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# Shaping Sustainable Chemicals Management: Refinement of the Chemical Leasing Sustainability Criteria and Application in Case Studies

## Final Report

For our Environment

Umwelt Bundesamt

TEXTE 112/2018

Environmental Research of the
Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

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# Shaping Sustainable Chemicals Management: Refinement of the Chemical Leasing Sustainability Criteria and Application in Case Studies

Final Report

by

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On behalf of the German Environment Agency

# Imprint

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**Kurzbeschreibung**

Für die international vereinbarten Nachhaltigkeitskriterien von Chemikalienleasing wurden Unterkriterien sowie qualitative und quantitative Indikatoren entwickelt. Langjährige Erfahrungen haben gezeigt, dass Chemikalienleasing zu wirtschaftlichen, sozialen und umweltrelevanten Vorteilen führt. Die Weiterentwicklung der bestehenden Nachhaltigkeitskriterien hat zum Ziel, diese Vorteile von Anwendungen des Geschäftsmodells besser herauszustellen. Dadurch möchte das Umweltbundesamt Unternehmen bei der Umsetzung sowie bei der Bewerbung für den Global Chemical Leasing Award unterstützen.

Die im Projekt erarbeiteten Indikatoren sind Bestandteil einer Basis-Checkliste, anhand derer die Anwender die relevanten Parameter qualitativ bewerten können. Eine Stufe weiter geht das Instrument SMART 5, mit dem Anwender konkrete quantitative Werte erfassen und eine Gesamtübersicht über ihre Chemikalienleasing-Anwendung generieren können. SMART 5 führt die Berechnung der erzielten Vorteile automatisch durch und generiert ein Factsheet, das übersichtlich die relativen Veränderungen durch die Anwendung zusammenfasst.

Die entwickelten Indikatoren in Form von Checkliste sowie SMART 5 hat das Projektteam hinsichtlich ihrer Praxistauglichkeit überprüft. Dafür wurden beide Instrumente von Fachpersonal in Fallstudien aus verschiedenen Branchen erprobt. Die Verbesserungen, die dabei quantifiziert wurden, hat das Projektteam anschließend hinsichtlich ihres Potenzials für die Branchen untersucht.

Bestandteil des Projekts war es weiterhin, die deutsche Chemikalienleasing-Internetpräsenz des UBA zu aktualisieren und entsprechende Beiträge vorzubereiten. Dies beinhaltet auch Aktualisierungen über verschiedene Veranstaltungen, die während der Projektlaufzeit zum Thema Chemikalienleasing stattgefunden haben. Diese Maßnahmen unterstützen auch die weitere Verbreitung des Geschäftsmodells.

Für die breitere Anwendung von Chemikalienleasing in der Landwirtschaft über bestehende Pilotprojekte hinaus, besteht ein besonderer Bedarf für ein Versicherungskonzept. Ein Vorschlag für ein solches Konzept wurde zusammen mit einem Rückversicherer erarbeitet.

**Abstract**

For the internationally agreed sustainability criteria of Chemical Leasing, sub-criteria as well as qualitative and quantitative indicators were developed. Several years of experience have shown that Chemical Leasing leads to economic, social and environmental benefits. The further development of the existing sustainability criteria aims at better highlighting the benefits of applying this business model. As a result, the German Environment Agency wants to support companies in the implementation of Chemical Leasing and in applying for the Global Chemical Leasing Award.

The indicators developed in the project are part of a basic checklist, with which users can qualitatively evaluate the relevant parameters. The SMART 5 instrument goes one step further, enabling users to capture specific quantitative values and generate an overview of their Chemical Leasing application. SMART 5 automatically performs the calculation of the benefits calculation and generates a fact sheet that clearly summarises the relative changes made by the application.

The developed indicators in the form of a checklist as well as SMART 5 were tested by the project team in order to check their suitability for practical use. For this purpose, both instruments were tested in case studies from various industries. The improvements quantified were then examined by the project team regarding their potential for the industries.

A further part of the project was the continuation of updating UBA´s German Chemical Leasing website and to prepare the respective contributions. This also includes updates on various events that took place during the project period on the subject of Chemical Leasing. These measures also support the enhanced dissemination of the business model.

For a wider application of Chemical Leasing in agriculture beyond existing pilot projects there is a particular need for an insurance concept. A proposal for such a concept was developed together with a reinsurer.

## Content

## List of figures

## List of tables

## List of acronyms

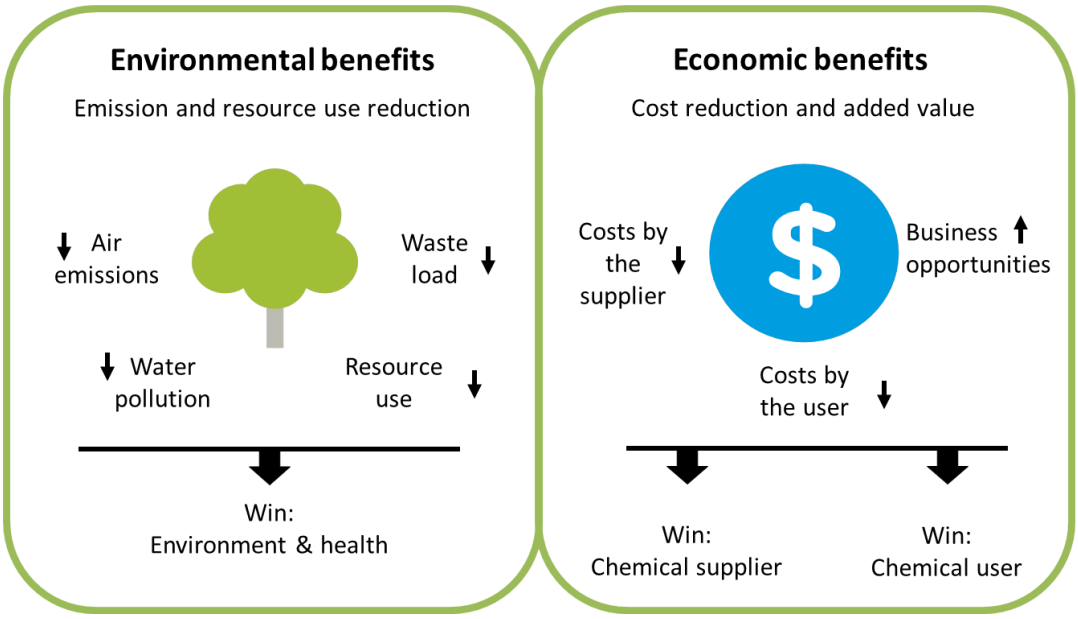
| | |
|---|---|
| **ACEA** | European Automobile Manufacturers´ Association |
| **BMLFUW** | Austrian Environment Ministry (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft Österreich (Ministerium für ein lebenswertes Österreich)) |
| **BMUB** | German Environment Ministry (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit) |
| **ChL** | Chemical Leasing |
| **COP23** | 23rd Conference of the Parties of the UN Framework Convention on Climate Change |
| **FCIO** | Austrian chemical industry association (Fachverband der Chemischen Industrie Österreichs) |
| **$ISC_3$** | International Sustainable Chemistry Collaborative Centre |
| **NCPC** | National Cleaner Production Center |
| **PER** | Perchloroethylene |
| **OECD** | Organisation for Economic Co-operation and Development |
| **SAICM** | Strategic Approach to International Chemicals Management |
| **SMART 5** | Electronic tool for the collection and evaluation of the indicators for the 5 sustainability criteria of Chemical Leasing |
| **TRGS** | German Technical Rule for Hazardous Substances (Technische Regel für Gefahrstoffe) |
| **TRI** | Trichloroethylene |
| **UBA** | German Environment Agency (Umweltbundesamt) |
| **UNFCCC** | United Nations Framework Convention on Climate Change |
| **UNIDO** | United Nations Industrial Development Organisation |
| **WP** | Work package |
| **WS** | Working step |

## Summary

### Background and objectives

Chemical Leasing is a business model that focuses on the function or service provided by chemicals. In contrast to traditional business models, the user of a chemical no longer pays the supplier per kilogram, tonne or litter of chemical, but per functional unit, e.g. coated surface, operating hours of a production line or purified wastewater. The business model has been successfully used by different companies worldwide for several years, leading to significant savings in the amount of chemicals and generating economic benefits for business partners. In addition, Chemical Leasing produces additional benefits, such as emission and waste reductions or improved working conditions, depending on the application. Figure 1 illustrates the major benefits of Chemical Leasing and the resulting triple-win situation.

Figure 1: "Triple-win" through Chemical Leasing for environment & health as well as for both business partners.




Source: own figure

To ensure the quality of Chemical Leasing applications, the five sustainability criteria must be met. These criteria are internationally recognised and form e.g. the prerequisite for applying for the Global Chemical Leasing Award. Chemical Leasing applications must fulfil the following criteria:

- Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes.
- Improved handling and storage of chemicals to prevent and minimize risks.
- No substitution of chemicals by substances with a higher risk.
- 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.
- Monitoring of the improvements needs to be possible.

The practical experience of recent years has shown that these five criteria are very helpful for the evaluation of Chemical Leasing applications. Nevertheless, often a more detailed consideration of e.g. the

reduced negative impact on the environment would be of interest. For this reason, sub-criteria and indicators to specify the five sustainability criteria have been developed in the project. The indicators have been included in an "indicator checklist" for screening as well as in the electronic instrument "SMART 5".

**Development of sub-criteria and indicators**

The first project step aimed at dividing the sustainability criteria into sub-criteria. These sub-criteria have been specified in a next step with concrete quantitative and qualitative indicators. Both steps were performed by the project team in consultation with the German Environment Agency on the basis of the experiences with Chemical Leasing applications and the international award as well as based on other evaluation approaches for sustainability or sustainable chemistry.

The result is an indicator checklist that provides users from companies or authorities with a quick overview of the possible relevant parameters of a Chemical Leasing application. It can be used to perform an initial screening of the application and prepare the work with SMART 5. It can be easily displayed for each indicator whether this indicator has improved or not; without requiring concrete values. As a result, benefits, potentials for improvement and also data gaps are qualitatively shown.

The checklist is available in German as well as in English and is attached to this report. It will be made available for download on the German and international Chemical Leasing websites.

**The instrument SMART 5**

For companies or Chemical Leasing stakeholders it should be possible to use the indicators in a standardised methodology for the evaluation of their applications. The SMART 5 instrument was developed to determine the benefits of Chemical Leasing. The Excel-based tool contains all indicators and can display the improvements of a Chemical Leasing application based on before/after values. On the one hand, SMART 5 users can use the tool to quantify the changes achieved by switching from a traditional business model to Chemical Leasing. On the other hand, SMART 5 can also be used to determine the improvements within a Chemical Leasing project, for example when comparing different years since the implementation.

SMART 5 is subdivided as follows using different sheets:

- Cover page
- The "Introduction" sheet briefly describes the objectives of the instrument. It should be noted that the company-specific data will not be disclosed.
- The "Project description" sheet allows a brief characterization of the chemical leasing project for which data is collected (see also the following figure). Here, also lessons learned during the duration of the project can be described.
- In the following five sheets, information on the individual Chemical Leasing sustainability criteria and sub-criteria are requested. These criteria have already been documented in the first interim report. For easier traceability of the upcoming versions, they are shown again in the following table.
- Thanks
- Fact Sheet
- Imprint

SMART 5 will be available in both, German and English versions, at the end of the project via the Chemical Leasing website of the German Environment Agency. In addition, the English version will be available on UNIDO's[1] international Chemical Leasing website.

Both tools, the checklist and SMART 5, have been reviewed and verified in the project by various stakeholders. Amongst others, the discussions with the national Chemical Leasing working group as well as the data collection and review of practical feasibility with company representatives have resulted in helpful suggestions for changes, which have been incorporated into the final versions.

**Objectives and benefits of the Indicator Checklist and SMART 5**

The following list summarises the key objectives and benefits of the use of the indicator checklist and SMART 5. The two instruments, each containing the developed sub-criteria and indicators for the sustainability criteria of Chemical Leasing, allow:

- Securing higher standards of Chemical Leasing cooperations
- Informing all stakeholders about the importance of sustainability criteria and their significance
- Standardised review of Chemical Leasing contracts for compliance with sustainability criteria
- Supporting companies with the introduction of Chemical Leasing and consecutive documentation
- Overview of possible parameters for documentation in the context of Chemical Leasing projects for the companies
- Standardised implementation of cooperation and monitoring measures

The fulfilment of the sustainability criteria is a prerequisite for a successful application for the Global Chemical Leasing Award[2]. The criteria and indicators facilitate the review and assessment of the applicants' performance in terms of the five sustainability criteria by the jury. Currently, the use of the indicators and SMART 5 is being discussed with UNIDO for the 2018 Award. Results are expected after the completion of this report.

**Data collection**

Subsequent to the development of indicators, these indicators were tested in practice with existing and well-quantified Chemical Leasing examples. The indicators and SMART 5 were revised based on the resulting need for adjustment and were then used for further data collection of Chemical Leasing collaborations.

Using the indicators data could be collected for the following cooperations:

- Chemical Leasing in metal cleaning, example 1: The companies SAFECHEM and Pero have been cooperating for many years on cleaning of industrial parts and have introduced Chemical Leasing. Beside significant savings in the quantity of solvent, waste and energy requirements could also be reduced. Further advantages which have resulted from the business model are shown in Tables 1 to 5.
- Chemical Leasing in metal cleaning, example 2: SAFECHEM now uses the Chemical Leasing business model with many of its customers. The second example depicts the information from the application with a customer in the UK. This application of Chemical Leasing is accompanied by the substitution of the solvent from trichloroethylene to perchloroethylene. Improvements

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1 United Nations Industrial Development Organization

2 The Global Chemical Leasing Award is presented by UNIDO within its Chemical Leasing Programme to outstanding Chemical Leasing cooperations and activities. The next award will be presented in 2018. Further information will be available at the international website: http://chemicalleasing.org/global-award .

achieved include savings in the amount of chemicals and increased training for employees. There is scarce quantitative information available from the application.

- Bonding of packaging: Chemical Leasing has been used for several years for the bonding of packaging in Serbia. The cooperating companies are Henkel as the supplier of the adhesive and Bambi, a manufacturer of confectionery, who bonds the cardboard packaging. The collaboration has allowed the use of a new, more efficient adhesive that also leads to energy savings in the application.
- Pesticide application in agriculture: The cooperation covers the use of agrochemicals in potato production in Sri Lanka. Besides significant savings in the amount of chemicals used and the hazardous waste, costs could be also reduced and staff training increased.
- Cleaning at the hotel: The application from Brazil concerns the cleaning of floors, rooms, dishes and laundry in a luxury hotel in Rio de Janeiro. Since the hotel was opened, Ecolab has provided the hotel with efficient cleaning agents as well as instructions for use, which has significantly reduced the amount of cleaning products used compared to other hotels. The application won the 2014 Global Chemical Leasing Award.
- Lubrication of conveyor belts: At a beverage producer in Serbia, Chemical Leasing is used to lubricate the production line conveyors in the bottling plant. The cooperation of the business partners has led to the fact that a lubricant can be used without water, so that a) less chemicals are needed and b) no more water in the process must be used. This leads again to savings in the amount of chemicals for water treatment.

The results of the data collection are presented per sustainability criterion in the following five tables.

Table 1: Results of the data collection for the indicators from sustainability criterion 1

| Criterion 1: Reduction of negative effects | | | | | | |
|---|---|---|---|---|---|---|
| | **Cleaning of metal parts 1** | **Cleaning of metal parts 2** | **Bonding of packaging** | **Agriculture** | **Cleaning at the hotel** | **Lubrication of conveyor belts** |
| **Air emissions** | Solvent -90% | Reduced, not quantified | Vapours of adhesive, not quantified | n/a | n/a | n/a |
| **Water pollution** | n/a | n/a | n/a | n/a | Reduced, not quantified | -100% through process substitution |
| **Waste** | Activated carbon -87%<br>Used oil 0%<br>Solvent -40% | Reduced, not quantified | -30% | -67% hazardous waste | Reduced packing waste | -30% |
| **Energy** | Direct: -46%<br>Indirect: -76% | n/a | Direct: -53% | n/a | n/a | n/a |
| **GHG** | n/a | n/a | n/a | n/a | n/a | n/a |
| **Resource** | PER -76%<br>stabiliser -74%<br>activated carbon -87% | Reduced through ChL and improved technology | Chemicals -30% | Between 34 and 55% depending on the pesticide | -80% chemicals | -30% lubricant<br>-100% chemicals for $H_2O$ treatment |

Despite some existing data gaps, it is visible that in all cases the amount of chemicals could be reduced; as well as additional resources in some cases. The savings range between 30 and 80%. Direct greenhouse gas emissions are not generated in the applications and therefore no data on GHG was collected. In all cases indirect emission reductions occur.

Table 2: Results of the data collection for the indicators from sustainability criterion 2

| Criterion 2: Avoiding substitution with higher risk | | | | | | |
|---|---|---|---|---|---|---|
| | **Cleaning of metal parts 1** | **Cleaning of metal parts 2** | **Bonding of packaging** | **Agriculture** | **Cleaning at the hotel** | **Lubrication of conveyor belts** |
| **Substitution** | none | Yes, from TRI to PER | Yes, through efficient glue | none | none | Yes, from wet to dry lubricant |
| **Material characteristics** | n/a | Less hazard | More efficient; both substances not classified | n/a | n/a | Substitute not classified |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Risk** | n/a | Reduction by substitute and SAFETAINER | Reduction due to lower temp. and pressure, automatic dosage | n/a | n/a | Reduction through less dangerous substitute |

As depicted in Table 2, in three of the cases a substitution takes place together with the conversion to Chemical Leasing. In no case a more dangerous chemical has been used or the overall risk increased.

Table 3: Results of the data collection for the indicators from sustainability criterion 3

| **Criterion: Improved handling and storage** | | | | | | |
|---|---|---|---|---|---|---|
| | **Cleaning of metal parts 1** | **Cleaning of metal parts 2** | **Bonding** | **Agriculture** | **Cleaning at the hotel** | **Lubrication** |
| **Safety data sheet** | available | available | available | available | available | available |
| **Accidents at work** | No accidents | No accidents | n/a | Reduction, not quantified | Reduction, not quantified | No accidents |
| **Exposure** | No change | Dermal, reduced exposure | Inhalative, reduced | dermal, better protection and handling | Automatic dosage | Reduction through substitute |
| **Risk** | Reduction by lower amount | Less by better storage and substitution | Less through substitution and new process parameters | Reduction through protection and storage | Reduced by less direct contact | Reduced by reduced risk of slipping |

Table 3 shows that for most case studies there is a good data base concerning handling and storage. Improvements have been made in all categories. These are either accompanied by substitution or better handling or a better storage of the chemicals. The training of employees (see Table 4) also leads to reductions on risk.

Table 4: Results of the data collection for the indicators from sustainability criterion 4

| Criterion 4: Economic and social benefits | | | | | | |
|---|---|---|---|---|---|---|
| | **Cleaning of metal parts 1** | **Cleaning of metal parts 2** | **Bonding** | **Agriculture** | **Cleaning at the hotel** | **Lubrication** |
| **Costs users** | -52% Costs for both business partners | Not quantified | Chemicals: -13%, maintenance and others up to 72% | -31% | -76% | -39% |
| **Suppliers performance** | | SAFECHEM still supplier | Yes, not quantified | Good, long term relationship | n/a | Improved (storage, transport, service) |
| **Business opportunities** | Stable partnership | n/a | Henkel is the only supplier | 6 new customers, +12% yield | environmental certificate | Ecolab sole supplier |
| **Qualification** | n/a | Regular training | n/a | 3 d for employees | Yes, but not quantified | n/a |
| **Jobs** | n/a | No change | No change | -67% | n/a | n/a |

Criterion 4 concerns economic and social improvements. Also here improvements have been made for most case studies or some indicators have not been quantified. Economic benefits, even if not quantified, are generated in all applications. Only in the example from Sri Lanka jobs have been lost due to the switch to Chemical Leasing. This can be explained by the reduced amount of pesticides applied to the fields by the sprayers. The remaining jobs are associated with more training and better working conditions after switching to Chemical Leasing.

Table 5: Results of the data collection for the indicators from sustainability criterion 5

| Criterion 5: Monitoring | | | | | | |
|---|---|---|---|---|---|---|
| | **Cleaning of metal parts 1** | **Cleaning of metal parts 2** | **Bonding** | **Agriculture** | **Cleaning at the hotel** | **Lubrication** |
| **Monitoring of indicators** | Yes | Yes, in reduced intervals | Yes | Yes<br>Before small monitoring | Yes | Yes |

Monitoring occurs in all applications. The detailed analysis and the percentage of monitoring over all indicators is provided in the description of the case studies in chapter 4.4.2.

Subsequent to the data collection, the branch potentials were considered with regard to the improvements achieved in the case studies:

- Cleaning of metal parts. Savings potential in Germany: i.a. 7.3 kt to 9.3 kt perchloroethylene (amounts to ca. 73 to 93%) and 298 TJ to 234 TJ energy.
- Bonding of paper and cardboard packaging. Savings potential in Germany per year: ca. 2,000 t adhesives and 8,300 t $CO_2$ equivalents.
- Application of pesticides in agriculture in Sri Lanka: increased yield by 12%.
- Cleaning in the hotel. Savings potential in Germany per year: 37 Mio. litres detergent; 2.670 t $CO_2$ equivalents; reduced emissions of over 2 t phosphorous equivalents in waste water; cost reduction of ca. 33 Mio. €
- Lubrication of conveyor belts. Savings potential in Germany per year: 41.4 t lubricants and about 1.200 GJ energy in the supply chain; during lubrication with a dry lubricant 30,000 $m^3$ water and 12,000 kg pollutants; ca. 36 t waste reduction.

The results are based on existing considerations and are provided in detail in chapter 4.3.

**Public relations**

The project included various public relations activities on Chemical Leasing. These relate on the one hand to various updates to the Chemical Leasing website (UBA, 2017a) as well as to events within or outside the project, which were linked to the project results or where, for example, the indicators and SMART 5 were presented.

**Website updates**

The German website on Chemical Leasing can be found on the UBA website. It is available via these two links:

- www.chemikalienleasing.de
- https://www.umweltbundesamt.de/chemikalienleasing-portaleinstieg

In the project, adjustments to the website were prepared by the project team. These were related to structural adjustments as well as to content updates, which are either already available on the website or will be updated after the project has ended. The latter updates primarily relate to an update on the project results and the provision of the indicator checklists and SMART 5 versions (in German and English, respectively). Suggestions for these adjustments are included in the chapter on website updates.

**Events**

Various events on Chemical Leasing have been accompanied, prepared, followed-up and carried out by the project team. The following events have been particularly relevant for the project:

- Meeting of the international working on Chemical Leasing group in Vienna, Nov. 2017
- Round Table on Sustainability and Chemical Leasing at the Climate Conference in Bonn on 15th November 2017
- Workshops with government representatives in different countries; specifically, the first workshop on 23 November 2017 in Brazil
- Final workshop on the project and meeting of the Chemical Leasing working group on 19th October 2017 in Munich
- Support of ISC3[3] Chemical Leasing activities discussed at the final workshop

[3] International Sustainable Chemistry Collaborative Centre

- Presentation and discussion on Chemical Leasing with members of ACEA[4] on 12th September 2017 in Brussels
- Meeting of the national working group to discuss the progress on the indicators and SMART 5 on 26th October 2016

More events and details are described in chapter 7.

**Insurance concept for the use of Chemical Leasing in agriculture**

The business model should be disseminated and used more widely in various industries. In agriculture, there are already successful pilot projects of Chemical Leasing for the use of pesticides in Serbia and Sri Lanka (see, for example, case study on potato cultivation in Sri Lanka).

One inhibiting factor for a further spread of the business model in this area is the lack of protection for crop failures. To overcome this obstacle, the project team has developed an insurance concept, which in cooperation with a reinsurer and a local insurance company, shall lead to more Chemical Leasing applications in agriculture in the future.

The concept was based on the sum insured in terms of the value of the yield. The actors involved are the farmer as policyholder and user of crop protection products, a local insurance company as well as a reinsurance company for hedging. In the event of damage (e.g. crop failure due to pest infestation) due to incorrect advice by the supplier, the insurance coverage for crop failure will apply. It is important that the policy specifies the supplier of the plant protection products, the type of plant protection product and the pests to be controlled. The specifications must be documented.

