chemicals could be identified.

**Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners**

⇒ Criterion not fulfilled

Justification: The partners could not agree on sufficient transparency and fair sharing of risks and benefits. A competition started as the user of the chemicals was beginning to sell the acquired knowledge on the market what caused frictions in the Chemical Leasing business model. This finally led to the termination of the Chemical Leasing contract.

**Criterion e) Monitoring of the improvements needs to be possible**

⇒ Criterion fulfilled

Justification: A continuous measurement was established from both parties. This was also an indication about the missing trust. (see criterion e).
5.10 Case 10: Dying of textiles in Morocco

Overview:

- Sustainability criteria could be checked only partially
- Project has been stopped before implementation
- Sector: textile industry
- Process: Dying
- Expected main environmental and health benefits: less chemicals are emitted to waste water, less waste

Chemical Leasing approach:

The project was prepared and negotiated, but never started. In one year. The original payment (USD per t of dyes) should be changed to USD per m or m2 of textiles produced. The supplier was requested to provide assistance and know how exchange on the optimization of the dying process. The sustainability criteria defined important topics in the negotiation phase.

Results of the sustainability criteria analysis:

Criterion a) Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes

⇒ Criterion could not be investigated

Justification: The planned process modification has foreseen the use of additional chemicals that could reduce the consumption of dying materials. A material flow balance or a deeper investigation of environmental and health impacts was not feasible as data were not available.

Criterion b) Improved handling and storage of chemicals to prevent and minimize risks

⇒ Criterion was expected to be fulfilled

Justification: The supplier committed himself to provide regular training of workers by his experts and advice on risk prevention measures.
Criterion c) No substitution of chemicals by substances with a higher risk

⇒ Criterion could not be investigated

Justification: A substitution was foreseen. The partners however did not disclose further information on the properties of the involved chemicals therefore the criterion could not be examined.

Criterion d) Economic and social benefits are generated; a contract should contain the objective of continuous improvements and should enable a fair and transparent sharing of the benefits between the partners

⇒ Criterion not fulfilled

Justification: The partners could not agree on a fair and transparent way of sharing risks and benefits what finally caused the failure of the project. The need to address this criterion in negotiations to a Chemical Leasing project was obvious. The supplier finally saw no possibility to achieve sustainable economic benefits and terminated the negotiations.

Criterion e) Monitoring of the improvements needs to be possible

⇒ Criterion expected to be fulfilled

Justification: The partners planned a continuous measurement of key parameters and consumption data.
Related to the sustainability criteria there was an intensive and long lasting discussion about the pros and cons of a certification process for sustainability. For most of the Chemical Leasing case studies additional costs and expected additional efforts have been the key argument against certification. The benefit of better defined processes and responsibilities between the partners and better proven environmental and health benefits have been recognized but were not strong enough in most cases to undergo an “official” auditing exercise.

On the other hand, public relation work associated to Chemical Leasing was in many case studies welcomed. UNIDO took this opportunity to require a fulfillment of sustainability criteria as a pre-condition for promotion activities. In particular for the next round of the international Chemical Leasing award the sustainability criteria will serve as major evaluation criteria. In this way the sustainability criteria are established as an efficient quality control element for Chemical Leasing projects.

It was also discussed and agreed with the international working group that the sustainability criteria define a pre-condition for further funding of pilot projects. A corresponding commitment shall be introduced for future letters of intent that typically mark the start of a UNIDO support.

In order to improve the application of the sustainability criteria UNIDO will include them into the Chemical Leasing toolkit.