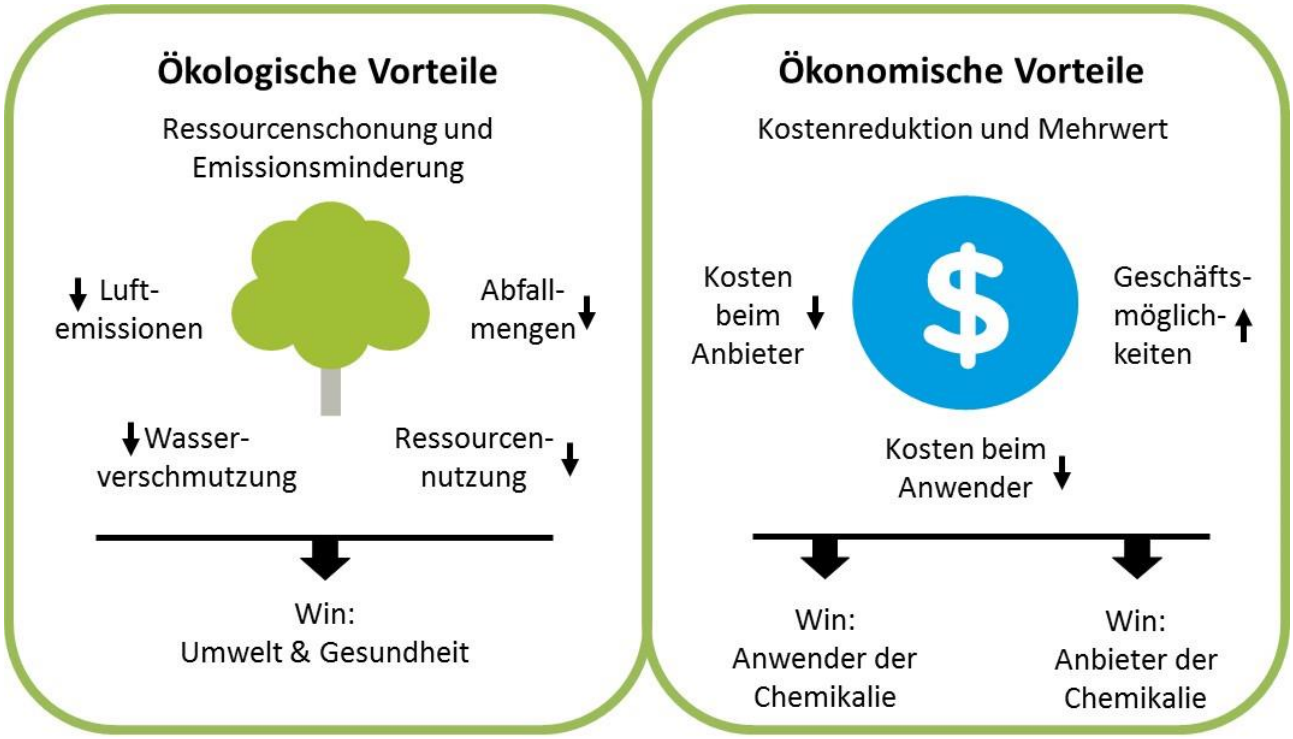
[4] European Automobile Manufacturers´ Association

# Zusammenfassung


## Hintergrund und Ziel

Chemikalienleasing ist ein Geschäftsmodell, bei dem der Fokus auf der Funktion bzw. dem von den Chemikalien erbrachten Service liegt. Im Kontrast zu traditionellen Geschäftsmodellen bezahlt der Anwender einer Chemikalie den Anbieter nicht mehr pro Kilogramm, Tonne oder Liter Chemikalie, sondern pro funktionelle Einheit, z.B. beschichteter Fläche, Betriebsstunden eines Fließbandes oder gereinigter Menge Abwasser. Das Geschäftsmodell wird seit mehreren Jahren von verschiedenen Firmen weltweit erfolgreich angewendet und führt zu erheblichen Einsparungen der Chemikalienmenge und generiert wirtschaftliche Vorteile für die Geschäftspartner. Darüber hinaus werden durch Chemikalienleasing je nach Anwendung weitere Vorteile wie Emissions- und Abfallminderung oder verbesserte Arbeitsbedingungen erzeugt. Abbildung 2 verdeutlicht die wesentlichen Vorteile durch Chemikalienleasing und die dadurch entstehende „Tripe-Win"-Situation.

Abbildung 2: „Triple-Win" durch Chemikalienleasing für Umwelt & Gesundheit sowie für die beiden Geschäftspartner (eigene Darstellung).




Zur Sicherung der Qualität von Chemikalienleasing-Anwendungen müssen die fünf Nachhaltigkeitskriterien erfüllt werden. Diese sind international anerkannt und bilden z.B. die Voraussetzung für eine Bewerbung beim Global Chemical Leasing Award. Anwendungen von Chemikalienleasing müssen die folgenden Kriterien erfüllen:

- Verringerung negativer Auswirkungen auf Umwelt, Gesundheit, Energiebilanz und Ressourceneffizienz von Chemikalien, die in Produktions- und Anwendungsprozessen verwendet werden.
- Verbesserte Handhabung und Lagerung von Chemikalien im Hinblick auf Risikovermeidung/-verminderung.
- Vermeidung einer Substitution durch Stoffe mit höherem Risiko.

- Wirtschaftliche und soziale Vorteile werden generiert und fair verteilt: Ein Vertrag sollte die Ziele der kontinuierlichen Verbesserungen und eine faire sowie transparente Aufteilung der wirtschaftlichen Vorteile zwischen den Vertragspartnern enthalten.
- Monitoring der Verbesserungen im Sinne der oben genannten Kriterien.

Die Praxiserfahrung der vergangenen Jahre hat gezeigt, dass diese fünf Kriterien zwar sehr hilfreich für die Bewertung von Chemikalienleasing-Anwendungen sind. Dennoch wäre oftmals eine ausführlichere Betrachtung von z.B. den reduzierten negativen Auswirkungen auf die Umwelt von Interesse. Aus diesem Grund sind im Projekt Unterkriterien und Indikatoren zur Spezifizierung der fünf Nachhaltigkeitskriterien entwickelt worden. Die Indikatoren sind in eine „Indikatoren-Checkliste" zum Screening sowie in das elektronische Instrument „SMART 5" eingeflossen.

**Entwicklung von Unterkriterien und Indikatoren**

Der erste Projektschritt zielte auf die Untergliederung der Nachhaltigkeitskriterien mittels Unterkriterien ab. Für diese Unterkriterien sind in einem nächsten Schritt mit konkreten quantitativen sowie qualitativen Indikatoren spezifiziert worden. Beide Schritte wurden vom Projektteam in Absprache mit dem Umweltbundesamt auf Grundlage der Erfahrungen mit Chemikalienleasing-Anwendungen und dem internationalen Award sowie basierend auf anderen Bewertungsansätzen für Nachhaltigkeit bzw. nachhaltige Chemie bearbeitet.

Das Ergebnis ist eine Indikatoren-Checkliste, die den Nutzern aus Unternehmen oder Behörden einen schnellen Überblick über die möglichen relevanten Parameter einer Chemikalienleasing-Anwendung verschafft. Sie kann verwendet werden kann, um ein erstes Screening der Anwendung durchzuführen und die Arbeit mit SMART 5 vorzubereiten. Hierbei kann für jeden Indikator einfach angezeigt werden, ob sich dieser verbessert oder verschlechtert hat; ohne dabei bereits konkrete Werte zu benötigen. Dadurch werden Erfolge, Verbesserungspotenziale und auch Datenlücken qualitativ aufgezeigt.

Die Checkliste ist auf Deutsch sowie auf Englisch verfügbar und im Anhang zu diesem Bericht enthalten. Sie soll weiterhin zukünftig auf der deutschen sowie der internationalen Chemikalienleasing-Internetseite zum Download bereitgestellt werden.

**Das Instrument SMART 5**

Für Unternehmen bzw. Chemikalienleasing-Akteure soll es möglich sein, die Indikatoren in einer standardisierten Methodik zur Evaluierung ihrer Anwendungen zu verwenden. Für die Ermittlung der Vorteile, die durch Chemikalienleasing entstehen, wurde das Instrument SMART 5 entwickelt. Das Excel-basierte Tool enthält alle Indikatoren und kann auf Basis von Vorher/Nachher-Werten die Verbesserungen einer Chemikalienleasing-Anwendung ausgeben. Die Nutzer von SMART 5 können mit dem Instrument einerseits die Veränderungen quantifizieren, die durch die Umstellung von einem traditionellen Geschäftsmodell auf Chemikalienleasing erreicht wurden. Andererseits kann SMART 5 auch genutzt werden, um die Verbesserungen innerhalb eines Chemikalienleasing-Vorhabens zu ermitteln, beispielsweise beim Vergleich von verschiedenen Jahren seit der Implementierung.

SMART 5 ist folgendermaßen mittels verschiedenen Registerblättern untergliedert:

- Titelblatt
- Im Registerblatt „Einleitung" wird die Zielsetzung des Instrumentes kurz beschrieben. Es wird darauf hingewiesen, dass die unternehmens-spezifischen Daten nicht weitergegeben werden.
- Das Registerblatt „Projektbeschreibung" ermöglicht eine kurze Charakterisierung des Chemikalienleasing-Projektes, zu dem Daten erfasst werden – siehe auch die nachfolgende Abbildung. Hier können auch Erfahrungen beschrieben werden, die während der Laufzeit des Projektes gemacht wurden.

- In den folgenden fünf Registerblättern werden Daten zu den einzelnen Chemikalienleasing-Nachhaltigkeitskriterien und den Unterkriterien abgefragt. Diese Kriterien wurden bereits im ersten Zwischenbericht dokumentiert. Für die leichtere Nachvollziehbarkeit der kommenden Ausführungen werden sie nochmals in der folgenden Tabelle gezeigt.
- Factsheet
- Imprint

SMART 5 wird nach Projektende sowohl als deutsche als auch als englische Version über die Chemikalienleasing-Internetseite des Umweltbundesamtes verfügbar sein. Zusätzlich soll die englische Version auf der internationalen Chemikalienleasing-Internetseite von UNIDO[5] erhältlich sein.

Beide Instrumente, die Checkliste und SMART 5, sind im Projekt durch verschiedene Akteure überprüft und verifiziert worden. U.a. haben sich aus den Diskussionen mit dem nationalen Arbeitskreis Chemikalienleasing sowie aus der Datenerhebung und Prüfung der Praxistauglichkeit mit Unternehmensvertretern hilfreiche Änderungsvorschläge ergeben, die in die finalen Versionen eingeflossen sind.

**Ziele und Nutzen von Indikatoren-Checkliste und SMART 5**

Die folgende Liste fasst die wesentlichen Ziele bzw. den Nutzen zusammen, der sich für die Anwender von Indikatoren-Checkliste und SMART 5 ergibt. Die beiden Instrumente, die jeweils die entwickelten Unterkriterien und Indikatoren für die Nachhaltigkeitskriterien von Chemikalienleasing enthalten, ermöglichen:

- Sicherung hoher Standards von Chemikalienleasing-Kooperationen
- Information aller Akteure über die Bedeutung der Nachhaltigkeitskriterien und ihre Bedeutung
- Standardisierte Überprüfung von Chemikalienleasing-Verträgen hinsichtlich Einhaltung der Nachhaltigkeitskriterien
- Unterstützung von Unternehmen bei der Einführung von Chemikalienleasing und der fortlaufenden Dokumentation
- Übersicht über mögliche Parameter zur Dokumentation im Rahmen von Chemikalienleasing-Projekten für die Unternehmen
- Standardisierte Implementierung von Kooperationen und Monitoring-Maßnahmen

Die Erfüllung der Nachhaltigkeitskriterien ist eine Voraussetzung für eine erfolgreiche Bewerbung um den Global Chemical Leasing Award[6]. Die Kriterien und Indikatoren erleichtern es der Jury des Awards das Abschneiden der Antragsteller hinsichtlich der fünf Nachhaltigkeitskriterien zu überprüfen und zu bewerten. Derzeit wird mit UNIDO die Nutzung der Indikatoren in Form von SMART 5 für den Award 2018 diskutiert. Ergebnisse werden nach Abschluss dieses Berichts erwartet.

5 United Nations Industrial Development Organization

6 Der Global Chemical Leasing Award wird von der UNIDO im Rahmen ihrer Aktivitäten im Chemical Leasing Programme an herausragende Chemikalienleasing-Kooperationen und andere Aktivitäten vergeben. Die nächste Verleihung findet 2018 statt. Weitere Informationen werden auf der internationalen Website bereitgestellt: http://chemicalleasing.org/global-award

### Datenerhebung

Im Anschluss an die Indikatorenentwicklung wurden diese in Praxistests mit bestehenden und gut quantifizierten Chemikalienleasing-Beispielen erprobt. Die Indikatoren und SMART 5 wurden auf Basis des daraus entstandenen Anpassungsbedarfs überarbeitet und für die weitere Datenerhebung für Chemikalienleasing-Kooperationen verwendet.

Mit den Indikatoren konnten Daten für die folgenden Kooperationen erhoben werden:

- Chemikalienleasing in der Metallreinigung, Beispiel 1: die Unternehmen SAFECHEM und Pero kooperieren seit vielen Jahren bei der industriellen Teilereinigung und haben Chemikalienleasing eingeführt. Neben erheblichen Einsparungen bei der Lösemittelmenge konnten außerdem Abfälle und der Energiebedarf reduziert werden. Weitere Vorteile, die sich aus dem Geschäftsmodell ergeben haben, sind in den Tabellen 1 bis 5 dargestellt.
- Chemikalienleasing in der Metallreinigung, Beispiel 2: SAFECHEM verwendet das Chemikalienleasing-Geschäftsmodell mittlerweile mit vielen seiner Kunden. Das zweite Beispiel stellt die Informationen aus der Anwendung mit einem Kunden in Großbritannien zusammen. Diese Anwendung von Chemikalienleasing geht mit der Umstellung des Lösemittels von Trichlorethylen auf Perchlorethylen einher. Erzielte Verbesserungen betreffen Einsparungen bei der Chemikalienmenge sowie vermehrt Schulungen für die Mitarbeiter. Aus der Anwendung sind wenig quantitative Informationen vorhanden.
- Verkleben von Verpackungen: Chemikalienleasing wird seit mehreren Jahren für das Verkleben von Verpackungen in Serbien verwendet. Die kooperierenden Unternehmen sind Henkel als Lieferant des Klebstoffs und Bambi, ein Hersteller von Süßwaren, der die Pappverpackungen verklebt. Durch die Kooperation konnte ein neuer, effizienterer Klebstoff verwendet werden, der auch zu Energieeinsparungen in der Anwendung führt.
- Pestizidanwendung in der Landwirtschaft: Die Kooperation umfasst die Verwendung von Agrarchemikalien im Kartoffelanbau in Sri Lanka. Neben signifikanten Einsparungen bei der verwendeten Chemikalienmenge und den gefährlichen Abfällen konnten die Kosten reduziert und die Qualifizierung der Mitarbeiter erhöht werden.
- Reinigung im Hotel: Die Anwendung aus Brasilien betrifft die Reinigung von Böden, Zimmern, Geschirr und Wäsche in einem Luxushotel in Rio de Janeiro. Seit Eröffnung des Hotels stellt Ecolab dem Hotel effiziente Reinigungsmittel sowie Anleitungen zum Gebrauch zur Verfügung, wodurch die verwendete Menge an Reinigungsmitteln gegenüber anderen Hotels erheblich reduziert werden konnte. Die Anwendung gewann 2014 den Global Chemical Leasing Award.
- Schmieren von Fließbändern: Bei einem Getränkeproduzent in Serbien wird Chemikalienleasing für das Schmieren der Fließbänder in der Abfüllung verwendet. Die Kooperation der Geschäftspartner hat dazu geführt, dass ein Schmiermittel ohne Wasser verwendet werden kann, sodass a) weniger Chemikalien benötigt werden und b) kein Wasser mehr im Prozess angewendet werden muss. Dies führt wiederum zu Einsparungen bei der Menge an Chemikalien zur Wasseraufbereitung.

Die Ergebnisse der Datenerhebung sind pro Nachhaltigkeitskriterium in den folgenden fünf Tabellen dargestellt.

Tabelle 6: Ergebnisse der Datenerhebung für die Indikatoren aus Nachhaltigkeitskriterium 1

| **Kriterium 1: Verringerung negativer Auswirkungen** | | | | | | |
|---|---|---|---|---|---|---|
| | **Metallreinigung 1** | **Metallreinigung 2** | **Verkleben von Verpackungen** | **Agrarsektor** | **Reinigung im Hotel** | **Schmieren von Fließbändern** |
| **Luftemissionen** | Lösemittel -90% | Verringert, nicht quantifiziert | Dämpfe von Klebstoff, nicht quantifiziert | n/a | n/a | n/a |
| **Wasseremissionen** | n/a | n/a | n/a | n/a | Reduktion, nicht quantifiziert | -100% durch Prozessumstellung |
| **Abfall** | Aktivkohle -87%<br>Altöl 0%<br>Lösemittel -40% | Verringert, nicht quantifiziert | -30% | -67% gefährliche Abfälle | Verringerter Verpackungs-abfall | -30% |
| **Energie** | Direkt: -46%<br>Indirekt: -76% | n/a | Direkt: -53% | n/a | n/a | n/a |
| **GHG** | n/a | n/a | n/a | n/a | n/a | n/a |
| **Ressourcen** | PER -76%<br>Stabilisator -74%<br>Aktivkohle -87% | Verringert durch ChL und verb. Technik | Chemikalien -30% | Zwischen 34 und 55% je nach Pestizid | -80% Chemikalien | -30% Schmierstoff<br>-100% Chemikalien für $H_2O$-Aufbereitung |

Trotz einiger vorhandener Datenlücken wird ersichtlich, dass in allen Fällen die Chemikalienmenge sowie teils weitere Ressourcen eingespart werden konnten. Die Einsparungen liegen dabei zwischen 30 und 80 %. Direkte Treibhausgasemissionen sind in den Anwendungen nicht aufgetreten. Daher wurden hierzu keine Daten erhoben. Es entstehen in allen Fällen indirekte Emissionsminderungen.

Tabelle 7: Ergebnisse der Datenerhebung für die Indikatoren aus Nachhaltigkeitskriterium 2

| **Kriterium 2: Vermeidung einer Substitution mit höherem Risiko** | | | | | | |
|---|---|---|---|---|---|---|
| | **Metallreinigung 1** | **Metallreinigung 2** | **Verkleben von Verpackungen** | **Agrarsektor** | **Reinigung im Hotel** | **Schmieren von Fließbändern** |
| **Substitution** | keine | Ja, von TRI zu PER | Ja, durch effizienteren Klebstoff | keine | keine | Ja, von Nass- auf Trockenschmierstoff |
| **Stoffeigenschaften** | n/a | Geringere Gefährlichkeit | Effizienter; beide Stoffe nicht eingestuft | n/a | n/a | Substitut nicht eingestuft |
| **Risiko** | n/a | Reduktion durch Substitut und SAFETAINER | Reduktion durch geringere Temp. Und Druck, automat. Dosierung | n/a | n/a | Reduktion durch weniger gefährliches Substitut |

Tabelle 7 zeigt, dass in drei der Fallbeispiele eine Substitution zusammen mit der Umstellung auf Chemikalienleasing stattfindet. In keinem Fall ist dabei eine gefährlichere Chemikalie verwendet worden oder hat sich das Gesamtrisiko erhöht.

Tabelle 8: Ergebnisse der Datenerhebung für die Indikatoren aus Nachhaltigkeitskriterium 3

| **Kriterium: Verbesserte Handhabung und Lagerung** | | | | | | |
|---|---|---|---|---|---|---|
| | **Metallreinigung 1** | **Metallreinigung 2** | **Verkleben** | **Agrarsektor** | **Reinigung im Hotel** | **Schmierung** |
| **SDB** | verfügbar | verfügbar | verfügbar | verfügbar | verfügbar | verfügbar |
| **Arbeitsunfälle** | Keine Unfälle | Keine Unfälle | n/a | Reduktion, nicht quantifiziert | Reduktion, nicht quantifiziert | Keine Unfälle |
| **Exposition** | Keine Änderung | Dermale, reduzierte Exposition | Inhalativ, verringert | dermal, besserer Schutz und Handhabung | Automatische Dosierung | Verringert durch Substitut |
| **Risiko** | Reduktion durch verringerte Menge | Geringer durch bessere Lagerung und Substitution | Geringer durch Substitution und neue Prozessparameter | Reduktion durch Schutz und Lagerung | Verringert durch weniger direkten Kontakt | Verringert durch verminderte Rutschgefahr |

Aus Tabelle 3 geht hervor, dass für die meisten Fallbeispiele eine gute Datengrundlage zu Handling und Lagerung besteht. In allen Kategorien sind Verbesserungen aufgetreten. Diese gehen entweder mit der Substitution oder auch mit einem besseren Handling bzw. einer besseren Lagerung der Chemikalien einher. Auch die Schulung der Mitarbeiter (siehe Tabelle 4) führt zu Reduktionen beim Risiko.

Tabelle 9: Ergebnisse der Datenerhebung für die Indikatoren aus Nachhaltigkeitskriterium 4

| Kriterium 4: Wirtschaftliche und soziale Vorteile | | | | | | |
|---|---|---|---|---|---|---|
| | **Metallreinigung 1** | **Metallreinigung 2** | **Verkleben** | **Agrarsektor** | **Reinigung im Hotel** | **Schmierung** |
| **Kosten Anwender** | -52% Kosten für beide Geschäftspartner | Nicht quantifiziert | Chemikalien: -13%, Instandhaltung und anderes bis 72% | -31% | -76% | -39% |
| **Performance Anbieter** | | SAFECHEM nach wie vor Lieferant | Ja, nicht quantifiziert | Gute, langfristige Beziehung | n/a | Verbessert (Lagerung, Transport, Service) |
| **Geschäftsmöglichkeiten** | Stabile Partnerschaft | n/a | Henkel als einziger Lieferant | 6 neue Kunden, +12 % Ertrag | Umweltzertifikat | Ecolab einziger Lieferant |
| **Qualifikation** | n/a | Regelmäßige Schulung | n/a | 3 d für Angestellte | Ja, aber nicht quantifiziert | n/a |
| **Arbeitsplätze** | n/a | Keine Änderung | Keine Änderung | -67% | n/a | n/a |

Kriterium 4 betrifft die wirtschaftlichen und sozialen Verbesserungen. Auch hier sind für die meisten Fallbeispiele Verbesserungen eingetreten bzw. es wurden einige Indikatoren nicht quantifiziert. Wirtschaftliche Vorteile, auch wenn nicht quantifiziert, sind in allen Anwendungen vorhanden. Lediglich im Beispiel aus Sri Lanka sind Arbeitsplätze durch die Umstellung auf Chemikalienleasing verloren gegangen. Dies ist durch die reduzierte Menge an Pestiziden zu erklären, die von den Sprayern auf die Felder aufgebracht werden. Die verbleibenden Arbeitsplätze sind nach Umstellung auf Chemikalienleasing mit mehr Trainings und besseren Arbeitsbedingungen verbunden.

Tabelle 10: Ergebnisse der Datenerhebung für die Indikatoren aus Nachhaltigkeitskriterium 5

| Kriterium 5: Monitoring | | | | | | |
|---|---|---|---|---|---|---|
| | **Metallreinigung 1** | **Metallreinigung 2** | **Verkleben** | **Agrarsektor** | **Reinigung im Hotel** | **Schmierung** |
| **Monitoring der Indikatoren** | ja | Ja, in reduzierten Intervallen | ja | Ja<br>Vorher keinerlei Monitoring | ja | ja |

Monitoring findet in allen Anwendungen statt. Die detaillierte Betrachtung mit den jeweils geprüften Indikatoren und den prozentualen Anteilen an den gesamten Indikatoren sind bei der Beschreibung der Fallbeispiele im Kapitel 4.2.2 enthalten.

Im Anschluss an die Datenerhebung erfolgte eine Betrachtung der Branchenpotenziale im Hinblick auf die in den fünf Fallbeispielen erzielten Verbesserungen:

- Reinigung von Metallteilen. Einsparpotential in Deutschland pro Jahr: u.a. 7,3 kt bis 9,3 kt Perchlorethylen (entspricht ca. 73 bis 93%) und 298 TJ bis 234 TJ Energie.
- Verkleben von Papier- und Pappverpackung. Einsparpotential in Deutschland pro Jahr: ca. 2.000 t Klebstoffe und 8.300 t $CO_2$-Äquivalenten.
- Pestizidanwendung in der Landwirtschaft in Sri Lanka: um 12% gesteigerter Ertrag.
- Reinigung im Hotel. Einsparpotential in Deutschland pro Jahr: 37 Mio. Liter Waschmittel; 2.670 t $CO_2$-Äquivalente; reduzierte Emissionen ins Abwasser von über 2 t Phosphor-Äquivalente; Kosteneinsparungen von ca. 33 Mio. €
- Schmieren von Fließbändern. Einsparpotential in Deutschland pro Jahr: 41,4 t Schmiermittel und rund 1.200 GJ Energie in der Lieferkette; im Schmierprozess durch eine Trockenschmierung 30.000 $m^3$ Wasser und 12.000 kg Schadstoffemissionen; ca. 36 t Abfallreduktion.

Die ausführlichen Ergebnisse sind auf Basis bestehender Betrachtungen in Kapitel 4.3 dargestellt.

**Öffentlichkeitsarbeit**

Teil des Projekts waren verschiedene Aktivitäten im Bereich der Öffentlichkeitsarbeit rund um das Thema Chemikalienleasing. Diese betreffen zum einen verschiedenen Aktualisierungen an der Chemikalienleasing-Internetpräsenz (UBA, 2017a) sowie Veranstaltungen im Projekt oder außerhalb des Projekts, die mit den Projektergebnissen verknüpft wurden oder wo beispielsweise die Indikatoren und SMART 5 vorgestellt wurden.

**Aktualisierung der Internetseite**

Auf der Webseite des UBA findet sich die deutsche Internetpräsenz Chemikalienleasing. Diese ist über diese beiden Links erreichbar:

- www.chemikalienleasing.de
- https://www.umweltbundesamt.de/chemikalienleasing-portaleinstieg

Im Projekt sind Anpassungen an der Website vom Projektteam vorbereitet worden. Diese betreffen einerseits strukturelle Anpassungen sowie andererseits inhaltliche Updates, die entweder bereits auf der Website vorhanden sind oder nach Projektende eingestellt werden sollen. Letztere Aktualisierungen betreffen vor allem ein Update zu den Projektergebnissen und das Bereitstellen der Indikatoren-Checklisten und SMART 5-Versionen (jeweils deutsch und englisch). Vorschläge für diese Anpassungen sind im Kapitel zur Aktualisierung der Internetpräsenz enthalten.

**Veranstaltungen**

Verschiedene Veranstaltungen zum Thema Chemikalienleasing sind vom Projektteam begleitet, vor- und nachbereitet und durchgeführt worden. Folgende Veranstaltungen sind für das Projekt besonders relevant (gewesen):

- Treffen der internationalen Arbeitsgruppe Chemikalienleasing in Wien
- Round-Table zu Nachhaltigkeit und Chemikalienleasing auf der Klimakonferenz in Bonn am 15. November 2017
- Workshops mit Regierungsvertretern in verschiedenen Ländern; konkret der erste Workshop am 23. November 2017 in Brasilien
- Abschlussworkshop zum Projekt und Treffen des Arbeitskreises Chemikalienleasing am 19. Oktober 2017 in München

- Unterstützung der ISC3[7]-Aktivitäten zu Chemikalienleasing, die auf dem Abschlussworkshop besprochen wurden
- Vorstellung und Diskussion zu Chemikalienleasing mit Mitgliedern von ACEA[8] am 12. September 2017 in Brüssel
- Treffen des nationalen Arbeitskreises zur Diskussion eines Zwischenstands zu den Indikatoren und SMART 5 am 26. Oktober 2016

Weitere Veranstaltungen und Details sind in Kapitel 6 beschrieben.

**Versicherungskonzept zur Anwendung von Chemikalienleasing in der Landwirtschaft**

Das Geschäftsmodell soll in verschiedenen Branchen weiter verbreitet werden und verstärkt verwendet werden. In der Landwirtschaft gibt es bereits erfolgreiche Pilotprojekte mit Chemikalienleasing für die Verwendung von Pestiziden in Serbien und Sri Lanka (siehe z. B. Fallbeispiel zum Kartoffelanbau in Sri Lanka).

Ein Hemmfaktor für eine weitere Verbreitung des Geschäftsmodells in diesem Bereich ist die fehlende Absicherung von Ernteausfällen. Um diese Hürde zu überwinden, hat das Projektteam ein Versicherungskonzept erarbeitet, das zukünftig in Kooperation mit einem Rückversicherer und einer lokalen Versicherung zu mehr Chemikalienleasing-Anwendungen in der Landwirtschaft führen soll.

Für das Konzept wurde die Versicherungssumme in Form des Werts der Ernte zugrunde gelegt. Die beteiligten Akteure sind der Landwirt als Versicherungsnehmer und Anwender von Pflanzenschutzmitteln, eine lokale Versicherung sowie eine Rückversicherungsgesellschaft zur Absicherung. Im Schadensfall (d.h. Ernteausfall durch Schädlingsbefall) durch eine Fehlberatung des Lieferanten greift der Versicherungsschutz für den Ernteausfall. Wichtig ist dabei, dass in der Police der Lieferant der Pflanzenschutzmittel, der Typ der Pflanzenschutzmittel sowie die Schädlinge, welche bekämpft werden sollen, angegeben werden müssen. Die Vorgaben sind zu dokumentieren.

7 International Sustainable Chemistry Collaborative Centre

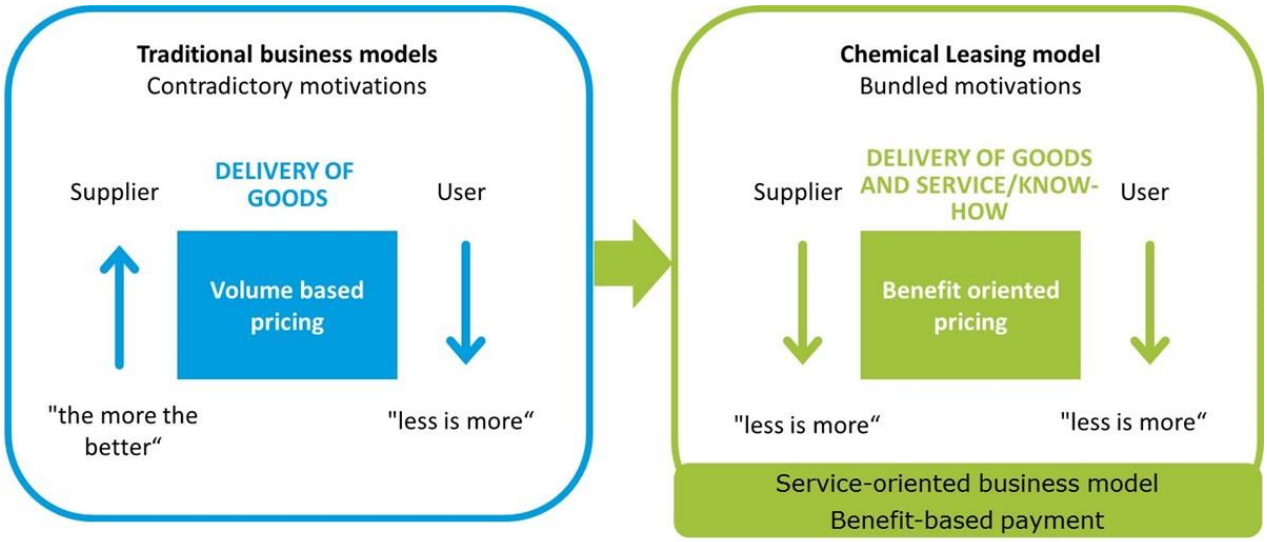
8 Europäischer Automobilverband

# 1 Background and objectives

## 1.1 Background

Chemical Leasing (ChL) is an innovative business model that has been used for more than 15 years in different industries, leading to savings in chemicals and other resources. The business model is based on the fact that chemicals shall fulfil a specific function in their application, e.g. the cleaning of parts, the bonding of materials or the control of pests in agriculture. Unlike traditional business models where the user pays for a chemical per kilogram or litre, Chemical Leasing focuses on the function or service performed by the chemicals. Therefore, the payment under Chemical Leasing takes place per service unit, for example per number of cleaned parts. As a result, the chemical also becomes a cost factor for the supplier (manufacturer or supplier) and the business partners work together to optimise the process in order to provide the required service by using smaller amounts of chemicals. Figure 3 illustrates this harmonisation of interests of both business partners.

Figure 3: Harmonisation of the interests of suppliers and users under Chemical Leasing compared to conventional business models.




Source: own figure

The international activities on Chemical Leasing are coordinated by the Global Chemical Leasing Program of the United Nations Industrial Development Organization (UNIDO). Since 2007, Germany has been supporting the program through the Federal Ministry for the Environment, Nature Protection, Building and Nuclear Safety (BMUB) and the German Environment Agency (UBA), and is supporting implementation project as well as the further development of Chemical Leasing through national initiatives.

In order to maintain internationally high standards and a common understanding of Chemical Leasing, UBA promoted the development of sustainability criteria for the business model between 2007 and 2010[9]. Five sustainability criteria have been developed, which define the international standard for

[9] The results are available in the final report to the research project „Chemikalienleasing als Modell zur nachhaltigen Entwicklung mit Prüfprozeduren und Qualitätskriterien anhand von Pilotprojekten in Deutschland“ - FKZ 3707 67 407

Chemical Leasing and are used, for example, in the evaluation of cooperation agreements within the Global Chemical Leasing Award[10]. The criteria are listed in the text box.

**The five sustainability criteria for Chemical Leasing**

- Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes.
- Improved handling and storage of chemicals to prevent and minimize risks.
- No substitution of chemicals by substances with a higher risk.
- 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.
- Monitoring of the improvements needs to be possible.

## 1.2 Objective

The sustainability criteria make an important contribution to the quality assurance of Chemical Leasing applications and contribute to the definition and delineation of the business model compared to other service models, for example, which do not focus on reducing negative environmental and health impacts. In practice, it has also been pointed out that the criteria require sufficient description in order to allow for a verification of their fulfilment. Such a concrete description was the aim of the research project and should be based on sub-criteria, which could be again verified using concrete indicators.

Therefore, UBA initiated the research project whose main goals were the design of the sustainability criteria for Chemical Leasing with sub-criteria and indicators including the development of an instrument for data collection using the criteria and indicators. The data collection tool can document both the implication of introducing Chemical Leasing (comparing conventional application to Chemical Leasing) as well as continuously monitoring an ongoing process. The indicators and tool developed in the project have been reviewed in practical examples and data from Chemical Leasing collaborations have been collected.

The project has continued to monitor current developments in Chemical Leasing at national and international level. Thus, the exchange with the European Automobile Manufacturers' Association (ACEA) was initiated and promoted, and the implementation of workshops in cooperation with UNIDO was supported. In the agricultural sector, there is a need for the involvement of an insurer in Chemical Leasing cooperations in order to secure risks of crop failures. For this purpose, an insurance concept was developed in the project. The project work also included an update of the website as well as the organisation and implementation of accompanying group meetings and a final workshop.

This final report describes the work done by the project team and results achieved between September 2015 and December 2017. The approach and concrete methodology will be explained in the description of the work packages in the following chapters. Chapter 2 describes the development of sub-criteria and qualitative and quantitative indicators for each of the five sustainability criteria for Chemical Leasing. Chapter 3 explains the concept and the creation of the electronic instrument "SMART 5", which enables data collection and presentation of Chemical Leasing collaborations. Chapter 4 presents the results of testing the tool and data collection for Chemical Leasing collaborations, which were then used for extrapolation to the industry. Chapter 5 describes the ongoing or outstanding updates to the Chemical Leasing website and Chapter 6 introduces the insurance concept developed in the project for Chemical Leasing in Agriculture. Chemical Leasing events that have taken place since the project began are covered in Chapter 7. Subsequently, a summarising outlook follows in chapter 8.

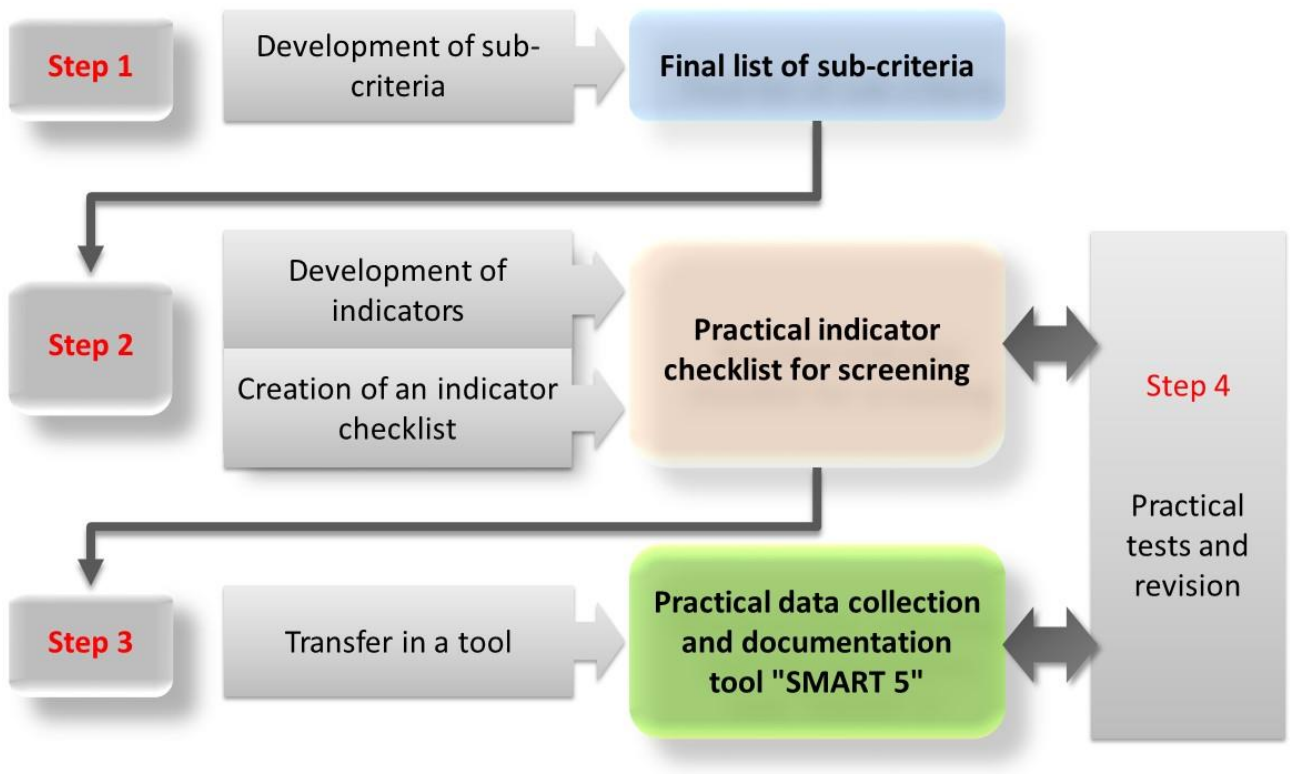
[10] http://chemicalleasing.org/global-award

# 2 Sub-criteria and indicators for the sustainability criteria of Chemical Leasing

The aim of the first work package in the project was the development of sub-criteria for each of the five sustainability criteria for Chemical Leasing and the subsequent specification by means of qualitative and quantitative indicators. The application of these criteria and indicators assists the sustainability assessment of Chemical Leasing cooperations. For example, the criteria and indicators support the jury of the Global Chemical Leasing Award in the review of the fulfilment of the five sustainability criteria, as the criteria for a successful application to the award must be met. Furthermore, the sub-criteria and indicators show companies the areas that are influenced by Chemical Leasing in the company and enable a structured recording of the relevant parameters as well as the identification of potentials for optimisation or the prioritisation of activities.

Figure 4 shows a schematic diagram of the workflow. The following chapters 2.1 and 2.2 describe this process and present the results: a list of 21 sub-criteria and 53 indicators as well as a "checklist" that will enable companies to quickly screen the indicators and get started with SMART 5.

Figure 4: Working process for the creation of sub-criteria and indicators for Chemical Leasing and the transfer of results to SMART 5 (see chapter 3).




Source: own figure

## 2.1 Development of sub-criteria

First, the project team developed sub-criteria for each sustainability criterion. The project team drew on existing experience in the development of criteria and indicators and incorporated these into the development of the sub-criteria (see, inter alia, the UBA research project "Contributions to the sustainability strategy: reducing resource consumption in the chemical industry through instruments of sus-

tainable chemistry", FKZ 3713 93 425). Furthermore, additional experiences from initiating, implementing and reviewing numerous Chemical Leasing collaborations were used, in which the project team was involved in recent years. The list of indicators was adapted during the course of the project to the findings and results of the further work packages. This was mainly based on the discussions in the working group and based on the case studies. The result of the working step is the list of sub-criteria listed in Table 11. They are listed together with the five sustainability criteria. The interaction of the sub-criteria is to be understood in the sense of an "and/or" link, since they should be applicable as far as possible to all sectors and areas of application of chemicals. In order to fulfil a sustainability criterion, one or more sub-criteria may therefore be relevant for each criterion, since for example, not every company produces wastewater during production.

Table 11: Existing sustainability criteria for Chemical Leasing and sub-criteria developed in the project[11]

| Criterion | Sub-criteria |
|---|---|
| **Reduction of adverse impacts for environment, health, energy and resource consumption** | Pollutants emitted into the air |
| | Pollutants emitted in waste water |
| | Volume of waste and waste water (total and hazardous waste) |
| | Energy demand during the application |
| | Energy demand (indirect) in the supply chain |
| | Greenhouse gas emissions during the application |
| | Resource demand during the application |
| **No substitution of chemicals by substances with a higher risk** | Substitution of the chemical |
| | Material characteristics of substitutes |
| | Overall risk |
| **Improved handling and storage of chemicals** | Available information base |
| | Number and extend of work accidents |
| | Exposure of workers |
| | Risk of accidents resulting from the application of chemicals |
| | Risk of accidents resulting from the storage of chemicals |
| **Economic and social benefits** | Costs for the user |
| | Economic performance of the supplier |
| | Business opportunities |
| | Qualification of employees |
| | Creation of new jobs |
| **Monitoring of the improvements** | Measurement of the indicators for the criteria 1-4 |

[11] The order of the sustainability criteria has been slightly changed for the practicality in checklist and SMART 5, i.e. criteria 2 and 3 were interchanged. This change has purely practical reasons and does not affect the statement or validity of the sustainability criteria in any way.

## 2.2 Elaboration of indicators and checklist

In order to check the compliance of the sustainability criteria and sub-criteria, quantitative indicators are helpful that facilitate easy data collection. In addition, qualitative indicators are needed to map non-measurable effects. Additional requirements for the indicators included the need for being comprehensible and achievable and cover a wide variety of Chemical Leasing applications. The development of the indicators for the sub-criteria was based on the experience gained from existing Chemical Leasing applications and the data collected there. Furthermore, indicators that are also used in other methods for capturing effects, for example the ones used in the area of sustainability assessment, were considered for the set. The developed indicators were discussed several times with different actors and were further improved. Key contributions to the review for improvement came from the participants of the national working group meeting in October 2016, feedback from company representatives and from National Cleaner Production Centers that successfully apply or monitor Chemical Leasing in different countries and regions of the world.

The development of indicators resulted in a set of 53 indicators which specify the sub-criteria. Between one and eight indicators are attributed to each sub-criterion. Figure 5 shows the indicators for selected sub-criteria for two of the sustainability criteria. A complete list of all indicators can be found in the checklist attached to this report.

**Benefits of the indicators**

The aim of the indicators is a standardised review of Chemical Leasing contracts with regard to their fulfilment of the sustainability criteria. This helps to ensure a high standard of the business model and its applications. The capturing of quantitative and qualitative values, and thus the measurement or definition of the effects of the business model, shows to both business partners the advantages achieved and is also an essential basis for admission to the Global Chemical Leasing Award. Data collection is particularly supported by the SMART 5 tool for standardised data collection (Chapter 3).

Furthermore, the set offers the possibility for authorities and companies to inform themselves about the possible parameters that can influence Chemical Leasing and to get an overview of the relevant figures for documentation.

Besides the verification of the fulfilment of the indicators, it is the contractors view that the indicators can also identify the benefits, potentials and possibilities for improvement of planned Chemical Leasing projects. Thus, they are an important instrument for the further dissemination of Chemical Leasing.

**Indicator checklist**

Based on its experience in the (chemical) industry, the project team takes the view that a Chemical Leasing indicator set, which should support the introduction of the business model, should be practical and clear to the companies applying it. This means in particular that the indicator set should also serve to enable a quick and uncomplicated first check or screening of the indicators and thus fulfil a "signal light function". Companies should be able to quickly get an overview of the areas in which Chemical Leasing has led to an improvement, which parameters have not changed and which, if necessary, need to be examined more closely or where there may have been deteriorations due to the business model. Here, the indicators serve as a signal light or indication of possible conflicting goals and more precise observation requirements. The indicator checklist is designed to support this enquiry and prepares the user for detailed data entry in SMART 5.

The checklist is available in both German and English. Both versions are included in chapters 10.1 and 10.2 of the annex of this report. The list provides an overview of the five sustainability criteria, their respective sub-criteria and lists all indicators. For each indicator, the tendency (e.g., reduced or increased, still without quantitative values) is indicated. The tendency is colour-coded characterising according to the signal lamp for each indicator, whether this develops in the direction intended by the

sub-criteria (positive development is marked green or constant results are neutrally coloured) or whether a parameter has developed negatively (for example, increased = red) and thus the fulfilment of a sub-criteria is uncertain and there is a need for a closer look at the goals and goal conflicts.

The checklist thus allows companies to get an overview of the data required to fulfil all criteria and draws attention to conflicting goals or the possible non-fulfilment of individual criteria. In addition, the checklist will help those companies interested in Chemical Leasing but without experience and reservations about the verifiability and fairness between business partners, as it provides an overview of the quality assurance of Chemical Leasing business models.

To sum up, the list offers the following advantages:

- Overview of the Chemical Leasing sustainability criteria, their sub-criteria and indicators
- Filtering the relevant parameters for the work with SMART 5
- Identification of data gaps, if necessary for further investigation
- Quick overview of sustainability (sub-)criteria that are easily met and those where the fulfilment is uncertain or requires more detailed information
- Attention to other parameters which can be positively influenced by Chemical Leasing and for example can be considered in the future

Figure 5: Exemplary overview of indicators of selected sustainability criteria and sub-criteria (dark green = sustainability criterion, light green = sub-criterion, grey = indicator)

| | | |
|---|---|---|
| **Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes** | Pollutants emitted into the air | Nitrogen oxides, ammonium, sulphur dioxide, volatile organic compounds (VOCs), fine dust, POPs, heavy metals, Other emissions |
| | Volume of waste and waste water | Waste generation in t<br>Wastewater in $m^3$<br>Tonnes or % of hazardous waste |
| | Energy demand in the application | kWh or MJ<br>(separately for electrical and thermal energy) |
| | Resource demand in the application | Amount of chemical<br>Amount of water<br>Quantity of other resources in the supply chain in kg, $m^3$, l (e.g., recycling) |
| **No substitution of chemicals by substances with a higher risk** | Chemical substitution | Did a substitution of one or more chemicals take place (other substance or improved quality)? |
| | Substitute properties | Safety data sheet of the substitute<br>Environmental and health hazards (e.g. CMR substances, irritant, bioaccumulative)<br>Other hazards |
| | Overall risk | Changed risk due to substitution (overall assessment and justification) |

# 3 Development of SMART 5 as an electronic data collection solution

The aim of the second work package was the development of an electronic instrument to verify and document data on Chemical Leasing projects in standardised form. The collection of data is required to carry out evaluations using the sub-criteria and indicators developed in the work package (WP) 1. At the same time, working with the instrument should motivate companies to implement sustainability criteria in their companies as an objective and to comply with them.

In addition, the data collection serves other purposes. The anonymised data can be used at the political level and can be used publicly. Companies will be able to better highlight the many benefits and positive impacts of Chemical Leasing, including environmental, energy efficiency, resource and health protection, as well as economic aspects such as cost reduction, profit and business relations from the data obtained. As a result, companies also have the opportunity to demonstrate their achievements in terms of sustainability to the public in a demonstrable and targeted manner. In addition, the success of chemical policies can be better estimated or assessed if there is sufficient data on the base of which sustainable chemistry is more strongly promoted.

Uniform data collection and structured data analysis are important requirements for the quantitative assessment of the state of Chemical Leasing. Reliable data from existing applications in companies also enables to determine and document compliance of the sustainability criteria in the projects, to compare different projects and to find further development opportunities.

The following two chapters describe the concept development and the implementation into an Excel-based instrument ("SMART 5").

## 3.1 Concept development

The aim of the work in WP 2 is an easy-to-use and attractively designed documentation and analysis tool. It should be used independently by companies that implement Chemical Leasing. It should enable them to record the existing, sometimes confidential data in the company with little effort.

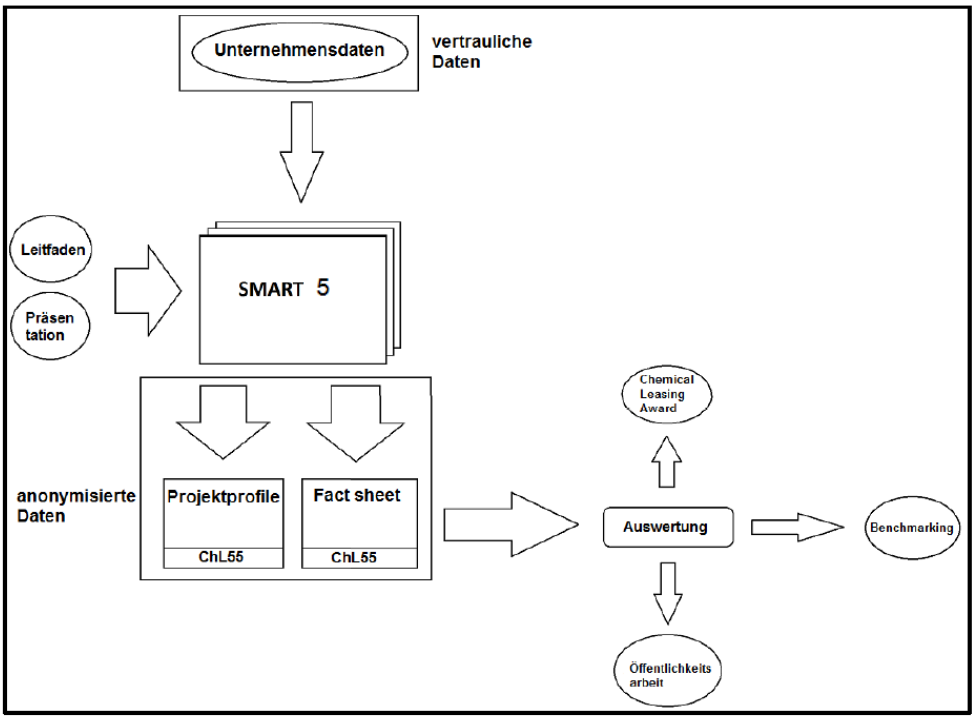
The instrument contains an automatic summary of the entered confidential data into an anonymous report sheet ("factsheet"). This contains all information relevant for assessing the benefits, but separates them from the company-specific data (which remain available in a parallel project profile).

The data collection tool should have the following characteristics:

- The instrument should be understood and applied by companies independently and without external individual support.
- The instrument should be able to be used with existing programs that are available as globally as possible.
- The data documentation should be easy and done without much time.
- The design should also convey knowledge about the Chemical Leasing and about sustainability principles in parallel to the data entry.
- The data documentation ensures that confidential business data is not shared.
- There are possibilities in the electronic instrument to check the fulfilment of the sustainability criteria for Chemical Leasing.
- The instrument supports the comparison of projects in the context of applications for the UNIDO Global Chemical Leasing Award.

In the context of these requirements, the concept for the electronically supported data documentation and evaluation was based on the structure shown in Figure 6.

Figure 6: Structure of the concept. The so-called "project profile" consists of a description of the project and of the five index sheets, which refer to the sustainability criteria.




Source: own figure

The concept can be summarised as follows:

- In order to achieve the different objectives which are associated with the use of the data, the basis is a technical system that enables a structured and automated data fusion and export. These functionalities are available based on the Excel program. Technically more complex is the implementation on the basis of *Access*. In addition, *Access* is globally less common. To ensure broad applicability, the data collection tool is implemented in *Excel*.
- The documentation system should be available as a separate file that can be downloaded by the companies.
- The instrument – hereafter referred to as "SMART 5" – supports the data entry through its structure, but also the later uses. For this purpose, a classification into three sections has been made. The first section contains a description of the instrument and an explanation of the procedure. In the second section, a brief characterisation of the company and the documented project is carried out. Comments concerning the project and the data collection can be made in this section. Five sustainability criteria with the corresponding sub-criteria and indicators can then be sampled in five index sheets. The third section automatically generates a compilation of the entered data that can be exported. Optionally, hints can be given on the possibility to further implement Chemical Leasing.

The data documentation requires only two steps from the user:

- The short characterisation and the annotation of the project.
- Entering the project data for the sustainability criteria.

The data entry in the criteria section is supported by drop-down menus, options for entering numbers and free text fields for comments.

After manual entry by the company, the data is automatically combined in a separate register sheet to form a report sheet ("factsheet"). It is the basis of further work with the data. The factsheet is linked to the project profile only via an anonymous project short title. The project short title results from a company-selected abbreviation and an automatically generated random number. The report sheet ensures the automatic anonymization of the data.

The report sheet shows at a glance for which of the five sustainability criteria the data is existent. This gives the company feedback on the implementation status directly after the data has been entered.

The completed file SMART 5 can be made available to the German Environment Agency. The German Environment Agency or its cooperation partners use the anonymous data, which have been combined in the report sheets for the evaluation and the public relations work.

## 3.2 SMART 5: The electronic instrument

After agreement on the concept, the instrument was elaborated. The result is the Excel file "SMART 5". Figure 7 shows the welcome page of the instrument.

Figure 7: Electronic data collection and evaluation for Chemical Leasing projects: Title page of the excel file SMART.

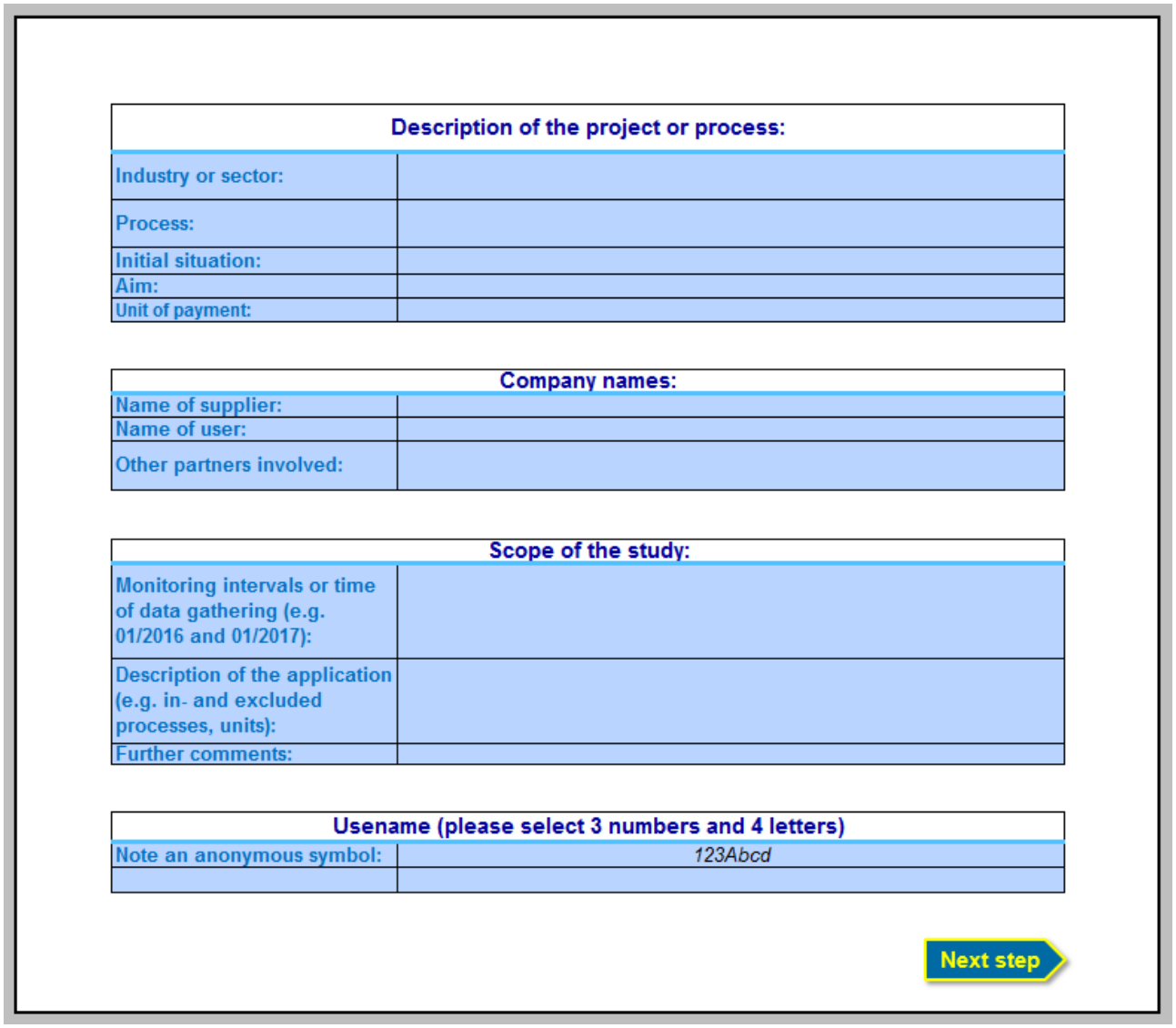

Source: own figure from SMART 5 (Excel-file)

The Excel-file SMART 5 consists of the following index pages:

- Title page
- The index page „Introduction" briefly describes the objectives of the instrument. It is pointed out that no automatic export of the data takes place and that the company-specific data will not be passed on if the company decides to submit the information to UBA.
- The index page "Project description" allows a brief characterisation of the Chemical Leasing project, for which data is collected – see also the following Figure. Experiences that were made during the term of the project can be described here.

- The following five index pages provide information on the individual Chemical Leasing sustainability criteria and sub-criteria.
- Factsheet
- Imprint

Figure 8: Input option for a short characterisation (project or process) in the instrument SMART 5.



| Description of the project or process: | |
|---|---|
| Industry or sector: | |
| Process: | |
| Initial situation: | |
| Aim: | |
| Unit of payment: | |

| Company names: | |
|---|---|
| Name of supplier: | |
| Name of user: | |
| Other partners involved: | |

| Scope of the study: | |
|---|---|
| Monitoring intervals or time of data gathering (e.g. 01/2016 and 01/2017): | |
| Description of the application (e.g. in- and excluded processes, units): | |
| Further comments: | |

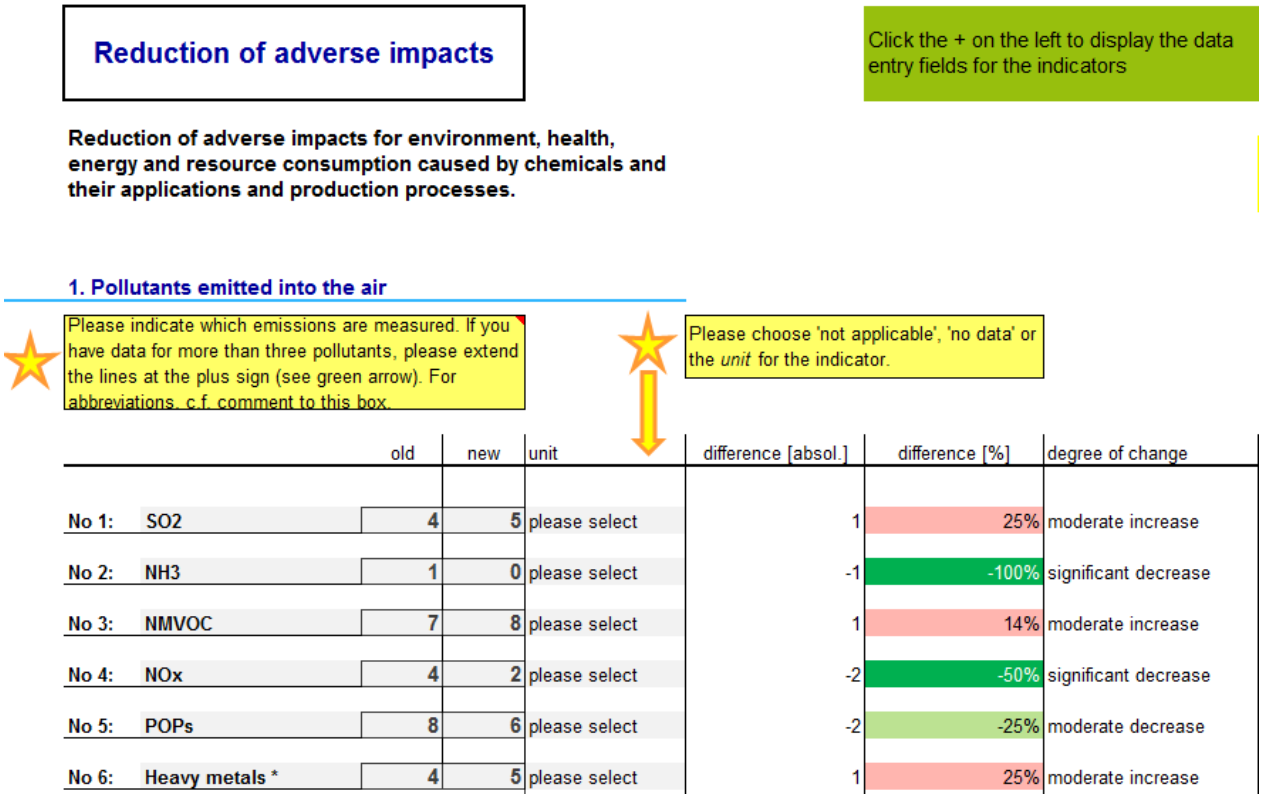
| Usename (please select 3 numbers and 4 letters) | |
|---|---|
| Note an anonymous symbol: | *123Abcd* |
| | |

Next step

Source: own figure from SMART 5 (Excel-file)

For each sub-criterion, quantitative or qualitative information may be entered. This is illustrated by the following Figure as an example for sustainability criterion 1 “reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes”.

Figure 9: Structure of the data entry for individual criteria in the instrument SMART 5. Example criterion 1: Reduction of adverse impacts. Excerpt from the index page.

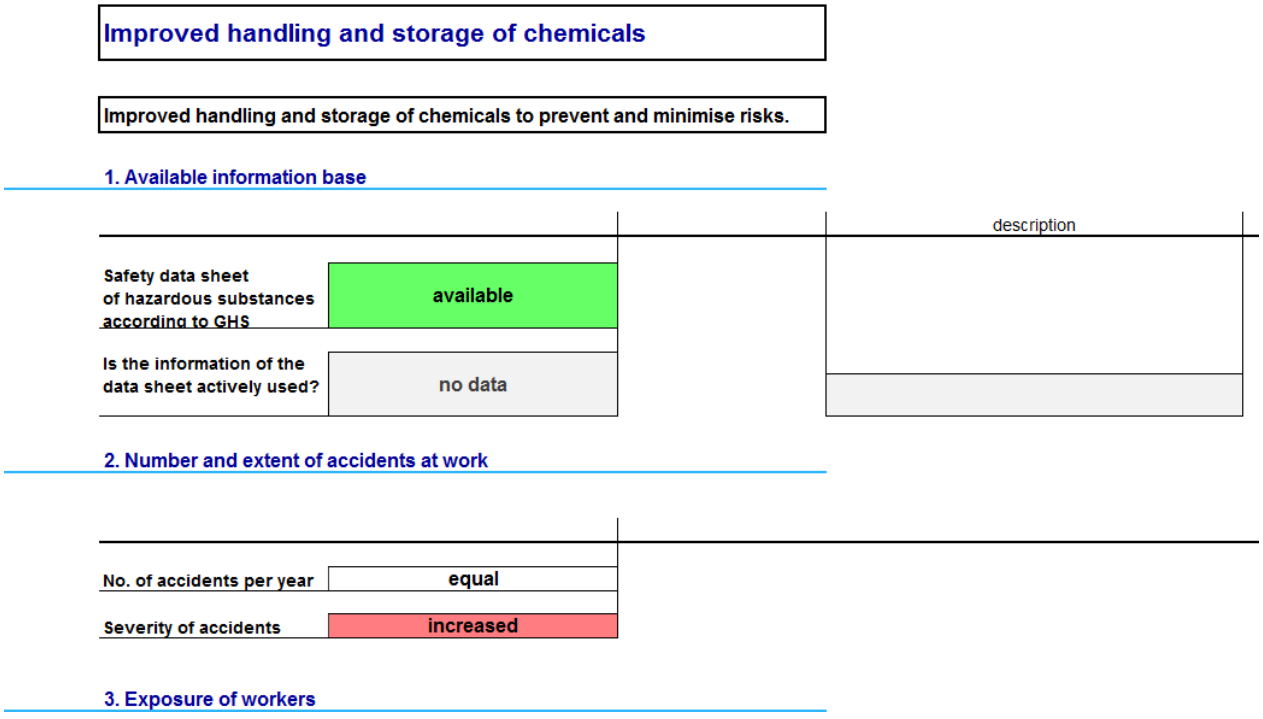



Source: own figure from SMART 5 (Excel-file)

To enter the units (e.g. grams or kilograms/year), a selection menu is available. Only the absolute values have to be entered – before and after the implementation of the measure. The difference in absolute numbers, the difference in percent and the extent of the change are calculated automatically. In addition, the colour scheme indicates the percentage of decrease or increase (from low to significant).

The index pages for the individual criteria are uniformly structured. This facilitates the usage. The following figure shows an example of an excerpt from the index page for the third criterion. It is about assessing whether the handling and storage of chemicals has improved.

Figure 10: Structure of the data entry for individual criteria in the instrument SMART 5 using the example of criterion 3: Improved handling and storage of chemicals. Excerpt from the register page.

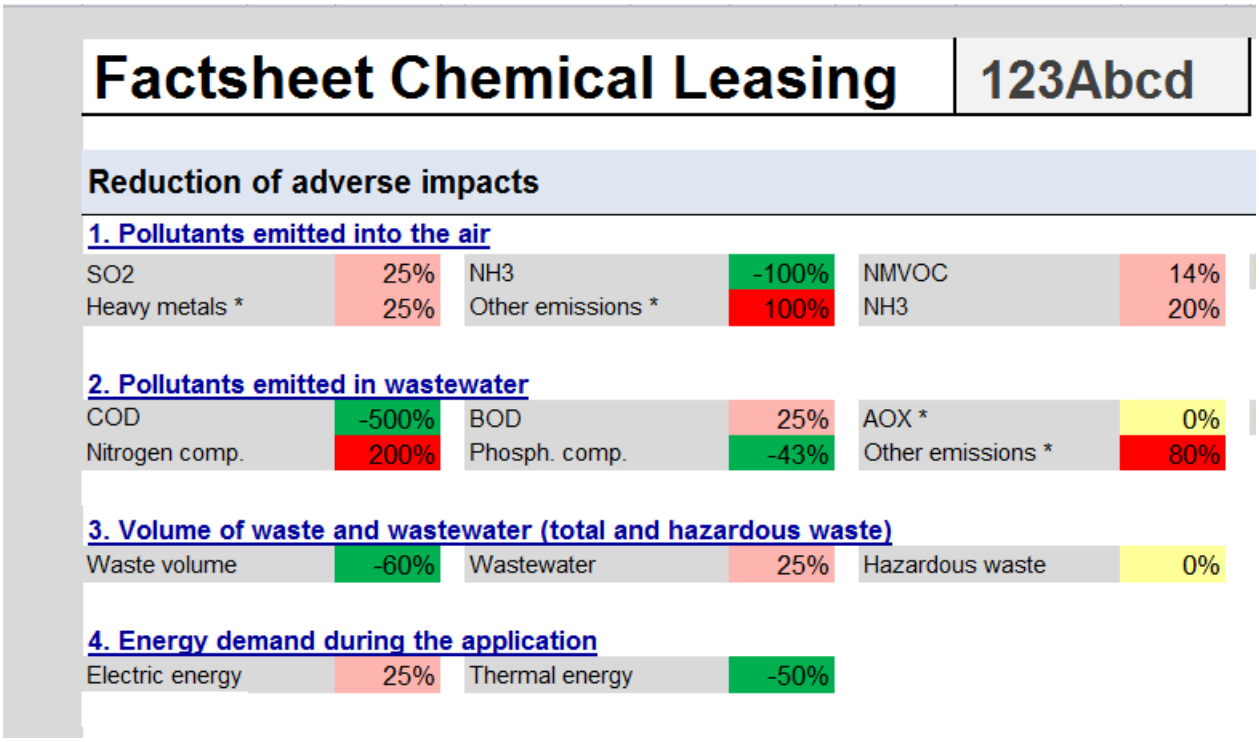



Source: own figure from SMART 5 (Excel-file)

For some developed indicators, a qualitative assessment of the development before and after a measure is proposed. The example above questions whether the severity of accidents at work has changed. In these cases, the exact way of entering the results in the worksheet is currently unknown. It makes sense to translate the qualitative description into a quantitative assessment key. This allows an evaluation of the results similar to the other indicators.

In SMART 5, information on the Chemical Leasing sustainability criteria can be entered on five index pages. In the following index page, all sub-criteria and indicators that have been backed up with data are automatically displayed on one sheet. This report sheet ("factsheet") shows at a glance for which indicators information have been provided. It also specifies the characterising number of the project, which was generated in one of the first index pages in the description of the project. The following figure shows how the report sheet may look like. The example displays information about the first sub-criterion of the criterion "reduction of adverse impacts".

Figure 11: The "factsheet" in the instrument SMART 5: Summary of the entered data for the individual Chemical Leasing indicators.



**Factsheet Chemical Leasing** | **123Abcd**

**Reduction of adverse impacts**

**1. Pollutants emitted into the air**

| | | | | | |
|---|---|---|---|---|---|
| SO2 | 25% | NH3 | -100% | NMVOC | 14% |
| Heavy metals * | 25% | Other emissions * | 100% | NH3 | 20% |

**2. Pollutants emitted in wastewater**

| | | | | | |
|---|---|---|---|---|---|
| COD | -500% | BOD | 25% | AOX * | 0% |
| Nitrogen comp. | 200% | Phosph. comp. | -43% | Other emissions * | 80% |

**3. Volume of waste and wastewater (total and hazardous waste)**

| | | | | | |
|---|---|---|---|---|---|
| Waste volume | -60% | Wastewater | 25% | Hazardous waste | 0% |

**4. Energy demand during the application**

| | | | |
|---|---|---|---|
| Electric energy | 25% | Thermal energy | -50% |

Source: own figure from SMART 5 (Excel-file)

## 3.3 Application experiences, recommendations for use and benefits for the companies

SMART 5 was designed to be used in all industries. Therefore, it is universally applicable and can be used without the need for adjustment by different and also possibly new users and industries. The comparability between different results is simple. Politically important keywords (e.g. POP emissions) are present in the instrument, although they will only be of importance for some users.

A disadvantage of this structure is that in many cases it will contain superfluous indicators that do not affect an industry or application. As a result, SMART 5 has been working increasingly with selection menus that facilitate focus within the instrument. The usability of SMART 5 has been improved in several places. Automatic buttons now support the step-by-step documentation and the automatic forwarding of the results to the Federal Environment Agency.

In the prototype of SMART 5, the format and the abundance of the questions initially had a deterrent effect. The revisions made SMART 5 leaner and more user-friendly. For this purpose, selection menus were entered and criteria 2 and 3 were exchanged. The instruction has been improved and recommends a prior screening using the checklist to identify the key indicators for each company. The present version of SMART 5 allows the comfortable documentation of the data, which has been added to the individual sustainability criteria and facilitates its evaluation significantly. The instrument is designed in a clear format. Therefore, it is possible to show additional input options during processing only when necessary. The instrument also provides the possibility to enter data for the estimation of exposure levels for chemicals used.

The first target group for SMART 5 are the practitioners in companies that use Chemical Leasing. One difficulty here is the variety of topics covered by the indicators. This often requires the involvement of different departments or practitioners in large companies for the data entry.

One approach to the solution is to identify the central person, who can answer most of the questions on its own, and specific support for the remaining questions. Especially in larger companies, additional contact persons should be contacted in the company who have data on industrial accidents or economic benefits (for example, obtaining new customers through the use of Chemical Leasing).

At the time of the data collection until mid-2017, there was no concrete incentive for companies to use SMART 5 and transmit the data collected.

In the future, there may be incentives to use SMART 5 in evidence of sustainability compliance. These are, for example:

a) Submission of the application for the Global Chemical Leasing Award using checklist and SMART 5
b) Request for a "Conformity Declaration Certificate" for Chemical Leasing (e.g. through UNIDO) via checklist and SMART 5
c) Review of existing service-based business models with regard for compliance with Chemical Leasing.

## 3.4 Preparation and interpretation of the results

In cases where indicators and therefore also sub-criteria improve or remain the same, a positive assessment of the overall criterion in terms of fulfilling the criterion is easy.

However, there may be Chemical Leasing applications where individual indicators and sub-criteria improve but others show a negative effect. This is indicated by the signal light function of the indicator, for example, for one of the sub-criteria is specified 'increased' instead of 'decreased' or 'equal'. For example, by introducing Chemical Leasing, a company could have reduced its emissions to wastewater, but at the same time the amount of waste could have increased. In the event of such conflicts of interest, a consideration of the goals is necessary, and it has to be considered for the individual case whether the overall balance is still positive. This requires an interpretation by the user or the evaluating institutions, e.g. in the case of the award.

## 3.5 Translation of the materials

The development of the indicators and SMART 5 was originally done in German. However, in the course of the project, the need for an English checklist and SMART 5 version emerged both for the purpose of verifying applicability and for later use at international level. All materials were therefore first revised and finalised in English. The translation into German happened afterwards in order to adopt all changes to the indicators or their preparation and presentation and to avoid duplication of work

# 4 Practical testing of indicators and data collection for existing cooperation agreements

Following the development of SMART 5, the indicators in the form of the checklist and SMART 5 should be tested in practice using existing Chemical Leasing collaborations. These tests provided valuable information on the need for optimisation of indicators and SMART 5, which the project team has gradually incorporated. The data obtained will also be used to quantify the improvements in the various criteria. In addition, they are used afterwards to deduce the potential of the respective industry.

The objective of the review of the sub-criteria and indicators was also to determine whether sector-specific adjustments are necessary. Minor adjustments could be incorporated directly into SMART 5 and the indicator checklist by the project team and there is currently no need to create differentiated versions. This is possible since not all sub-criteria and indicators are relevant for each use case and this can be indicated in the selection menu by "not relevant". The indicators thus cover a wide range of possible parameters that are relevant in the case of Chemical Leasing applications and companies only need to fill in the information they relevant to them.

The following describes the essential steps in testing and data collection:

- Verification of the applicability of sub-criteria and indicators
- Data collection
- Extrapolation to the respective industry

## 4.1 Verification of the applicability of sub-criteria and indicators

In the course of the project work, the project team made several revisions to the sub-criteria, the indicators (including the associated checklist) and the instrument SMART 5. The essential steps were:

- Verification based on exemplary cooperation
- Contributions and discussions at the national working group meeting
- Feedback in the course of data collection
- Final revisions at the end of the project

The single steps of the changes are documented in interim or progress reports on the project. The text box at the end of the chapter summarises all major changes and revisions to the indicators and SMART 5. In the following, the revision steps are briefly described separately.

**Verification based on exemplary cooperations**

The first step of the verification concerned the indicator checklist, which provides an overview of the five sustainability criteria for Chemical Leasing, as well as all sub-criteria and indicators. It serves to give company representatives and other stakeholders a quick overview of the requirements and to carry out a first qualitative verification of the indicators in terms of a screening. For each indicator, this screening may indicate the trend of the development of the individual indicators according to the principle of a signal lamp: positive developments are marked green, consistent results are neutrally coloured and parameters with a negative trend are marked in red.

All changes that have already occurred during the verification of the checklist have been transferred to the SMART 5 tool by the project team. Subsequently, SMART 5 was specifically verified for its practicability. Essential aspects of the verification were e.g. a logical structure and a simple understanding of the instrument, an easy applicability for the user and a clear output of the results.

Two well-quantified collaborations formed the basis for the verification of the practicality of the checklist and SMART 5, which both contain the sub-criteria and indicators. The project team used the following two case studies:

- Pero and SAFECHEM, cleaning of metal parts, German-Austrian cooperation
- Henkel and Bambi, bonding of packaging in Serbia

For the two listed projects, previous projects on the subject of Chemical Leasing already provide a well-founded data basis, so that an initial testing of the checklist and tool could be designed efficiently. The project team attempted to close data gaps identified during the testing of the checklist and SMART 5 by requesting additional information from the companies or employees of the National Cleaner Production Centres in Serbia. As the experience from similar projects shows, however, no further quantitative data could be collected due to the retrospective analysis. Some additional qualitative information could be reported, e.g. about the constant amount of workplaces in the application. The remaining tests on the tool were made by the project team with assumptions to check the functionality.

**Discussion of the practicality in the national working group**

On 26 October 2016, the 5th meeting of the national working group Chemical Leasing took place in Berlin. A central subject of the event was the presentation of the research project described here with its sub-criteria and indicators. After the presentation of the sub-criteria and the indicators by the contractor, the twelve participants discussed the completeness and the applicability of the indicators and agreed upon several changes. The project team has incorporated the adopted changes after the event.

The participants continued to exchange on the benefits and opportunities of the factsheets at the end of SMART 5. The need for such a factsheet was a key result of the discussions, as key information on the five sustainability criteria from the single index pages of SMART 5 shall be summarised in an overview. Evaluating the sustainability of a Chemical Leasing project is therefore easier and can be done on the basis of an overview.

**Revision the course of data collection**

In the course of the project, the team collected data on existing Chemical Leasing cooperation using the checklist and SMART 5 (see chapter 4.2). During the data collection, further enhancements to SMART 5 have been identified and guidance for customisation has been provided by company representatives. These enhancements were incorporated by the project team, if necessary after consultation with the UBA, into the checklist and SMART 5 until the end of the project. The project team then tested the changes to the remaining case studies.

**Final revisions at the end of the project**

Based on the suggestions for optimising SMART 5, all intermediate results and the discussion results of the project team with the client, final adjustments to SMART 5 were incorporated at the end of the project period. These include the automatic combination of results described in chapter 3 as well as the change of the structure of criteria 2 and 3, where the order had to be changed due to the otherwise necessary duplications of the indicators. Thus, the sub-criteria and indicators could be made leaner. Furthermore, SMART 5 as well as the checklist are also designed as German versions.

The following text box summarises all the major revisions to the sub-criteria and indicators in the checklist and SMART 5.

**Summary of adjustments to the indicators checklist and SMART 5 based on the practical testing**

Users without knowledge of the checklist and SMART 5 need an explanation for the use of the instruments and a recommendation on how to use them. The project team outlined an introductory text to the checklist with an instruction on how to proceed and adapted it after consultation with UBA. SMART 5 also includes a short introduction and guide to assist users in completing the tool. The texts aim to ensure that the instruments can be understood without explanation by e.g. the contractor. In addition, a

short description has been elaborated that will be available on the website together with the two instruments.

Some indicators of the first sustainability criterion (reduction of adverse impacts) were specified by the project team on the basis of the discussion in the national working group. Wastewater was added as a separate indicator and resource needs were divided into the categories chemicals, water and other resources (e.g. during the recycling). For a better understanding and to highlight important representatives, some examples and explanations supplement the indicators (for example, the reference to mercury in the indicator heavy metals).

The original criteria 2 (handling and storage) and 3 (substitution) were swapped in their order in the checklist and in SMART 5, since duplication in the query of the indicators can thus be avoided.

The sub-criteria and indicators of the criteria substitution, handling and storage were adjusted with regard to different aspects. Thus, it is first requested whether a substitution takes place. If yes, more indicators are following. If not, it can be continued with criterion 3 (handling and storage). The material characteristics of the substitute and the associated risks are requested. Furthermore, users of the checklist and SMART 5 should assess the changed overall risk through the substitution. In terms of handling and storage, the available information base is requested first; i.e. safety data sheets should be available for hazardous substances and the information should be used. This is followed by the indicators on industrial accidents, exposure and risks.

The exposure indicators have been changed significantly by the project team based on the comments of the various actors involved. The type and amount of the exposure as well as the exposure time are requested. Furthermore, measures can be described that have led to changes in these areas (e.g. installation of technical equipment, better use of protective equipment).

The indicators on accident risks have been changed. Qualitative indicators ask about the changes in the risk as well as a description of the measures. In the international area the question is kept general and the reference to the German TRGS[12] has been removed.

The changes in criterion 4 (economic and social benefits) mainly refer to the indicator business opportunities, which uses a yes/no query to request the various effects of Chemical Leasing collaborations. An explanatory description can be added to the answer.

The project team added an indicator for criterion 5, to monitor improvements. In addition to asking whether monitoring of the individual indicators takes place, it is requested whether an improved monitoring process has been established. The fulfilment of these sub-criteria must be considered in a differentiated way. Together with the Federal Environment Agency, a percentage breakdown for monitoring has been developed.

Furthermore, minor improvements that are not detailed here, have been made. Examples are details regarding the description of the change of some indicators or improvements or uniform wording. Also, the implementation of query in SMART 5 have been improved in terms of wording, selection menus and examples and the colour codes in the selection menus have been adjusted.

12 Technical Rule for Hazardous Substances

The revisions in SMART 5 for usability enhancements are already covered in chapter 1. They include drop-down menus, options for inserting additional fields for additional substances as well as tips on the individual worksheets. The feedback from the working group participants showed that the selection menus should include the options “not applicable” and “no data” in order to indicate on the one hand that the certain emissions do not play a role in application and on the other hand, these data gaps can be shown. Significant for the benefits of SMART 5 for business and governments is the development of an automated factsheet at the end of SMART 5. All existing information are summarised automatically in one sheet (see chapter 3).

In general, care is taken that the file is saved empty, that means without entered data and with the first worksheet as the start page in order to guarantee the user the start on the first page when opening SMART 5.

## 4.2 Data collection for Chemical Leasing cooperations

After the sub-criteria and indicators as well as the checklist have been verified and adjusted where necessary by the first two examples, the project team has collected data for various Chemical Leasing cooperation and systematically reviewed the criteria, sub-criteria and the indicators for them in order to evaluate the benefits of Chemical Leasing. The following chapters describe the approach and the results of the data collection.

### 4.2.1 Approach for data collection and received feedback

The data collection should demonstrate the concrete benefits of Chemical Leasing in various industries for the developed indicators. After quantifying the benefits, the data should be used to extrapolate the results to the respective industry (see Chapter 4.3).

**Approach**

To collect data for the different Chemical Leasing applications using the indicators, the project team used the existing contacts with companies and National Cleaner Production Centers (NCPCs). The project team was also in contact with different companies to identify new possible collaborations, to generate case studies and to attain them for the data collection. The project team negotiated with various companies regarding the introduction of Chemical Leasing and was in constant contact with the UBA to inform them about the current status.

The companies or NCPSs which have been involved in Chemical Leasing projects have been approached by phone, in person or by email in a first step. They have been informed about the project and the project team has requested assistance in collecting the data. The contact persons were given the checklist and SMART 5 (either together or in succession) and the procedure was explained. For the missing answers, the project team again reminded and encouraged the contact persons by phone or mail to support the project with hints for suitability for daily use and data on their cooperation. The benefits for companies and the relevance for the further development and the retransmission of Chemical Leasing were emphasised. It was pointed out that SMART 5 also supports the application for the Global Chemical Leasing Award by providing a meaningful evidence of sustainability compliance and by allowing companies to easily and quickly quantify and check the benefits of their Chemical Leasing project. The project team also offered to extract a list of the needed data from the tool or to transfer the data the information in SMART 5 based on existing documents for the companies. In according to requirements, the project team has explained the indicators and the use of SMART 5 in detail via Skype.

### Overview of the feedback

Between July 2016 and November 2017, the project team has contacted a large number of individuals on Chemical Leasing and the provision of data. Specifically, 53 representatives of companies or NCPCs were contacted in person, by phone or email, which were selected primarily on the basis of an application to the Global Chemical Leasing Award.

The table in Annex 1 (not public) gives an overview of the essential contact persons for the data collection and the results for the exchange with the project team.

### Summary of concrete feedback

Overall, the response from the contacted representatives is hesitant. It should be noted that the received feedback for easy recording was initially very positive for the indicators and the SMART 5 tool. It has been confirmed that the specification of the sustainability criteria is desirable and helpful and that an instrument supports for example the application for the award or, more generally the understanding of the impact of Chemical Leasing on different sectors. Both provide clarity about the sustainability criteria and their significance.

Various contact persons provided helpful feedback regarding the set-up and the structure of the indicators or their clarification, which was implemented by the project team in checklist and SMART 5. It was also confirmed that SMART 5 is basically easy to use, logical and uncomplicated in its navigation.

However, only two responses have been received from contact persons who have specifically collected data and returned the obtained data to the project team. Another four data sets were generated by the project team, based on existing information; for this purpose, the project team used well-quantified data sets from various applications. In order to fill data gaps in these examples, the project team has asked the contact persons, e.g. asked the NCPC Serbia for further information. Due to the retrospective view, only a few qualitative new information could be provided by the contact persons.

The difficulties in collecting data can be summarised on the basis of the experiences and the feedback of different contact persons in the following aspects:

*Current additional value for the companies*

Despite the initially expressed interest from various companies, these could not be obtained for a case study because the associated expenses for the companies were not matched by any specific benefit at the time. A possible application for the Global Chemical Leasing Award supported by the tools provides an incentive, for example, for the Cleaner Production Centers in Uganda and Sri Lanka, as well as for Magna. It is thus expected that further applications of SMART 5 will be generated in the future.

*Complexity of the tool*

Two feedbacks from Sri Lanka showed that the tool can provide an overview of other indicators that can be considered in the future. Nevertheless, it is very extensive and represents a cost factor for companies to measure the data. The cost factor results either from the necessary time and personnel expenditure or, as in the case of the agricultural sector, from the fact that external companies have to be commissioned for the measurement.

The indicators were described by some company representatives as extensive and universally applicable, so that the checklist and SMART 5 can be applied in different industries. At the same time, this leads to it losing relevance. It therefore often requires a specific contact person and a detailed introduction. Screening through the checklist has been useful to focus on the key sub-criteria and indicators in SMART 5.

**Derived recommendations for using checklist and SMART 5**

When using the indicator checklist and SMART 5, it must be clearly communicated that not all indicators are relevant for each application and that the instrument does not claim to be complete. Considering the abundance of potential improvements through Chemical Leasing, this also prevents users from having the impression that their application generates less benefit than others.

In general, the instrument seems complex and loses this appearance only after detailed introduction or consideration. However, this barrier has to be overcome. The screening by means of the checklist provides first support. An improved introduction and usage guide as well as a short description has been created by the project team and is included in the final version of the checklist and SMART 5.

### 4.2.2 Results of the individual data collections

The following sections describe the data results from the data collection. The data is presented according to the data collection procedure with SMART 5.

Each case study is presented in two tables: a) an overview table describing the Chemical Leasing application based on the "project description" table in SMART 5 and b) a table with the collected data for the five sustainability criteria. The main achievements of the application are briefly highlighted in the beginning.

It was planned to gain more data sets, preferably from the automotive industry. This results from the project team's activities with the European automobile association ACEA and the meeting in September 2017. Further information on the meeting and the content can be found in chapter 7. The project team is currently in exchange with various companies. Until the time of the report generation, no further concrete data sets or information could be obtained. The project team will continue to submit all future developments and results to the Federal Environment Agency. Amongst others, it should be examined what similarities exist between already established, service-based business models in the automotive industry with Chemical Leasing.

#### 4.2.2.1 Cleaning of metal parts, example 1

The companies Pero and SAFECHEM cooperate in the industrial cleaning of metal parts. The main results of the companies' Chemical Leasing cooperation are the 90% reduction of solvent emissions of perchloroethylene (PER) and the 87% reduction in activated carbon used as filter material. Thus, waste and resource requirements decrease significantly.

Table 12 describes the application and Table 13 presents the results of the data collection.

Table 12: Project description from SMART 5 for metal cleaning at Pero and SAFECHEM

| **Project description** | |
|---|---|
| **Description of the project or process** | |
| Industry or sector: | Automotive |
| Process: | Cleaning of metal parts |
| Initial situation: | Cleaning of metal parts with PER without Chemical Leasing |
| Aim: | To provide a latest state-of-the-art technology cleaning machine with high performing components to maximize the reduction of emissions and energy consumption. PERO is also providing the know-how to run the equipment in an optimum way. |
| Unit of payment: | Number of parts cleaned |
| **Company names** | |
| Name of supplier: | SAFECHEM |

| | |
|---|---|
| Name of user: | Pero Innovative Services |
| Other partners involved: | Automobiltechnik Blau |
| **Scope of the study** | |
| Monitoring intervals or time of data gathering: | Before and after ChL |
| Description of the application: | Reduction of PER use through improvement of technology and new business model, focus on chemicals and emissions reduction, no substitution |
| Further comments: | None |

Table 13: Results of the data collection for the five sustainability criteria in the application Pero and SAFECHEM

| **Sustainability criteria and results of their indicators** | |
|---|---|
| **Criterion: Reduction of adverse impacts** | |
| Pollutants emitted into the air | From 10 to 1 (kg/100 kg removed oil) for other emissions into the air; i.e. PER **(-90%)** |
| Pollutants emitted in wastewater | not applicable as no water is used in the process |
| Volume of waste and wastewater | From 700 to 90 kg active carbon waste **(-87%)**<br>From 9,958 to 9,958 kg used oil **(0%)**<br>From 5 to 3 kg (kg/100kg removed oil) PER **(-40%)** |
| Energy demand during the application | from 367,333 to 198,700 kWh **(-46%)** (In application) |
| Energy demand (indirect) in the supply chain | from 94,415 to 22,494 MJ **(-76%)** (Indirect through PER reduction) |
| Greenhouse gas emissions during the application | indirect reduction of 76% due to energy savings in the application |
| Resource demand during the application | From 2,956 kg to 704 kg PER **(-76%)**<br>From 30 to 7.8 l stabilizers **(-74%)**<br>From 700 to 90 kg activated carbon **(-87%)** |
| **Criterion: Avoidance of higher risks** | |
| Substitution of the chemical | No substitution of chemicals occurred (continue with criterion 3) |
| Material characteristics of substitutes | Not applicable, as no substitution occurred |
| Overall risks[13] | Not applicable, as no substitution occurred |
| **Criterion: Improved handling and storage** | |
| Available information base | Safety data sheet available, no information on active use |
| Number and extend of accidents at work | No change as there are no accidents associated to the cleaning process. |
| Exposure of workers | Use of PER (CAS 127-18-4) (H351, R40 H-phrases). No change. |

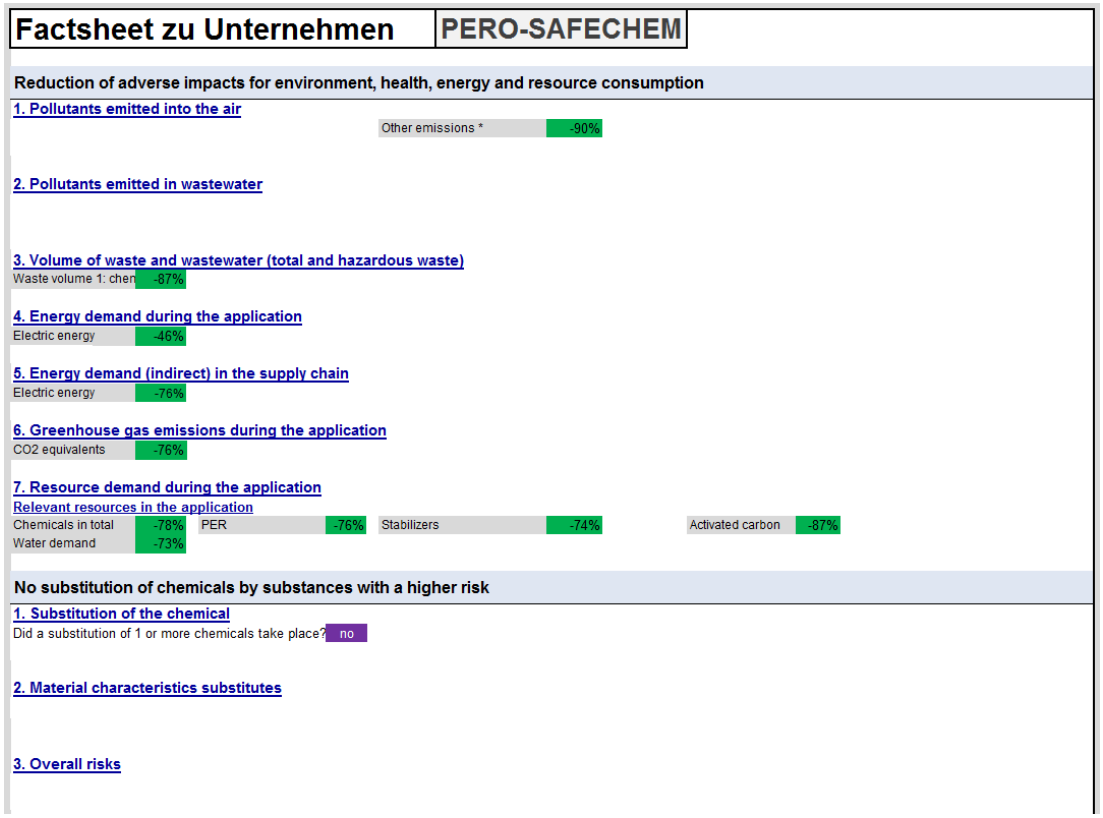
[13] Risk change related to substitution; the request to change the risk by introducing ChL was part of criterion 2

| | |
|---|---|
| Risk of accidents resulting from the application of chemicals | Change of risk: **Decreased**<br>Reasons: Decrease of amount of chemical. |
| Risk of accidents resulting from the storage of chemicals | No data |
| **Criterion: Economic and social benefits** | |
| Costs for the user | From 90,133 to 43,256 €/year **(-52%)** (Total cost savings that are shared among the partners) |
| Economic performance of the supplier | See above |
| Business opportunities | Stable and long-term business relation established |
| Qualification of employees | No data |
| Creation of new jobs | No data |
| **Criterion: Monitoring of the improvements** | |
| Measurement of the indicators for the criteria 1 - 4[14] | Criterion 1: 100% monitored<br>Criterion 2: 80% monitored<br>Criterion 3: not applicable<br>Criterion 4: 60% monitored<br>No information on improvements of monitoring process |

Data entry in SMART 5 generates a factsheet for the case study that contains all relevant information similar to the list in the table. The factsheet is shown in Figure 12. For the other examples, the respective factsheets are present in the SMART 5 files and are not displayed again because of the information already contained in the tables. The SMART 5 files were sent separately to the Federal Environmental Agency.

[14] For each criterion, it is recorded as a percentage how many of the sub-criteria are measured. It is assumed that sub-criteria that are not relevant are fulfilled and thus measured. Existing data gaps on the sub-criteria and indicators are considered not measured when the indicator is relevant. The percentage of monitoring results from the number of sub-criteria (criterion 1: 7 out of 7 measured: 100%; criterion 2: not applicable, because not substituted; criterion 3: 4 out of 5 measured: 80%, criterion 4: 3 out of 5 measured: 60%).

Figure 12: Factsheet of data collection from SMART 5 for the case study cleaning of metal parts of Pero and SAFECHEM



**Factsheet zu Unternehmen** | **PERO-SAFECHEM**

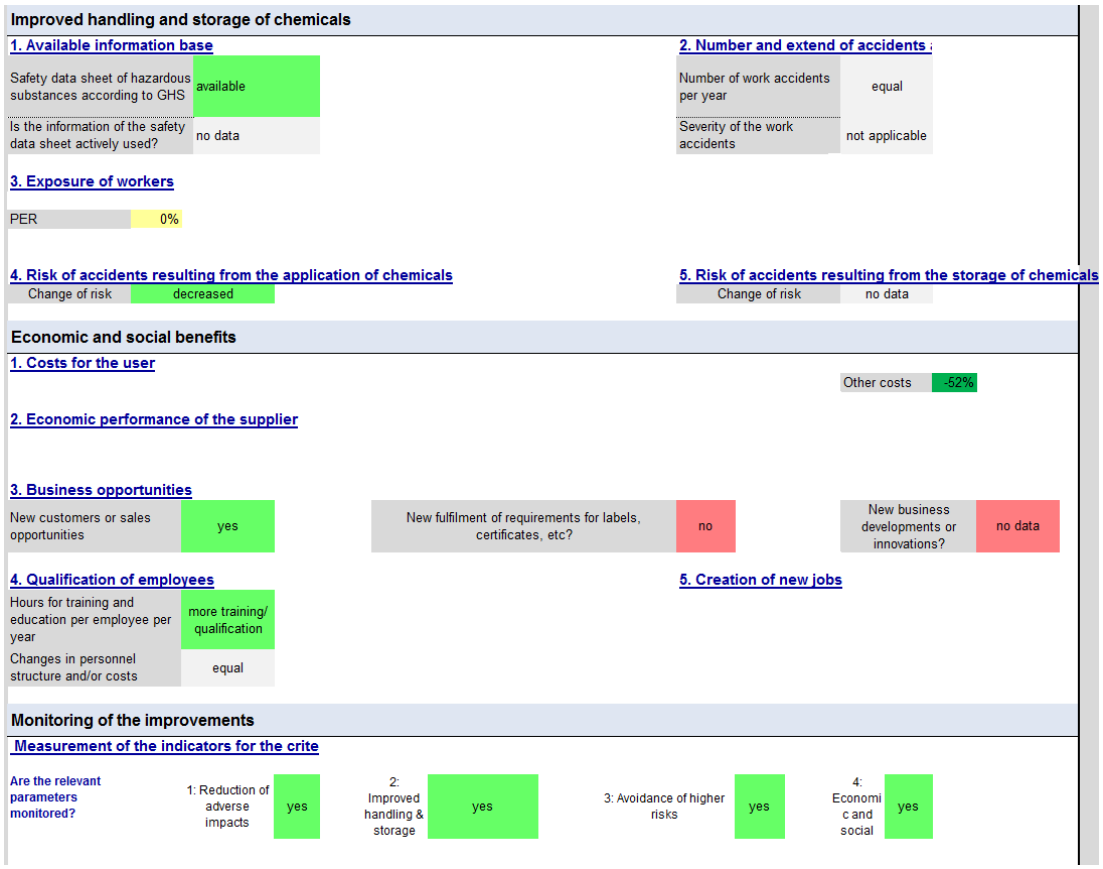
**Reduction of adverse impacts for environment, health, energy and resource consumption**

1. Pollutants emitted into the air
   - Other emissions * -90%
2. Pollutants emitted in wastewater
3. Volume of waste and wastewater (total and hazardous waste)
   - Waste volume 1: chen -87%
4. Energy demand during the application
   - Electric energy -46%
5. Energy demand (indirect) in the supply chain
   - Electric energy -76%
6. Greenhouse gas emissions during the application
   - CO2 equivalents -76%
7. Resource demand during the application

   Relevant resources in the application
   - Chemicals in total -78%
   - PER -76%
   - Stabilizers -74%
   - Activated carbon -87%
   - Water demand -73%

**No substitution of chemicals by substances with a higher risk**

1. Substitution of the chemical
   - Did a substitution of 1 or more chemicals take place? no
2. Material characteristics substitutes
3. Overall risks



**Improved handling and storage of chemicals**

1. Available information base
   - Safety data sheet of hazardous substances according to GHS: available
   - Is the information of the safety data sheet actively used?: no data
2. Number and extend of accidents
   - Number of work accidents per year: equal
   - Severity of the work accidents: not applicable
3. Exposure of workers
   - PER 0%
4. Risk of accidents resulting from the application of chemicals
   - Change of risk: decreased
5. Risk of accidents resulting from the storage of chemicals
   - Change of risk: no data

**Economic and social benefits**

1. Costs for the user
   - Other costs -52%
2. Economic performance of the supplier
3. Business opportunities
   - New customers or sales opportunities: yes
   - New fulfilment of requirements for labels, certificates, etc?: no
   - New business developments or innovations?: no data
4. Qualification of employees
   - Hours for training and education per employee per year: more training/ qualification
   - Changes in personnel structure and/or costs: equal
5. Creation of new jobs

**Monitoring of the improvements**

Measurement of the indicators for the crite

Are the relevant parameters monitored?
- 1: Reduction of adverse impacts: yes
- 2: Improved handling & storage: yes
- 3: Avoidance of higher risks: yes
- 4: Economic and social: yes

Source: own figure from SMART 5 (Excel-file)

#### 4.2.2.2 Cleaning of metal parts, example 2

In this case study, Chemical Leasing was introduced between the company SAFECHEM and a client in the UK in conjunction with a substitution and the introduction of new technology for the cleaning of metal parts. A concrete recording of the indicators does not take place in the application, so that only some parameters are available. Table 14 describes the application and Table 15 presents the existing results of the data collection.

Table 14: Project description from SMART 5 for metal cleaning at a SAFECHEM customer in the UK

| **Project description** | |
|---|---|
| **Description of the project or process** | |
| Industry or sector: | Aeronautic industry |
| Process: | Cleaning of metal parts |
| Initial situation: | Use of trichloroethylene (TRI) solvent for cleaning |
| Aim: | Change to COMPLEASE™ Chemical Leasing and investing in a new machine. Substitution from TRI to PER |
| Unit of payment: | Monthly service fee |
| **Company names** | |
| Name of supplier: | SAFECHEM |
| Name of user: | supplier of aeronautic industry |
| Other partners involved: | none |
| **Scope of the study** | |
| Monitoring intervals or time of data gathering: | ChL was implemented in 2012 with no “before/after” comparison. No changes have been made to the process since the introduction of ChL. |
| Description of the application: | The customer manufactures metal parts for the aeronautic industry that need to be cleaned with solvents. |
| Further comments: | none |

Table 15: Results of the data collection for the five sustainability criteria in the application at SAFECHEM and a customer in the UK

| **Sustainability criteria and results of their indicators** | |
|---|---|
| **Criterion: Reduction of adverse impacts** | |
| Pollutants emitted into the air | Emission to air of volatile organic compounds **decreased**. No numerical values known. |
| Pollutants emitted in wastewater | No water is applied in the closed loop solvent process |
| Volume of waste and wastewater | The waste volumes **reduced** due to the machine change and remain about equals since then.<br>The waste is mainly composed of oil and changes with the level of activities of the company. |
| Energy demand during the application | no data |
| Energy demand (indirect) in the supply chain | no data |
| Greenhouse gas emissions during the application | No direct emissions during cleaning |

| | |
|---|---|
| Resource demand during the application | Resource demand decreased, but no clear distinction can be made between the effects of the technology change and ChL. No numerical values are known. |
| **Criterion: Avoidance of higher risks** | |
| Substitution of the chemical | Substitution from TRI to PER<br>Associated hazards for environment and health decreased |
| Material characteristics of substitutes | data according to SDS available but not provided<br>PER is less hazardous than TRI |
| Overall risks[15] | Reduced due to the reduced hazards and the handling in the SAFE-TAINER™ System |
| **Criterion: Improved handling and storage** | |
| Available information base | Safety data sheet of hazardous substances are available. It is partly used actively |
| Number and extend of accidents at work | Equal;<br>No accidents occurred before and after ChL related to cleaning activities |
| Exposure of workers | **Decreased**<br>Type of exposure: inhalative<br>Reason: both the duration and the level of exposure decreased due to the machine changes; no quantification available |
| Risk of accidents resulting from the application of chemicals | **Decreased**<br>Reason: the solvent was changed from TRI to PER |
| Risk of accidents resulting from the storage of chemicals | **Decreased**<br>Reason: the SAFE-TAINER™ System provided by SAFECHEM and more regular training to safety with solvent |
| **Criterion: Economic and social benefits** | |
| Costs for the user | Not quantified, the payment is done on a monthly basis for average cleaning activities and adapted as needed but no comparison to the costs before ChL was done |
| Economic performance of the supplier | Not applicable, SAFECHEM was already the supplier before the introduction of ChL |
| Business opportunities | no data |
| Qualification of employees | **More training/qualification**<br>Reason: SAFECHEM provides more regular training to safety with solvent |
| Creation of new jobs | No change |
| **Criterion: Monitoring of the improvements** | |

15 Risk change related to substitution; the request to change the risk by introducing ChL was part of Criterion 2

| | |
|---|---|
| Measurement of the indicators for the criteria 1 - 4[16] | Criterion 1: 50% monitored<br>Criterion 2: 100% monitored<br>Criterion 3: 50% monitored<br>Criterion 4: 50% monitored<br>Due to the low emissions of the new machine the monitoring frequency reduced |

#### 4.2.2.3 Bonding of packaging

Henkel is supplying the confectionery manufacturer Bambi with glue for bonding of their packaging. The key improvements achieved by the switch to Chemical Leasing are for criterion 1, where chemicals and waste have decreased by 30%, energy demand by 53% and indirect greenhouse gas emissions by 34%.

Table 16 describes the application and Table 17 presents the results of the data collection.

Table 16: Project description from SMART 5 for bonding packaging at Bambi together with Henkel

| **Project description** | |
|---|---|
| **Description of the project or process** | |
| Industry or sector: | Food industry |
| Process: | Bonding of packing cardboard (boxes) |
| Initial situation: | Glue based on polyvinyl acetate |
| Aim: | To substitute polyvinyl acetate and improve the technology |
| Unit of payment: | Number of boxes |
| **Company names** | |
| Name of supplier: | Henkel AG & Co. KGaA |
| Name of user: | Bambi a.d. |
| Other partners involved: | Cleaner Production Center Serbia |
| **Scope of the study** | |
| Monitoring intervals or time of data gathering: | Before and after ChL |
| Description of the application: | Polyvinyl acetate based glue was substituted by hydrocarbon resins based glue |
| Further comments: | none |

[16] For each criterion, it is recorded as a percentage how many of the sub-criteria are measured. It is assumed that sub-criteria that are not relevant are fulfilled and thus measured. Existing data gaps on the sub-criteria and indicators are considered not measured when the indicator is relevant. The percentage of monitoring results from the number of sub-criteria.

Table 17: Results of the data collection for the five sustainability criteria in the application at Bambi and Henkel

| Sustainability criteria and results of their indicators | |
|---|---|
| **Criterion: Reduction of adverse impacts** | |
| Pollutants emitted into the air | Fumes from adhesives, not quantified |
| Pollutants emitted in wastewater | No water involved in the process |
| Volume of waste and wastewater | From 14,000 to 9,800 kg adhesive waste at the end of life of packaging **(-30%)** |
| Energy demand during the application | Electric energy demand: from 15,163 to 7,127 kWh **(-53%)** |
| Energy demand (indirect) in the supply chain | not quantified |
| Greenhouse gas emissions during the application | From 67,201 to 44,465 kg/ $CO_2$ equivalents **(-34%)** (indirect reduction in the supply chain, no direct emissions occur) |
| Resource demand during the application | From 14,000 kg to 9,800 kg of chemicals (adhesive) **(-30%)** (kg/year for all packing cardboard) |
| **Criterion: Avoidance of higher risks** | |
| Substitution of the chemical | Substitution of chemicals occurred. Polyvinyl acetate based glue was substituted by hydrocarbon resins based glue to improve energy and resource efficiency (e.g. lower temperature), both mixtures are not classified |
| Material characteristics of substitutes | Safety Data Sheet of the substitute available. Substance or mixtures used as substitutes: hydrocarbon resins based glue, not classified according to GHS. Risks for environment and health not applicable (not classified). |
| Overall risks[17] | Altered risk due to the substitution: **Decreased**<br>Reason: automatic dosing, reduced temperatures and pressures |
| **Criterion: Improved handling and storage** | |
| Available information base | The adhesives are not hazardous, thus no safety data sheet is required. An SDS is available for the substitute (see criterion 3) |
| Number and extend of accidents at work | no data |
| Exposure of workers | Inhalative, level not quantified, workplace exposure limit: 2 to 6 mg/m$^3$ (long and short term, respectively) |
| Risk of accidents resulting from the application of chemicals | Change of risk: **Decreased**<br>Reasons: Substitute requires lower temperatures and pressures and is automatically dosed, resulting in reduced risk from burning |
| Risk of accidents resulting from the storage of chemicals | No change and no recorded accidents related to storage |
| **Criterion: Economic and social benefits** | |

[17] Risk change related to substitution; the request to change the risk by introducing ChL was part of Criterion 2

| | |
|---|---|
| Costs for the user | Costs for chemicals from 48.300 to 42.238 €/year **(-13%)**<br>Costs for maintenance from 11.923 to 4.754 €/year **(-60%)**<br>Costs for energy demand from 6.551 to 3.079 €/year **(-53%)**<br>Other costs from 1360 to 380 €/year **(-72%)** |
| Economic performance of the supplier | benefits due to lower adhesive consumption and usage of more valuable adhesive |
| Business opportunities | sole adhesive supplier to the company |
| Qualification of employees | No data |
| Creation of new jobs | No change |
| **Criterion: Monitoring of the improvements** | |
| Measurement of the indicators for the criteria 1 - 4[18] | Criterion 1: 71% monitored<br>Criterion 2: 60% monitored<br>Criterion 3: 75% monitored<br>Criterion 4: 80% monitored<br>No information on improvements of monitoring process |

#### 4.2.2.4 Pesticide application in agriculture

In the examined application in the agricultural sector in Sri Lanka, the use of pesticides in potato cultivation with Chemical Leasing is improved. The major improvements concern the resource requirements. Furthermore, training for employees has been introduced and working conditions have improved in terms of reduced risk.

However, as in the case described, the reduction in the quantities of chemicals can also be accompanied by a reduction in the number of jobs required. Such effects are not known from industrial applications and Chemical Leasing often improves employee qualification. The latter is also the case in potato cultivation in Sri Lanka, although jobs were lost.

Table 18 describes the application and Table 19 presents the results of the data collection.

Table 18: Project description from SMART 5 for the application of Chemical Leasing in the agricultural sector in Sri Lanka

| **Project description** | |
|---|---|
| **Description of the project or process** | |
| Industry or sector: | Agriculture Sector, potato cultivation |
| Process: | Application of agrochemicals |
| Initial situation: | Use more than recommended level |
| Aim: | To reduce agrochemicals usage |
| Unit of payment: | Based on yield |
| **Company names** | |
| Name of supplier: | Kandurata Agro Advisory Services |
| Name of user: | Farmer |

[18] For each criterion, it is recorded as a percentage how many of the sub-criteria are measured. It is assumed that sub-criteria that are not relevant are fulfilled and thus measured. Existing data gaps on the sub-criteria and indicators are considered not measured when the indicator is relevant. The percentage of monitoring results from the number of sub-criteria.

| | |
|---|---|
| Other partners involved: | National Cleaner Production Centre Sri Lanka |
| **Scope of the study** | |
| Monitoring intervals or time of data gathering: | During the cultivation period (5months) |
| Description of the application: | see process description above, application of agrochemicals |
| Further comments: | None |

Table 19: Results of the data collection for the five sustainability criteria in the agricultural sector application in Sri Lanka

| **Sustainability criteria and results of their indicators** | |
|---|---|
| **Criterion: Reduction of adverse impacts** | |
| Pollutants emitted into the air | not measured |
| Pollutants emitted in wastewater | not measured |
| Volume of waste and wastewater | From 12 to 4 kg hazardous waste **(-67%)**, assuming that all agrochemicals container waste is hazardous waste |
| Energy demand during the application | not measured |
| Energy demand (indirect) in the supply chain | no data |
| Greenhouse gas emissions during the application | no direct emissions during spraying of pesticides |
| Resource demand during the application | Different agrochemicals per 1 ha:<br>From 25.25 kg to 16.65 kg **(-34%)**<br>From 19 to 8.6 l **(-55%)**<br>From 250 to 150 g/ha of pesticide **(-40%)** |
| **Criterion: Avoidance of higher risks** | |
| Substitution of the chemical | No substitution took place |
| Material characteristics of substitutes | Not applicable, as no substitution occurred |
| Overall risks[19] | Not applicable, as no substitution occurred |
| **Criterion: Improved handling and storage** | |
| Available information base | no data |
| Number and extend of accidents at work | no data |
| Exposure of workers | Dermal,<br>Appropriate personal protective equipment was provided |

[19] Risk change related to substitution; the request to change the risk by introducing ChL was part of Criterion 2

| | |
|---|---|
| | Also, proper machine cleaning procedure (not using river water) was introduced |
| Risk of accidents resulting from the application of chemicals | no change |
| Risk of accidents resulting from the storage of chemicals | Change of risk: **Decreased**<br>Reason: Use of uncovered chemicals containers has caused several injuries. Therefore, a cover for chemical storing container was introduced and appropriate personal protective equipment was provided. |
| **Criterion: Economic and social benefits** | |
| Costs for the user | From 226 to 173 $ **(-31%)** (Sri Lanka Rupies: 33000 to 25200) |
| Economic performance of the supplier | Improved long-term business relations with the customer |
| Business opportunities | Since the introduction of ChL, 6 new customers were found.<br>The yield Increased by 12%.<br>Improved sharing of information between the partners. |
| Qualification of employees | Before no training and education took place, after the introduction of ChL, **20 hours (3 days) training** on safe chemicals handling were conducted for the employees<br>No cost for the user occurred for this because the supplier provided the training free of charge. |
| Creation of new jobs | From 3 to 1 **(-67%)**[20] |
| **Criterion: Monitoring of the improvements** | |
| Measurement of the indicators for the criteria 1 - 4[21] | Criterion 1: 43% monitored<br>Criterion 2: 60% monitored<br>Criterion 3: not applicable<br>Criterion 4: 100% monitored<br>In the traditional model, no parameters were monitored because the farmer applied the agrochemicals based on his experience. In the ChL model a proper monitoring system was established. |

#### 4.2.2.5 Cleaning at the hotel

In Rio de Janeiro, Brazil, Chemical Leasing is used to clean rooms, laundry and dishes at the hotel. Table 20 describes the application and Table 21 presents the results of the data collection. The biggest enhancements due to the service-based business model were caused by the resource requirements: It was possible to save 80% of the chemicals compared to another hotel. There is no direct comparison scenario for the Chemical Leasing case study as the hotel has been using Chemical Leasing since its opening. Therefore, another hotel was used for the comparison.

20 Due to the reduced amount of chemicals being sprayed on the fields, fewer jobs (sprayers) are required.

21 For each criterion, it is recorded as a percentage how many of the sub-criteria are measured. It is assumed that sub-criteria that are not relevant are fulfilled and thus measured. Existing data gaps on the sub-criteria and indicators are considered not measured when the indicator is relevant. The percentage of monitoring results from the number of sub-criteria.

Table 20: Project description from SMART 5 for cleaning at Hotel Windsor together with Ecolab

| **Project description** | |
|---|---|
| **Description of the project or process** | |
| Industry or sector: | Hotel industry |
| Process: | Cleaning of rooms, laundry and dish washing |
| Initial situation: | Since the opening of the hotel it is cleaned under the ChL business model, for comparison to a previous scenario data from another hotels is used |
| Aim: | To improve the Sustainable Management System and reduce the consumption of water, energy, chemicals, waste and pollutant releases |
| Unit of payment: | Number of occupied rooms |
| **Company names** | |
| Name of supplier: | Ecolab Inc. |
| Name of user: | Windsor Atlantica Hotel |
| Other partners involved: | CTS Ambiental/UNIDO22 – technical support to develop an evaluation of benefits and analysis about Chemical Leasing compared to conventional purchase of chemicals in lodges |
| **Scope of the study** | |
| Monitoring intervals or time of data gathering: | After the implementation of ChL, the starting point is represented by another hotel since no conventional business model has been implemented in the hotel |
| Description of the application: | The service is paid per occupied room.<br>Chemicals account for ca. 8 % of the total costs of the hotel.<br>ChL including training, chemicals storage control, dosage devices without human interventions and contact with workers skin |
| Further comments: | ChL application running since 2010 |

Table 21: Results of data collection for the five sustainability criteria in the application at Windsor and Ecolab

| **Sustainability criteria and results of their indicators** | |
|---|---|
| **Criterion: Reduction of adverse impacts** | |
| Pollutants emitted into the air | no air emissions occur from the chemicals |
| Pollutants emitted in wastewater | The demand for chemicals is reduced; therefore, fewer chemicals are emitted into the wastewater (not quantified). |
| Volume of waste and wastewater | Ecolab aims at reducing the packaging waste. The amount of wastewater is reduced because the detergents provided by Ecolab require less water |
| Energy demand during the application | no data |
| Energy demand (indirect) in the supply chain | no data |

[22] National Cleaner Production Centre of Brazil der United Nations Industrial Development Organization

| | |
|---|---|
| Greenhouse gas emissions during the application | no direct emissions during cleaning process |
| Resource demand during the application | From 1.348 to 0.276 l of chemicals **(-80%)**<br>unit is l per room per day<br>Leakage and spills were reduced due to automatic filling into spray bottles. Water and chemicals are automatically mixed in a device which improves the dosing and saves resources. |
| **Criterion: Avoidance of higher risks** | |
| Substitution of the chemical | Substitution of chemicals did not occur<br>Since its opening the hotel used the Chemical Leasing business model. Therefore, no other chemicals were used before the introduction of ChL. However, compared to other supplier's chemicals, those from Ecolab are considered less toxic and require less water and energy in the appliances. |
| Material characteristics of substitutes | Not applicable, as no substitution occurred |
| Overall risks[23] | Not applicable, as no substitution occurred |
| **Criterion: Improved handling and storage** | |
| Available information base | Safety Data Sheets of hazardous substances according to GHS available. No data available regarding their active use but training on correct use is provided from Ecolab. |
| Number and extend of accidents at work | Number of work accidents per year decreased; not quantified |
| Exposure of workers | **Decreased** (see explanation for risk below) |
| Risk of accidents resulting from the application of chemicals | **Decreased**<br>Reason: workers do not have direct contact with chemicals, automatic dosing is implemented, spray bottles are automatically filled with cleaning agent dilution, thus no direct contact and reduced risk of dermal exposure |
| Risk of accidents resulting from the storage of chemicals | no data |
| **Criterion: Economic and social benefits** | |
| Costs for the user | From 6.1 to 2 R$ per room per day **(-67%)** |
| Economic performance of the supplier | no data |
| Business opportunities | ChL contributed to comply with the hotel environment certification requirements (Travel Life). |
| Qualification of employees | More training/qualification induced by environmental education of the employees |
| Creation of new jobs | no data |
| **Criterion: Monitoring of the improvements** | |

[23] Risk change related to substitution; the request to change the risk by introducing ChL was part of Criterion 2

| | |
|---|---|
| Measurement of the indicators for the criteria 1 - 4[24] | Criterion 1: 57% monitored<br>Criterion 2: 50% monitored<br>Criterion 3: not applicable<br>Criterion 4: 60% monitored<br>No information on improvements of monitoring process |

#### 4.2.2.6 Lubrication of conveyor belts

In Serbia, the two companies Ecolab and Knjaz Miloš use Chemical Leasing for lubricating conveyor belts in the beverage industry. The application has primarily led to improvements in criterion 1. The process is more efficient through the substitute and generates less emissions and waste.

Table 22 describes the application and Table 23 presents the results of the data collection.

Table 22: Project description from SMART 5 for the Chemical Leasing application between Knjaz Milos and Ecolab

| **Project description** | |
|---|---|
| **Description of the project or process** | |
| Industry or sector: | Food industry, beverage production |
| Process: | Lubrication of conveyor belts in the packaging of PET mineral water bottles |
| Initial situation: | All six packaging lines are lubricated with a lubricant that is mixed with water and sprayed onto the conveyor belts |
| Aim: | make the packaging process safer and more efficient |
| Unit of payment: | Operating hours of the assembly line |
| **Company names** | |
| Name of supplier: | Ecolab Serbia |
| Name of user: | Knjaz Miloš |
| Other partners involved: | National Cleaner Production Center Serbia |
| **Scope of the study** | |
| Monitoring intervals or time of data gathering: | ChL was introduced on one of six production lines (line 3) and the improvements were closely monitored. |
| Description of the application: | Chemical Leasing was first introduced in 2011 on one (line 3) of the six production lines. Meanwhile, all lines are operated with this business model. Data is only available for line 3. Considered is the lubrication of the assembly line and the water treatment that was necessary before the introduction of Chemical Leasing. |
| Further comments: | none |

[24] For each criterion, it is recorded as a percentage how many of the sub-criteria are measured. It is assumed that sub-criteria that are not relevant are fulfilled and thus measured. Existing data gaps on the sub-criteria and indicators are considered not measured when the indicator is relevant. The percentage of monitoring results from the number of sub-criteria.

Table 23: Results of the data collection for the five sustainability criteria in the application at Knjaz Milos and Ecolab

| Sustainability criteria and results of their indicators | |
|---|---|
| **Criterion: Reduction of adverse impacts** | |
| Pollutants emitted into the air | no emissions into the air |
| Pollutants emitted in wastewater | From 900 to 0 kg / year **(-100%)**<br>In the new process, no water is needed for lubrication. |
| Volume of waste and wastewater | From 6,000 to 4,200 kg of lubricant waste per year **(-30%)** |
| Energy demand during the application | No data |
| Energy demand (indirect) in the supply chain | Reduction by -58381 MJ due to reduced chemical production of the old lubricant |
| Greenhouse gas emissions during the application | No direct emissions from lubrication, only indirect savings from reduced production volumes of chemicals |
| Resource demand during the application | From 6,000 to 4,200 kg of chemicals (lubricant) per year **(-30%)**<br>From 270 to 0 litres of water treatment chemicals per year **(-100%)**<br>From 1,500 to 0 m3 of water **(-100%)** |
| **Criterion: Avoidance of higher risks** | |
| Substitution of the chemical | The wet lubricant was substituted with a dry lubricant so that no more water is needed in the process. New technology was introduced in this course. |
| Material characteristics of substitutes | An SDS is available but the dry lubricant is safe. The risks to the environment and health are thereby reduced. |
| Overall risks[25] | **Reduced**<br>Reason: Substitute is less dangerous and in the process no more water is needed, which reduces the risk of accidents. |
| **Criterion: Improved handling and storage** | |
| Available information base | Safety data sheet is available. No information regarding active use. |
| Number and extend of accidents at work | No change: neither before nor after the introduction of Chemical Leasing there were accidents at work in this production area. |
| Exposure of workers | Lubricant H318, H314<br>Water treatment chemicals H314<br>Dermal exposure, significant reduction in exposure to ChL<br>Exposure to water treatment chemicals is eliminated by substitution<br>Description of the change in exposure: Lubricant-water mixture was present in the old process throughout the plant. ChL lubricates without water. |
| Risk of accidents resulting from the application of chemicals | **Reduced**<br>Reason: No more risk of slipping due to water-lubricant mixture on the floor by introducing the dry lubricant. |

25 Risk change related to substitution; the request to change the risk by introducing ChL was part of Criterion 2

| | |
|---|---|
| Risk of accidents resulting from the storage of chemicals | No data |
| **Criterion: Economic and social benefits** | |
| Costs for the user | From 14,700 to 9,000 € / year **(-39%)**<br>Total cost reduction due to no downtime and cost savings for water and chemicals. |
| Economic performance of the supplier | **Improved**<br>Reduced storage and transportation costs and revenue generation based on service. |
| Business opportunities | Ecolab became the only lubricant supplier for the packaging process |
| Qualification of employees | n/a |
| Creation of new jobs | n/a |
| **Criterion: Monitoring of the improvements** | |
| Measurement of the indicators for the criteria 1 - 4[26] | Criterion 1: 86% monitored<br>Criterion 2: 70% monitored<br>Criterion 3: 100% monitored<br>Criterion 4: 60% monitored<br>No information on improvements of monitoring process |

## 4.3 Branch extrapolation

For the data obtained from the case studies, the savings potential for the respective industry was to be examined. The purpose of this estimation is to highlight the benefits of Chemical Leasing and to examine how far the use cases are applicable to the industry and what potential is expected. Various assumptions regarding the industries are necessary for this. For example, it must be assumed that the company and the application for which data was obtained is representative of the industry and the savings potential can also be generated in companies with similar requirements.

The difficulties of such a survey can be summarised as follows:

- The introduction of Chemical Leasing is in many applications also accompanied by the installation of new, improved technology. The savings that result from a before-and-after comparison are therefore not exclusively caused by the new business model, but rather arise from a combination of changed incentives and improved technology. In turn, the economic savings achieved by Chemical Leasing help to finance the new technology or make a changeover economically feasible.
- A Chemical Leasing application cannot be transferred directly to a similar process in other companies, but is always tailored specifically to the needs of the partner companies, the process, and other (e.g. country-specific) framework conditions. Existing applications can therefore only give indications of further possible applications and inspirations for the implementation, but cannot be transferred 1: 1. This also creates uncertainties for estimating the industry potential.
- A quantification of the economic benefits is subject to uncertainties because the service-related approach changes the framework conditions in the companies. Contracts are often agreed upon for longer terms and orders and business relations are characterised by greater

[26] For each criterion, it is recorded as a percentage how many of the sub-criteria are measured. It is assumed that sub-criteria that are not relevant are fulfilled and thus measured. Existing data gaps on the sub-criteria and indicators are considered not measured when the indicator is relevant. The percentage of monitoring results from the number of sub-criteria.

stability. Therefore, a simple before-and-after comparison is possible, but does not reflect the overall economic benefits (see also UNIDO 2015, p. 5f.).

- For many applications, data exists for a before-and-after comparison. For other case studies, this comparison cannot easily happen, because either no baseline scenario is available or the application has changed dramatically through Chemical Leasing. In the example of hotel cleaning, Chemical Leasing has been used since the hotel was opened and the comparison is based on assumptions from another hotel - therefore does not directly compare the same conditions. In the case of pesticide application in potato growing in Sri Lanka, training of employees, the new business model and a more conscious handling of the chemicals are causing many positive changes, but these are not quantifiable or have not been considered before the changeover. In the case of SAFECHEM's Chemical Leasing application in the UK, the model results in less monitoring and data, as the process builds on years of experience and trust, as well as reduced constraints due to reduced emissions from the new technology. Thus, there are significant improvements and simplifications for companies, but they are difficult to measure.

**Cleaning of metal parts**

For the project "Contributions to the Sustainability Strategy: Reduction of Resource Consumption in the Chemical Industry by Instruments of Sustainable Chemistry[27]" (UBA, 2017b), estimates of potentials for parts cleaning have already been made which the project team has verified for the estimation of the potentials here. For perchloroethylene (PER), this results in possible savings between 9.3 kt and 7.3 kt PER per year in its use as a solvent in metal parts cleaning in Germany, depending on the scenario considered. Based on the total amount of PER used for metal cleaning, these values are amount to 73 to 93%. The here considered scenarios take into account the previous use of either open and closed machines without Chemical Leasing or closed machines together with a service-oriented business model, which however does not include any benefit-based payment. The reduced PER volumes generate further supply chain savings, which are only recorded in terms of energy requirements under the Chemical Leasing indicators. The assumed reduction in the PER quantity shows savings between 298 TJ and approx. 234 TJ of energy, without considering the energy requirements directly in the application. Also, a substitution of currently existing applications of trichlorethylene to a cleaning with PER, as in the second considered case study for metal cleaning, would raise further, but much smaller potentials.

**Bonding of paper and cardboard packaging**

The analysis of the industry potentials for the bonding of packaging (solely paper and cardboard packaging excluding plastic or composite materials) assuming transferability from the Serbian case study has shown that in Germany per tonne of the estimated 5,500 kt of bonded packaging materials (reference year 2012) 3.75 kg of adhesive can be saved. This results in a total of approximately 2.08 kt of reduced adhesives per year, which could be achieved with Chemical Leasing, assuming that 10% of the total amount of bonded cardboard and paper packaging is processed as in the Chemical Leasing case study. The savings in adhesive production result in further environmental benefits due to the reduced use of materials and energy. In terms of greenhouse gas emissions, which can be saved by the reduced amount of adhesive, savings of around 8,300 t $CO_2$ equivalents can be estimated (UBA, 2017b, p. 89f.).

[27] FKZ 3713 93 425

### Pesticide application in agriculture

The data collected for the case study comes from Sri Lanka. The general conditions differ considerably from those in Germany or Europe, so that a direct extrapolation to Germany is not possible. For example, the chemicals are manually applied by sprayers on the field and there was no protective clothing prior to the introduction of Chemical Leasing. Also, due to the low prices of agricultural chemicals in Sri Lanka, more than the recommended amount of chemicals is often used by the farmers. This also generated the motivation in the application described to switch to Chemical Leasing. Other framework conditions, such as a more environmentally friendly cleaning of the equipment, have been improved, but are not measurable.

For applications in Sri Lanka itself, as well as in other emerging and developing nations with high pesticide use, the project team sees great potential for further disseminating Chemical Leasing in the use of pesticides. In addition to reducing the amount of chemicals and the associated multiple environmental benefits for resources, soil and groundwater, Chemical Leasing can also improve working conditions, as, for example, hazardous chemicals are stored properly, training takes place and protective equipment is introduced.

As in other agricultural applications, the yield increased in this application (12%). Thus, in addition to the reduced costs, this is another motivating factor for farmers to introduce the business model. The insurance concept developed in the project should contribute to an increased application in the field of agriculture.

### Cleaning in the hotel

A UNIDO study (2015) looked at the potential for Chemical Leasing in hotels. The calculation was made for the information available and for hotels in Brazil. The consideration results in savings potential for water consumption and $CO_2$ emissions with regard to detergents for dishwashing and laundry cleaning of 2012 $m^3$ of water and almost 50 t of $CO_2$ per year. The assumptions include i.a. a reference to 17,000 rooms in Brazilian 4- and 5-star hotels.

The estimation in Germany was based on 950,000 rooms in German hotels. The use of Chemical Leasing could save more than 37 million litres of detergent per year if the quantities used and the reductions in detergents correspond to those used in the case study (1.4 or 0.3 litres of chemicals per room and day, reduction by 80%) and if the application is assumed to be applicable for 10% of the German hotels. This reduction will result in savings in indirect greenhouse gas emissions of 2,670 tonnes of $CO_2$ equivalent per year (through detergent production), cost savings of approximately € 33 million per year, and reduced emissions to wastewater of over 2 tonnes of phosphorus equivalents per year (UBA, 2017b, p. 91f.).

### Lubricating assembly lines

The conversion to Chemical Leasing for the lubrication of production lines in the filling of PET bottles in Germany was examined in a UBA study (2017b, FKZ 3713 93 425) based on the assumption that the savings achieved in Serbia also apply to the plants in Germany. Based on the assumption that around 10 billion PET bottles are produced annually in Germany (GVM, 2016, p. 16 and UBA, 2017c, p. 93) and that the conditions from the case study are transferable to 10% of the German production. There is a saving potential of approximately 41.4 tonnes of lubricant and approximately 1,200 GJ of energy per

year in the supply chain, without consideration of the impacts of the substitute[28]. Substituting dry lubrication in the lubrication process will result in potential reductions of more than 30,000 $m^3$ of water and 12,000 kg pollutant emissions per year. Waste reduction is estimated to be around 36 t per year.

[28] In the case study, there is no information about the composition or environmental effects of the dry lubricant, so that no extrapolation can be conducted.

# 5 Updating the website

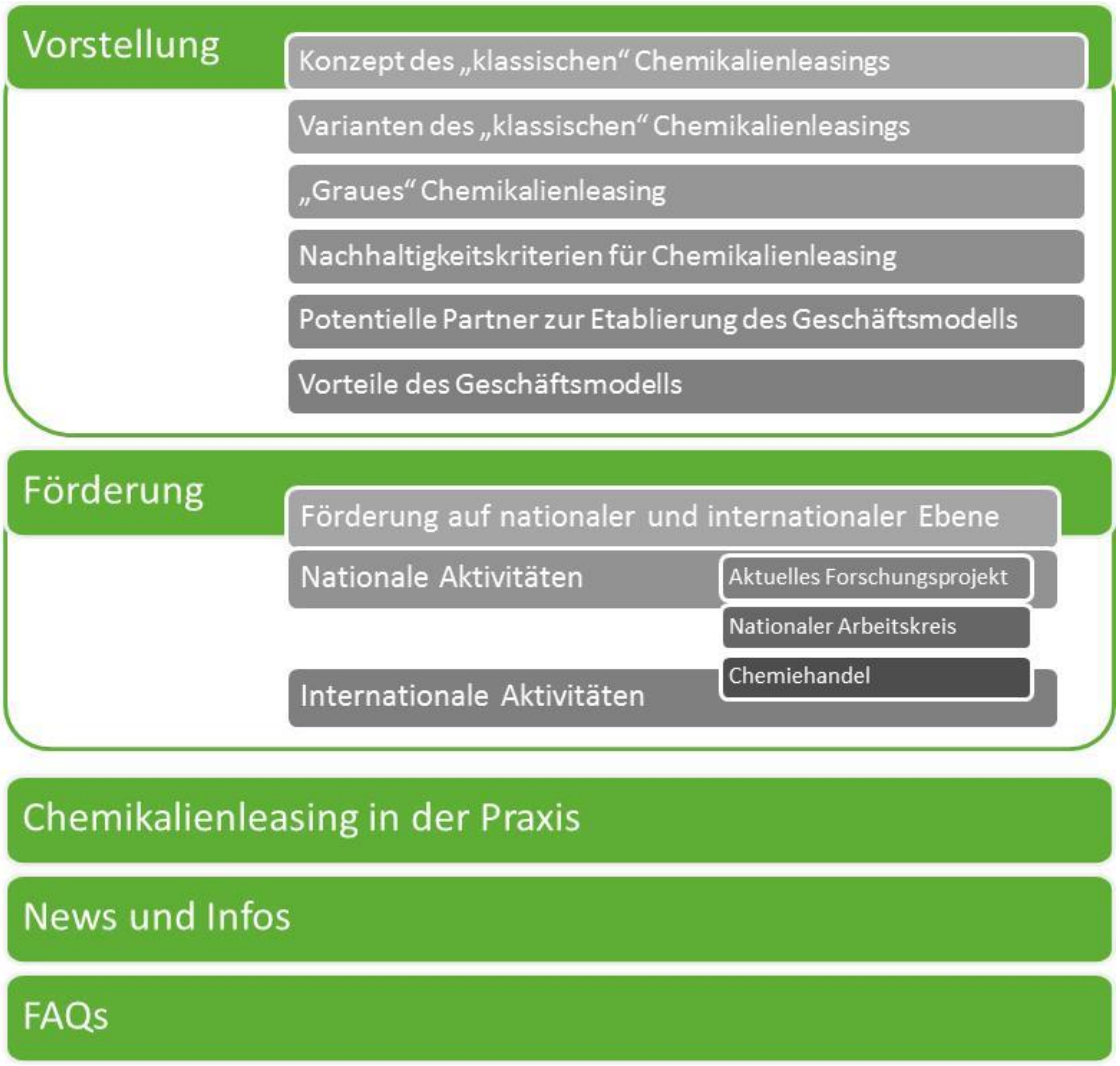
The following chapter provides an overview of the structure and the content of the German Chemical Leasing website on the homepage of the UBA. Furthermore, the project team has suggested various updates, which were implemented during the project. All changes to the content of the website are summarised in the following sections.

### 5.1.1 Structure and content of the website

The official homepage of the UBA for Chemical Leasing is: https://www.umweltbundesamt.de/chemikalienleasing-portaleinstieg and is also accessible via a redirect from www.chemikalienleasing.de.

Figure 13 shows the main topics of the website and their subdivision points. From the start page, users can view more details about Chemical Leasing on the five pages (highlighted in green) and their outline points (shaded in grey).

Figure 13: Structure of the main contents of the Chemical Leasing internet presence (only available in German).




The figure reflects the website as at May 2017 (UBA, 2017a), own figure.

### 5.1.2 Revisions and updates

The proposals for the revision of the website were explained in detail in the interim report or status reports of the project. In the following, the changes that have taken place are only summarised in a nutshell:

- New entries on the start page including a short description and, as far as possible, links to further information on the topics:
  1. Announcement and invitation to the workshop "Sustainable Chemical Management through Chemical Leasing Realizing and Measuring Success""
  2. Joint Declaration of Intent on Chemical Leasing
  3. Workshop „Chemical Leasing 4.0: Recognize and use the opportunities of an innovative business model" in Vienna
  4. OECD report „Economic Features of Chemical Leasing"
- Revision of sections of the text and links to linked websites or documents; the existing links were checked by the project team and updated if necessary
- Adjustments to the structure of the start page to better define current information from the archive.

In addition, the following updates to the website are pending at the time of reporting. The subsequent text boxes contain suggestions for the content of these updates.

- Results of the workshops (Suggestion for the German text for the website in text box)
- Results of the research projects: indicator checklist and SMART 5 (Suggestion for the German text in text box)
- Extension of the FAQ section with an explanation of the term leasing to explain the origin of the word Chemical ***Leasing*** (German suggestion in text box)

**Aktualisierung der Internetpräsenz zum Workshop „Nachhaltiges Chemikalienmanagement durch Chemikalienleasing – Erfolge realisieren und messen"**

Am 19. Oktober 2017 fand in München ein Workshop zu Chemikalienleasing statt. Dabei sind verschiedene Vertreter u.a. von nationalen und internationalen Behörden und Institutionen sowie Unternehmen zusammengekommen, um sich über die Aktivitäten der einzelnen Beteiligten auszutauschen und das weitere Vorgehen hinsichtlich Chemikalienleasing zu koordinieren.

Das Programm beinhaltete folgende Punkte:

- UBA Aktivitäten zu Chemikalienleasing und nachhaltiger Chemie
- Chemikalienleasing im Kontext von REACH, SAICM und nachhaltiger Entwicklung
- Aktuelle Entwicklungen zu Chemikalienleasing auf internationaler Ebene
- Indikatoren für Chemikalienleasing und das Instrument SMART 5
- Umsetzung von Chemikalienleasing in verschiedenen Branchen
- Moderierte Diskussion zu Erfolgsfaktoren, weiteren Möglichkeiten und Hemmnissen für Chemikalienleasing

Die Diskussion hat die vielfältigen Entwicklungen und Erfolge von Chemikalienleasing hervorgehoben und auch auf den weiterhin benötigten Kommunikationsbedarf und die notwendige Öffentlichkeitsarbeit hingewiesen. Die Dokumentation des Workshops ist hier *(bitte Link einfügen)* abrufbar.

## Aktualisierung der Internetpräsenz zum Indikatorenset für Chemikalienleasing und SMART 5

**Ergebnisse des Forschungsprojekts zur Weiterentwicklung der Nachhaltigkeitskriterien für Chemikalienleasing**

In einem UBA-Forschungsprojekt entwickelten die Auftragnehmer in Abstimmung mit nationalen und internationalen Expertinnen und Experten ein Indikatorenset, das die Bewertung der Vorteile Chemikalienleasing-Anwendungen unterstützen soll. Die so entstandene Indikatoren-Checkliste ermöglicht Anwendern des Geschäftsmodells ein erstes Screening der Auswirkungen der Chemikalienleasing-Anwendung und vereinfacht die Arbeit mit dem ebenfalls im Projekt entwickelten Instrument „SMART 5“.

**SMART 5**

Die standardisierte Methodik der auf Excel basierenden Anwendung erleichtert Unternehmen die Einführung von Chemikalienleasing und unterstützt sie beim Erreichen ihrer Nachhaltigkeitsziele. So soll mit SMART 5 ein Beitrag zur Optimierung und weiteren Verbreitung des Geschäftsmodelles als Baustein einer Nachhaltigen Chemie geleistet werden und die Erreichung der Sustainable Development Goals (SDG) vorantreiben.

*Optional: Abbildung zu SMART 5, beispielsweise das Titelblatt wie in Figure 7.*

Die Indikatoren-Checkliste und SMART 5 sind in fünf Abschnitte unterteilt, die den Nachhaltigkeitskriterien von Chemikalienleasing entsprechen:

1. Verringerung negativer Auswirkungen auf Umwelt, Gesundheit, Energie- und Ressourcenverbrauch von Chemikalien, die in Produktions- und Anwendungsprozessen verwendet werden
2. Vermeidung einer Substitution durch Stoffe mit höherem Risiko
3. Verbessertes Handling und verbesserte Lagerung von Chemikalien im Hinblick auf Risikovermeidung/-verminderung
4. Wirtschaftliche und soziale Vorteile werden generiert: Ein Vertrag sollte die Ziele der kontinuierlichen Verbesserungen und eine faire sowie transparente Aufteilung der wirtschaftlichen Vorteile zwischen den Vertragspartnern enthalten
5. Monitoring der Verbesserungen im Sinne der oben genannten Kriterien

Für jedes Kriterium werden die relevanten Parameter einzeln abgefragt. SMART 5 überträgt schließlich die Kerninformationen automatisch in ein sogenanntes „Factsheet“, wodurch alle für das jeweilige Unternehmen relevanten Daten über die Chemikalienleasing-Anwendung in einem einzelnen Tabellenblatt übersichtlich zusammengefasst werden.

Die Anwendbarkeit von SMART 5 wurde in diversen Testläufen mit realen Firmendaten aus unterschiedlichen Sektoren überprüft, um einem möglichst breiten Spektrum an Anwendern zu entsprechen. Im Zuge dessen konnte die Flexibilität verbessert und somit auch die Einsatzbreite erhöht werden.

Die Checkliste sowie das Tool SMART 5 sind auf Deutsch und Englisch unter den folgenden Links frei als Downloads verfügbar (*bitte Verknüpfung mit den jeweiligen Dateien*):
Indikatoren-Checkliste (Deutsch)
Indicator checklist (English)
SMART 5 (Deutsch)
SMART 5 (English)

Eine Kurzbeschreibung von Checkliste sowie SMART 5 ist auf Deutsch und Englisch unter den folgenden Links (*bitte Verknüpfung mit den jeweiligen Dateien*) abrufbar.

**Erweiterung der FAQ-Sektion „Warum *Leasing*“**

Der folgende Text kann entweder Teil der Antwort auf die bestehende Frage „Was sind die Unterschiede zwischen Chemikalienleasing und der klassischen Form von Leasing?“ sein oder die Erläuterung für eine separate Frage „Warum Chemikalien***LEASING***?“ sein.

In den allerersten Pilotprojekten zu Chemikalienleasing fand kein Wechsel des Besitzers der Chemikalie statt und die verwendeten Substanzen nach ihrem Gebrauch zur Aufbereitung zurückgenommen. Mit der Zeit hat sich das Geschäftsmodell über die Grenzen des klassischen Leasings hinaus weiterentwickelt. Entgegen des ursprünglich vorhandenen Leasingkonzeptes wurden zunehmend Modelle entwickelt, in denen eine Chemikalie im Laufe des Prozesses auch den Besitzer wechseln kann und/oder sie auf dem Produkt verbleibt und somit keine Rückgabe wie beim klassischen Leasing stattfindet. Aufgrund des etablierten Namens und dem Wiedererkennungswert wurde am Name Chemikalienleasing trotz der breiteren Anwendungsmöglichkeiten über ein Leasing im engeren Sinne hinaus festgehalten. Heute findet bei den meisten Modellen ein Besitzerwechsel statt.

# 6 Insurance concepts for Chemical Leasing applications in agriculture

In countries such as Sri Lanka and Serbia, successful applications of Chemicals Leasing in agriculture for the use of pesticides are already existent. However, the willingness of pesticide manufacturers to cooperate is often hampered by the fact that they cannot or do not want to be able to hedge the risk of crop failure alone, which can be the result of a miscounselling regarding the amount of pesticides.

This inhibiting factor can be dissipated by means of suitable insurance solutions. The starting point for insurance solutions is that, due to the altered (reduced!) use of pesticides due to the Chemical Leasing application, crop damage can occur which neither the user nor the supplier of plant protection products can or will bear.

The developed insurance concept consists of the following elements:

*Sum insured:* value of the harvest at market prices

*Insurance holder:* farmer = user of pesticides

*Insurer:* national / local insurance

*Hedging:* the national / local insurer can agree upon a reinsurance with a high coverage (to be agreed individually, greater than 90% possible)

*Maximum damage (PML = possible maximum loss):* corresponds to the sum insured

*Claim:* miscounselling of the supplier of the pesticides leads to crop failure (partially or completely) due to pest infestation

*Insurance premium:* percentage of the sum insured, to be agreed individually

*Reinsurance premium:* percentage of the sum insured, to be agreed individually

*Special features:* The policy must specify the supplier of the pesticides, the type of pesticides and the pests to be controlled. The specifications of the supplier of the pesticides with regard to the type and scope of the application must be documented.

The project team is in contact with the Munich Reinsurance Company (Munich Re), which is interested in such an insurance concept and is prepared to hedge initial pilot projects.

Basically, an insurance concept increases the costs for the participants, as long as no damage occurs. Since the insurance concept is proposed to reduce risks from the use of Chemical Leasing, the costs should not overcompensate the economic benefits of Chemical Leasing.

A sample calculation clarifies the concept. It is assumed that 60% of the pesticides used are superfluous and thus a reduction of the use of pesticides to 40% of the original amount is achieved by Chemical Leasing. A reduction in the use of pesticides reduces the costs for the manufacturer. These economic advantages must also be passed on to the user in a Chemical Leasing application by means of a contract. For the example calculation, it is assumed that cost savings of 20% can be realised by the user, i.e. the farmer pays by using Chemical Leasing, for example, 80 instead of 100 € to the manufacturer. Furthermore, costs for the insurance premium must be budgeted when using a Chemical Leasing model. These are set to half the amount of cost savings for the example, i.e. 10% of the original costs (e.g. original cost 100 €: 10 € insurance premium). The detailed amounts must be determined in each case of the application between all contracting parties.

Conditions before Chemical Leasing at the manufacturer:

- 20% Return on sales
- 70% Material costs
- 10% Overhead and counselling

Based on a breakdown of the manufacturer's turnover in the traditional model, where the sales return is 20% due to 70% material costs and 10% overhead and consulting costs, Table 24 shows the results of the example calculation in case that no damage occurs. Under Chemical Leasing, higher costs are incurred by the manufacturer for overhead and consulting (20 instead of 10 €) and sales are reduced (80 instead of 100 €). However, the savings in material (60% less pesticides) and the associated reduction in manufacturing costs can increase profits from € 20 to € 32. Part of the reduced costs will be passed on to the user. Instead of the previous 100 € the user only pays 80 € (20 € savings for pesticides). The costs for the insurance premium (10 €) generate a cost saving of 10 € for the farmer.

Table 24: Results of the sample calculation for the insurance concept, if no damage occurs

| **Classic Model** | | **Chemical Leasing** | | |
|---|---|---|---|---|
| **Manufacturer** | **Farmer** | **Manufacturer** | **Farmer** | **Insurer** |
| 100 € Sales<br>70 € Material<br>10 € Overhead and consultation | 100 € Costs | 80 € Sales<br>28 € Material<br>20 € Overhead and consultation | 80 € Costs manufacturer<br>10 € Insurer | 10 € |
| 20 € Profit | 100 € Costs | 32 € Profit (+ 12) | 90 € Costs<br>10 € Saving | 10 € Profit |

The example calculation reveals that all involved actors can realise economic benefits. The profit of the insurance company only arises if no damages occur.

In case of damage, the results for the manufacturer and the user remain the same, the insurer would suffer a loss. In this respect, the premium must be calculated in such a way that profits are generated over the long term and with a sufficiently large number of policies.

# 7 Events on Chemical Leasing

During the project several Chemical Leasing events have taken place since the end of 2015. These events are listed below and described briefly or in more detail depending on their relevance to the project.

### *Meeting of the international working group on Chemical Leasing in Vienna*

On 30 November 2017, international stakeholders met in Vienna to discuss the latest developments of Chemical Leasing and the fourth Global Chemical Leasing Award in 2018. The discussions among the participants concerned the following topics:

- Petra Schwager, Introduction and overview of Chemical Leasing activities
- Reinhard Joas, The Chemical Leasing dissemination initiative
- Christopher Blum, Indicators for Chemical Leasing and Introduction of SMART 5
- Petra Schwager, Presentation Chemical Leasing Award Criteria and Discussion
- Tour de Table – One year after the signing of the Declaration of Intent
- Ingrid Kaltenegger, Overview of the Chemical Leasing Book
- Discussion of the Chemical Leasing Book
- Tour de Table – Upscaling Chemical Leasing and Final Discussion
- Petra Schwager, Conclusion and way forward

For the award in 2018, three categories were defined:

1. Case Studies: This award is presented separately to users and providers and differentiates in the evaluation by the jury regarding environmental and health benefits as well as economic and social impacts.
2. Special Innovation Award: This award is particularly aimed at new technical solutions that, for example, contribute to the circular economy and promote a new approach to chemicals.
3. Research Award: This award elects good examples of scientific work in the area of Chemical Leasing.

In addition to the award, all applicants who fulfil the minimum requirements will receive a *Chemical Leasing Conformity Declaration*. Therefore, the five sustainability criteria have to be fulfilled.

One of the major discussion points was the question on the use of SMART 5 in the frame of the Award. The participants agreed that SMART 5 will be provided to all applicants as a central tool and it is recommended to be used for data gathering and proof of the minimum requirements for the award. No mandatory use of SMART 5 has been adopted.

Participants continued to discuss a new book on Chemical Leasing, for which initial proposals and concepts have already been developed. Further details, such as interviews with stakeholders in the field of Chemical Leasing are currently under discussion.

### *Climate Conference in Bonn*

At the time of the report generation, the UN-Climate Conference takes place in Bonn[29]. Chemical Leasing can make a contribution to climate protection through the savings of direct and indirect energy consumption. UNIDO and the ISC$_3$[30] have included Chemical Leasing into their Side Events.

[29] 23rd Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC)

[30] International Sustainable Chemistry Collaborative Centre

As part of Ramboll's presence in Bonn, the project team organised a roundtable on the subject "Innovative and collaborative solutions for circular economy and sustainability". At the two-hour event on 15 November 2017, attendees from public authorities, industry and other stakeholder groups discussed the following topics; each of them introduced through a brief presentation:

- Sustainable production and application: Presentation of Chemical Leasing as a new business model, which reduces the consumption of chemicals and contributes to the reduction of $CO_2$ emissions.
- Collaborative approaches to increase sustainability in retail
- International collaboration in the field of waste and recycling

All participants valued the event as a big success. The discussions revealed the essential contribution of Chemical Leasing to both, the sustainability as well as the climate protection targets.

*Workshops with government representatives*

The project also supports the activities of the project team together with UNIDO. The background is the distribution (mainstreaming) of Chemical Leasing and the increasing attention on the part of political representatives since the signing of *the Joint Declaration of Intent on Chemical Leasing* between UNIDO, Germany, Austria and Switzerland in November 2016.

More specifically, workshops will take place in different countries. The aim of the events is to introduce Chemical Leasing and to draw the countries interest in signing the *Joint Declaration*. Expected participants are government representatives from, for example, environmental ministries or agencies and other authorities as well as interested industrial representatives and consultants.

The workshops take place in Brazil, China and Brussels, with representatives from Belgium, France, the Netherlands and Luxembourg in Brussels. Other countries, such as Denmark or the UK, are scheduled for such workshops next year.

In the course of workshops with government representatives, the project team also organises trainings in the local Ramboll offices of the respective countries in order to increase the capacity for disseminating Chemical Leasing and to use synergies with existing contacts. Such a training was already held in Copenhagen on 12 October and will take place at the end of November before the workshop in Brazil (23.11.) for the colleagues located there.

The project team is responsible for the organisation, preparation, postprocessing as well as the realisation of workshops with government representatives. The countries were selected in close consultation with UNIDO on the basis of their interest in joining the *Joint Declaration.* In order to show the countries experiences from existing Chemical Leasing activities, representatives of UNIDO or Austria and Germany will be participating in the events. As part of the coordination, the project team therefore ensures a constant exchange between all stakeholders.

*Workshop in Brazil*

One of the first workshops with government representatives took place on November 23, 2017 in Brazil. The following topics have been discussed by the participants:

- Presentation of the Chemical Leasing concept and discussion of case studies
- Joint Declaration on Chemical Leasing and Q&A session

As an outcome of the event, the Brazilian Ministry for the Environment will meet with the Brazilian Ministry for Economics for coordination and evaluate the chances for Chemical Leasing in Brazil and how a dissemination of the business model could be supported. The most important area of application identified is the use of pesticides in agriculture, where the application of Chemical Leasing is expected to lead to considerable increases in efficiency and a reduction in unnecessary emissions.

In addition, Ramboll consultants in Brazil started to contact enterprises (e.g. Bosch) regarding the opportunities for Chemical Leasing after the training.

*Final workshop to the project*

On 19 October 2017, the final workshop on the project took place in Munich, which was organised and carried out by the project team in consultation with the Federal Environment Agency.

The invitation letter, the agenda and the minutes of the meeting are attached to this report in the Annexes (Annex 10.4, 10.5, and 10.6 respectively10.3).

The 13 participants discussed various current topics related to Chemical Leasing. The focus was on the relationships between Chemical Leasing and sustainable chemistry, as well as the contributions of the business model to international chemical policy goals such as SAICM[31] or the chemical-related goals of the *Sustainable Development Goals*. Chemical Leasing furthermore contributes to the authorisation of chemicals under the European chemicals regulation REACH. The participants discussed the example of the authorisation of trichlorethylene. Obstacles, such as the fear of losing know-how regarding the core competences of a company were also addressed. UNIDO presented the latest developments in Chemical Leasing on an international level, including in particular the 2018 Award, the Joint Declaration and a new book on Chemical Leasing.

The project team also presented the project results SMART 5 and the indicator checklist, as well as an overview of Chemical Leasing applications, e.g. in the automotive industry. These were discussed along with possible dissemination mechanisms such as industry dialogues and roundtables.

Following the workshop, the project team supported e.g. the video initiative of $ISC_3$[32] on sustainable chemistry, as agreed at the workshop. For this, the team has already collected existing Chemical Leasing videos and sent them to Mr. Barth of $ISC_3$. Another option for the exchange and mainstreaming of Chemical Leasing are sector dialogues, as regularly carried out by the BMWi.

*Chemical Leasing at the Sustainable Chemistry Summer School in Lüneburg*

An introduction to Chemical Leasing, its principles and benefits was given by the project team at the *S3C Summer School on Sustainable Chemistry for Sustainable Development* on 26 September 2017 in Lüneburg.

*ACEA Meeting in Brussels*

In February 2017, the project team was given the opportunity to present Chemical Leasing at a meeting of members of the European Automobile Manufacturers' Association ACEA. Due to the interest of the participants, the research project aims to strengthen the activities of Chemical Leasing in the automotive industry. For this purpose, a second meeting was arranged in which not only the project team but also representatives of the authorities from Germany and Austria were present. The meeting took place on 12 September 2017. The following presentations initiated the discussion:

- The view of the Policy Maker: Chemical Leasing and REACH / The Global Chemical Leasing Award (Dr. Thomas Jakl; BMLFUW)
- The political context of Chemical Leasing: international chemicals management, sustainable chemistry and the 2030 Agenda for Sustainable Development (Dr. Hans-Christian Stolzenberg und Dr. Christopher Blum; both UBA)

31 Strategic Approach to International Chemicals Management

32 International Sustainable Chemistry Collaborative Centre

The discussions with the participants revealed that Chemical Leasing-like models are used, e.g. in various fields at the supplier company Magna. The project team strives to communicate directly with individual business representatives to gain more information about existing applications. Magna is already interested in further information and the contact person is currently working on more concrete information about the existing applications. New findings resulting from the exchange with the ACEA members will be transmitted by the contractors to the UBA, regardless of the duration of the project.

Subsequent to the event, the project team compiled and submitted a summary of Chemical Leasing for the ACEA members. The aim was a concise summary of the essential information and the provision of links or hints for further details. The information sheet is included in the annex (chapter 10.7).

*Chemical Leasing Workshop in Vienna*

On 3 April 2017 a workshop on "Chemicals Leasing 4.0: Recognize and exploit opportunities of an innovative business model" was held in Vienna, which the project team organised together with the FCIO (Austrian Chemical Industry Association) and the BMLFUW (Federal Ministry of Agriculture and Forestry, Environment and Water Management Austria) and support of the Austrian Federal Economic Chamber.

*Events in 2016*

In 2016, several small meetings were held on Chemical Leasing, i.a. with UNIDO in Vienna or the company Roche in Switzerland.

The national working group, which also acted as a support group for the project, met in Berlin in addition to the final workshop on 26 October 2016 to discuss the intermediate result of the indicators. Based on this discussion, the indicators and SMART 5 have been further improved. The minutes of the event can be found in the annex in chapter 10.3.

*Brewery Fair 'BrauBeviale' in Nuremberg 2015*

Henkel have been involved in a Chemical Leasing project in Serbia for many years. Nevertheless, the business model did not spread further in the company. The project team and UNIDO could, within the framework of the Brewery Fair in Nuremberg in November 2015, present the business model to representatives of Henkel´s adhesive department. The participants exchanged experiences from Serbia or other projects to identify possibilities for further Chemical Leasing projects at Henkel.

*InfoPoint Lunch-time conference in Brussels*

In early November 2015, representatives of the European Commission (DG DEVECO), UNIDO and chemical manufacturers met in Brussels to talk and inform about Chemical Leasing. The project team supported UNIDO at the event. Present industry representatives have expressed great interest in the business model.

*RECP Conference in Davos*

At the "4th Global Network Conference on RECP" (Resource Efficient and Cleaner Production) in October 2015 in Davos, the 20-year anniversary of the RECP network was celebrated, initiated by UNIDO and UNEP (United Nations Environmental Program). Throughout the world, the network is committed to the development, application and dissemination of resource efficiency and optimisation measures and strategies, especially in developing countries and economies in transition. This also includes the Chemical Leasing business model, which has been successfully used by many RECP Centres (National Cleaner Production Centres – NCPCs). The business model has been presented to other interested parties from the network, as well as different organisations.

### *Side Event at ICCM4 in Geneva*

A Side Event on Chemical Leasing was held in Geneva at the end of September 2015 at ICCM4, the fourth session of the International Conference on Chemicals Management. The event addressed both political and business representatives, with positive feedback from both sides.

### *Sustainable Chemistry Conference in Berlin*

At the "Sustainable Chemistry Conference 2015: the way forward" in Berlin, organised by i.a. the Federal Environment Agency in September 2015, Chemical Leasing was presented to an audience of approx. 150 participants. The textile company MAS presented its environmental and economic successes with the business model and explained that there will be more Chemical Leasing projects in different phases of the production in the future.

# 8 Outlook

Sub-criteria and indicators for the five sustainability criteria of Chemical Leasing were developed in the project. These were incorporated into both the indicator checklist and the electronic instrument SMART 5. The instruments will be available for download on the UBA website. The project team designed the instruments as practically as possible and revised them several times. The benefits for practical work with Chemical Leasing were confirmed by various actors. In the future, an actual wide-ranging use of the instruments will have to be shown, or it will become clear whether there is still a need for adjustment with regard to the targeted use.

In summary, the indicators developed in the project with the checklist and SMART 5 make a significant contribution to quantifying the achievements which are achieved by Chemical Leasing applications.

Depending on the development, it may be examined in the future whether an online-based tool is possible and contributes to an increased use. With such a tool, it would be possible to filter all relevant aspects in advance by means of a screening in the sense of the checklist, so that the users only have to edit the indicators that affect them. For example, if water is not used in the process, there would be no need to ask questions about water use or emissions into the water. The benefits of such an extension must be weighed against the programming effort.

The indicators and the instrument SMART 5 will also be used in the next Global Chemical Leasing Awards. For this purpose, the project team regularly informed the representatives of the UNIDO Chemical Leasing Program about the current status of developments. Currently, the specific use of SMART 5 in the framework of the 2018 Award in Vienna is discussed within the jury, and the project team and the Federal Environment Agency are involved in the preparations for the next award. More information is not available at the time of writing and will be made available on the German and international website on Chemical Leasing.

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# 10 Annex

## 10.1 English indicator checklist



### Indicator Checklist for the Chemical Leasing Sustainability Criteria

*Developed on behalf of the German Environment Agency*

It is in the interest of all involved partners that a Chemical Leasing approach follows high quality standards. Therefore, the following sustainability criteria shall be fulfilled:

1. Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes
2. No substitution of chemicals by substances with a higher risk
3. Improved handling and storage of chemicals to prevent and minimize risks
4. 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
5. Monitoring of the improvements needs to be possible

The indicator checklist provides an overview of the five sustainability criteria for Chemical Leasing as well as of the sub-criteria and indicators. It shall support enterprise representatives and service providers to conduct a first assessment of the indicators of their Chemical Leasing project.

When filling out the checklist, solely the process in which Chemical Leasing is applied is subject to the consideration. The tendency of the development (without quantitative values) can be stated for each indicator. A colour code ('signal lamp') denotes for every indicator whether it has been developing towards the envisaged direction of the sub-criterion (positive development is denoted in green and steady results are colour-coded neutrally) or if a parameter has shown a negative development (e.g. 'increased' = red) and therefore questions the fulfilment of the sub-criterion and requires further investigation of the (conflicting) goals and potential trade-offs.

The checklist enables enterprises to get an overview of the necessary data for to meet the Chemical Leasing sustainability criteria and highlights conflicting goals or criteria that are potentially not fulfilled. Moreover, the checklist supports those enterprises that are interested in Chemical Leasing but have not yet made experiences or have reservations towards the controllability and fairness among the business partners as it provides an overview of the quality assurance of the business model.

#### Recommended approach for using this checklist:

- Start with reading the sustainability criteria for Chemical Leasing above or in the left-hand column of the checklist to get a short overview of the five criteria.
- Now proceed to the second column and have a look at the sub-criteria to get an impression of the topics for the following work step.
- Subsequently, consider your particular Chemical Leasing project and screen the indicators step by step. Tick the respective field for each indicator's development. If an indicator is not relevant, please make a note in the comment column or cross the whole field. In the comment column you may also enter more details about an indicator or notes regarding e. g. further need for investigation or explanations for particular indicator developments.
- It is not necessary to enter concrete, quantitative values. For that you may use the tool SMART 5, which helps you to document, processes and present your data on Chemical Leasing.

## Indicator Checklist with 'signal lamp' function (red = fulfilment of criterion in question)

| Sustainability criteria | Sub-criteria | Indicators for Chemical Leasing | Screening | Comment or specification |
|---|---|---|---|---|
| **1 Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes** | Pollutants emitted into the air | Nitrogen oxides ($NO_x$) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Ammonia ($NH_3$) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Sulphur dioxide ($SO_2$) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Non-methane volatile organic compounds (NMVOC, e.g. benzene) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Particulate matter (PM2.5/PM10) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | POPs (persistent organic pollutants) | ☐ decreased<br>☐ equal<br>☐ increased | *Which one(s)?* |
| | | Heavy metals (e.g. mercury) | ☐ decreased<br>☐ equal<br>☐ increased | *Which one(s)?* |
| | | Other emissions into the air<br>..... | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Pollutants emitted in waste water | COD (chemical oxygen demand) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | BOD (biological oxygen demand) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | AOX (adsorbable organic halogen compounds) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | POPs (persistent organic pollutants) | ☐ decreased<br>☐ equal<br>☐ increased | *Which one(s)?* |
| | | Heavy metals (e.g. mercury) | ☐ decreased<br>☐ equal<br>☐ increased | *Which one(s)?* |
| | | Nitrogen compounds | ☐ decreased<br>☐ equal<br>☐ increased | |

| | | | | |
|---|---|---|---|---|
| | | Phosphorus compounds | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Other emissions in waste water<br>..... | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Volume of waste and waste water (total and hazardous waste) | Waste volume (e.g. in metric tonnes) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Waste water (e.g. in $m^3$) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Tonnes or % of hazardous waste | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Energy demand during the application | kWh or MJ<br>(separately for electric and thermal energy demand) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Energy demand (indirect) in the supply chain | kWh or MJ | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Greenhouse gas emissions during the application | Amount of $CO_2$ equivalents | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Resource demand during the application | Amount of chemicals | ☐ decreased<br>☐ equal<br>☐ increased | *Which one(s)?* |
| | | Amount of water | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Amount of other resources in the supply chain in kg, $m^3$, l (e.g. recycling) | ☐ decreased<br>☐ equal<br>☐ increased | *Which one(s)?* |
| **2**<br>**No substitution of chemicals by substances with a higher risk** | Substitution of the chemical | Did a substitution of one or more chemicals take place (different substance or improved quality)? | ☐ yes<br>☐ no | *If no: Continue with criterion 3* |
| | Material characteristics of substitutes | Safety Data Sheet (SDS) of the substitute | ☐ available<br>☐ not available | |
| | | Hazards for environment and health (e.g. CMR[1] substances, irritant, bioaccumulative) | ☐ decreased<br>☐ equal<br>☐ increased | |

[1] substances classified as carcinogenic, mutagenic, or toxic for reproduction

| | | | | |
|---|---|---|---|---|
| | | Other hazards (e.g. flammability) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Overall risk | Altered risks due to the substitution (overall assessment and reasons) | ☐ decreased<br>☐ equal<br>☐ increased | |
| **3. Improved handling and storage of chemicals to prevent and minimise risks** | Available information base | Safety Data Sheets (SDS) for hazardous substances according to GHS | ☐ available<br>☐ not available | |
| | | Is the information actively used (e.g. is it read by workers or is there a notice at the production site or are trainings performed)? | ☐ yes<br>☐ partly<br>☐ no | |
| | Number and extend of work accidents | Number of work accidents per year | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Severity of the work accidents | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Exposure of workers | Type of exposure (per hazardous substance, if applicable) | ☐ dermal<br>☐ inhalative<br>☐ oral | |
| | | Level of exposure, e.g. concentration of pollutants in the air in mg/m³ (separately per hazardous substance) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Duration of exposure in min/day (separately per hazardous substance) | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Description of the measures that caused a change in the direct contact or exposure of workers to the applied chemical (e.g. personal protective equipment, air extraction are in place and in use) | | |
| | Risk of accidents resulting from the application of chemicals | Change of risk | ☐ decreased<br>☐ equal<br>☐ increased | |
| | | Description of the reasons for the changed risk (e.g. performance of hazard or risk assessments, availability of operating instructions for applying the chemical, derivation and implementation of measures, probability and severity of accidents, prevention measures) | | |
| | Risk of accidents resulting from the storage of chemicals | Change of risk | ☐ decreased<br>☐ equal<br>☐ increased | |

| | | | | |
|---|---|---|---|---|
| | | Description of the reasons for the changed risk (e.g. provision of instructions for the proper (and combined) storage and handling (e.g. for delivery, application) of the provided chemical by the supplier, derivation and implementation of measures, probability and severity of accidents, prevention measures) | | |
| **4 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** | Costs for the user | e.g. €/year<br>If possible distinguish between costs for chemicals, maintenance, energy demand, complaints, etc. | ☐ decreased<br>☐ equal<br>☐ increased | |
| | Economic performance of the supplier | e.g. €/year | ☐ improved<br>☐ equal<br>☐ decreased | |
| | | Description of the changes in business relations with customers (e.g. sole supplier, long-term planning security) | | |
| | Business opportunities | New customers or sales opportunities? | ☐ yes<br>☐ no | |
| | | New fulfilment of requirements for labels, certificates, etc.? | ☐ yes<br>☐ no | |
| | | New business developments or innovations? | ☐ yes<br>☐ no | |
| | Qualification of employees | Hours for training and education per employee per year (possibly including the topic) or description of changes in personnel structure and/or costs | ☐ more training/ qualification<br>☐ equal | |
| | Creation of new jobs | Number of jobs that are related to the application at the user side | ☐ more<br>☐ equal<br>☐ less | |
| | | Number of jobs that are related to the application at the supplier side | ☐ more<br>☐ equal<br>☐ less | |
| **5 Monitoring of the improvements needs to be possible** | Measurement of the indicators for the criteria 1-4 | Are the relevant parameters monitored? | ☐ yes<br>☐ partly<br>☐ no | |
| | | Is an improved monitoring process established? | ☐ yes<br>☐ partly<br>☐ no | |

## 10.2 German indicator checklist



### Indikatoren-Checkliste für die Nachhaltigkeitskriterien von Chemikalienleasing

*Im Auftrag des Umweltbundesamts*

Chemikalienleasing-Projekte sollten im Interesse aller Beteiligten hohen Qualitätsstandards folgen. Um dies zu gewährleisten, sollen die folgenden Nachhaltigkeitskriterien erfüllt sein:

1. Verringerung negativer Auswirkungen auf Umwelt, Gesundheit, Energie- und Ressourcenverbrauch von Chemikalien, die in Produktions- und Anwendungsprozessen verwendet werden
2. Vermeidung einer Substitution durch Stoffe mit höherem Risiko
3. Verbessertes Handling und verbesserte Lagerung von Chemikalien im Hinblick auf Risikovermeidung/-verminderung
4. Wirtschaftliche und soziale Vorteile werden generiert: Ein Vertrag sollte die Ziele der kontinuierlichen Verbesserungen und eine faire sowie transparente Aufteilung der wirtschaftlichen Vorteile zwischen den Vertragspartnern enthalten
5. Monitoring der Verbesserungen im Sinne der oben genannten Kriterien

Die Indikatoren-Checkliste stellt eine Übersicht über die fünf Nachhaltigkeitskriterien für Chemikalienleasing sowie alle Unterkriterien und Indikatoren bereit und unterstützt somit Unternehmensvertreter, eine erste Überprüfung der Indikatoren für ihr Chemikalienleasing-Projekt durchzuführen.

Zum Ausfüllen der Checkliste wird ausschließlich der Prozess im Unternehmen betrachtet, bei dem Chemikalienleasing angewendet wird. Für jeden Indikator kann die Tendenz der Entwicklung (noch ohne quantitative Werte) angegeben werden. Im Sinne einer Signalleuchte ist für jeden Indikator farblich gekennzeichnet, ob sich dieser in die von den Unterkriterien vorgesehene Richtung entwickelt (positive Entwicklung ist grün gekennzeichnet bzw. gleichbleibende Ergebnisse sind neutral gefärbt) oder ob sich ein Parameter negativ entwickelt hat (beispielsweise ‚erhöht' = rot) und somit die Erfüllung eines Unterkriteriums fraglich ist und Bedarf für eine genauere Betrachtung der Ziele und Zielkonflikte besteht.

Die Checkliste ermöglicht es somit den Unternehmen einen Überblick über die notwendigen Daten für die Erfüllung aller Chemikalienleasing-Kriterien zu bekommen und macht auf Zielkonflikte oder die mögliche Nichterfüllung einzelner Kriterien aufmerksam. Weiterhin hilft die Checkliste jenen Unternehmen, die an Chemikalienleasing interessiert sind, jedoch noch keine Erfahrung und ggf. Vorbehalte gegenüber der Überprüfbarkeit und Fairness zwischen den Geschäftspartnern haben, einen Überblick über die Qualitätssicherung des Geschäftsmodells zu erhalten.

#### Empfohlenes Vorgehen für die Verwendung der Checkliste:

- Lesen Sie sich zunächst die Nachhaltigkeitskriterien für Chemikalienleasing oben oder in der linken Spalte der Checkliste durch, um einen Überblick über die fünf Kriterien zu gewinnen.
- Verschaffen Sie sich nun einen Eindruck über die Unterkriterien in der zweiten Spalte, um die Themengebiete für die anschließende Bearbeitung kennenzulernen.
- Betrachten Sie anschließend ihr spezielles Chemikalienleasing-Projekt und bearbeiten Sie schrittweise die einzelnen Indikatoren. Kreuzen Sie für jeden Indikator die jeweilige Entwicklung an. Falls der Indikator nicht relevant ist, vermerken Sie dies bitte in der Kommentarspalte. Hier können Sie beispielsweise auch Vermerke zu weiterem Überprüfungsbedarf oder Erläuterungen zu einzelnen Entwicklungen von Indikatoren einfügen.
- Das Eintragen von konkreten Werten ist nicht erforderlich. Dafür steht Ihnen das Instrument SMART 5 zur Verfügung, das die eingegebenen Informationen übersichtlich aufbereitet.

1

**Indikatoren-Checkliste mit Signalleuchten-Funktion (rot = Erfüllung des Kriteriums fraglich)**

| Nachhaltigkeits-kriterium | Unterkriterien | Indikatoren für Chemikalienleasing | Überprüfung/Screening | Kommentar |
|---|---|---|---|---|
| **1 Verringerung negativer Auswirkungen auf Umwelt, Gesundheit, Energie und Ressourcen von Chemikalien, die in Produktions- und Anwendungsprozessen verwendet werden** | Schadstoffemissionen in die Luft | Stickoxide ($NO_x$) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Ammonium ($NH_3$) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Schwefeldioxid ($SO_2$) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | flüchtige organische Verbindungen (NMVOC, z.B. Benzen) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Feinstaub (PM2.5/PM10) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | POPs (persistente organische Schadstoffe) | ☐ verringert<br>☐ gleich<br>☐ erhöht | *Welche?* |
| | | Schwermetalle (z.B. Quecksilber) | ☐ verringert<br>☐ gleich<br>☐ erhöht | *Welche?* |
| | | Sonstige Emissionen in die Luft<br>..... | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Schadstoffemissionen ins Abwasser | CSB/COD (Chemischer Sauerstoffbedarf) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | BSB/BOD (Biochemischer Sauerstoffbedarf) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | AOX (adsorbierbare organische Halogenverbindungen) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | POPs (persistente organische Schadstoffe) | ☐ verringert<br>☐ gleich<br>☐ erhöht | *Welche?* |
| | | Schwermetalle (z.B. Quecksilber) | ☐ verringert<br>☐ gleich<br>☐ erhöht | *Welche?* |
| | | Stickstoffverbindungen | ☐ verringert<br>☐ gleich<br>☐ erhöht | |

| | | | | |
|---|---|---|---|---|
| | | Phosphorverbindungen | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Sonstige Emissionen ins Abwasser<br>..... | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Abfall- und Abwassermengen (gesamt und gefährlicher Abfall) | Abfallaufkommen (z.B. in Tonnen) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Abwasser in (z.B. in Kubikmeter) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Tonnen oder %-Anteil gefährlicher Abfall | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Energiebedarf in der Anwendung | kWh oder MJ<br>(separat für elektrische und thermische Energie) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Energiebedarf (indirekt) in der Lieferkette | kWh oder MJ | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Treibhausgasemissionen in der Anwendung | Menge der $CO_2$-Äquivalente | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Ressourcenbedarf in der Anwendung | Menge der Chemikalie | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Menge an Wasser | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Menge anderer Ressourcen in der Lieferkette in kg, $m^3$, l (z.B. Recycling) | ☐ verringert<br>☐ gleich<br>☐ erhöht | *Welche?* |
| **2 Vermeidung einer Substitution durch Stoffe mit höherem Risiko** | Substitution der Chemikalie | Fand eine Substitution einer oder mehrerer Chemikalien statt (andere Substanz oder verbesserte Qualität)? | ☐ ja<br>☐ nein | Falls nein: weiter mit Kriterium 3 |
| | Stoffliche Eigenschaften der Substitute | Sicherheitsdatenblatt des Substituts | ☐ vorhanden<br>☐ nicht vorhanden | |
| | | Risiken für Umwelt und Gesundheit (z. B. CMR-Stoffe[1], reizend, bioakkumulativ) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |

[1] Stoffe, die als karzinogen (krebserzeugend), keimzellmutagen (erbgutverändernd) oder reproduktionstoxisch (fortpflanzungsgefährdend) eingestuft sind

| | | | | |
|---|---|---|---|---|
| | | Sonstige Risiken (z. B. Brennbarkeit) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Gesamtrisiko | Geändertes Risiko durch die Substitution (Gesamteinschätzung und Begründung) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| **3 Verbessertes Handling und verbesserte Lagerung von Chemikalien im Hinblick auf Risikovermeidung/-verminderung** | Vorhandene Informationsgrundlage | Sicherheitsdatenblatt für gefährliche Substanzen nach GHS | ☐ vorhanden<br>☐ nicht vorhanden | |
| | | Wird die Information aktiv genutzt (von den Arbeitern gelesen, gibt es Aushänge am Produktionsort oder Trainings)? | ☐ ja<br>☐ teilweise<br>☐ nein | |
| | Zahl und Ausmaß von Arbeitsunfällen | Anzahl der Arbeitsunfälle pro Jahr | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Schwere der Arbeitsunfälle | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Exposition von Arbeitnehmern | Art der Exposition (falls möglich separat pro Gefahrstoff) | ☐ dermal<br>☐ inhalativ<br>☐ oral | |
| | | Höhe der Exposition, z. B. Schadstoffkonzentration in der Luft in mg/m³ (separate pro Gefahrstoff) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Expositionszeit in min/Tag (separat pro Gefahrstoff) | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Beschreibung der Maßnahmen, die zur Änderung des direkten Kontakts / der Exposition zwischen Arbeitern und der verwendeten Chemikalie geführt haben (z. B. Schutzausrüstung, Absaugung ist vorhanden und wird verwendet) | | |
| | Unfallrisiken aus der Anwendung von Chemikalien | Änderung des Risikos | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Beschreibung der Ursachen für die Risikoänderung (z.B. Durchführung einer Gefährdungsbeurteilung oder Risikobewertung (z. B. nach TRGS[2] 400), vorhandene Betriebsanweisungen für den Umgang mit der Chemikalie (z. B. nach TRGS 555), Ableitung und Durchführung von (Präventions-)Maßnahmen, Wahrscheinlichkeit und Schwere von Arbeitsunfällen) | | |

[2] Technische Regel für Gefahrstoffe

Indikatoren-Checkliste für die Nachhaltigkeitskriterien von Chemikalienleasing

| | | | | |
|---|---|---|---|---|
| | Unfallrisiken aus der Lagerung von Chemikalien | Änderung des Risikos | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | | Beschreibung der Ursachen für die Risikoänderung<br>(z. B. Anweisungen zur korrekten Lagerung (und Zusammenlagerung mit anderen Chemikalien nach TRGS 510) bzw. zum Handling (z. B. bei Anlieferung, Verwendung) der bereitgestellten Chemikalie durch den Lieferanten, Ableitung und Durchführung von (Präventions-)Maßnahmen, Wahrscheinlichkeit und Schwere von Arbeitsunfällen) | | |
| **4 Wirtschaftliche und soziale Vorteile werden generiert: Ein Vertrag sollte die Ziele der kontinuierlichen Verbesserungen und eine faire sowie transparente Aufteilung der wirtschaftlichen Vorteile zwischen den Vertragspartnern enthalten** | Kosten beim Anwender | z.B. €/Jahr<br>Wenn möglich aufzuteilen in Kosten für Chemikalien, Instandhaltung, Energiebedarf, Reklamationen, etc. | ☐ verringert<br>☐ gleich<br>☐ erhöht | |
| | Wirtschaftliches Ergebnis beim Anbieter | z.B. €/Jahr | ☐ verbessert<br>☐ gleich<br>☐ verschlechtert | |
| | | Beschreibung der Veränderung der Geschäftsbeziehung zum Kunde (z. B. alleiniger Lieferant, langfristige Planungssicherheit etc.) | | |
| | Geschäftsmöglichkeiten | Neue Kunden oder Absatzchancen? | ☐ ja<br>☐ nein | |
| | | Neue Erfüllung von Anforderungen für Label, Zertifikate etc.? | ☐ ja<br>☐ nein | |
| | | Neue Geschäftsentwicklungen oder Innovationen? | ☐ ja<br>☐ nein | |
| | Qualifizierung von Mitarbeitern | Stunden für Aus- und Weiterbildung pro Mitarbeiter und Jahr (wenn möglich mit Nennung der Themen) oder Beschreibung der Änderungen in der Personalstruktur und/oder -kosten | ☐ mehr Qualifizierung<br>☐ gleich | |
| | Schaffung neuer Arbeitsplätze | Anzahl der Arbeitsplätze auf der Anwenderseite, die mit der Anwendung in Verbindung stehen | ☐ mehr<br>☐ gleich<br>☐ weniger | |
| | | Anzahl der Arbeitsplätze beim Anbieter, die mit der Anwendung in Verbindung stehen | ☐ mehr<br>☐ gleich<br>☐ weniger | |
| **5 Monitoring der Verbesserungen im Sinne der oben genannten Kriterien** | Messung der Indikatoren für die Kriterien 1-4 | Werden die relevanten Parameter gemessen (Monitoring)? | ☐ ja<br>☐ teilweise<br>☐ nein | |
| | | Wurde ein verbesserter Monitoringprozess eingeführt? | ☐ ja<br>☐ teilweise<br>☐ nein | |

## 10.3 Protocol of the 5th meeting of the national working group on Chemical Leasing (in German)

26.10.2016, Berlin, Umweltbundesamt, Bismarckplatz 1, Raum 1134

11:00-16:00 Uhr

**Teilnehmende:**

- Abraham, Veronika (BiPRO; Protokoll)
- Blum, Christopher (UBA)
- Bunke, Dirk (Öko-Institut)
- Decker, Nils (UNIDO)
- Düzenli, Nurdan (BMUB)
- Ehold, Verena (BMLFUW)
- Geiß, Ralph (UBA)
- Hanek, Martin (CSC JÄKLECHEMIE)
- Joas, Reinhard (BiPRO)
- Kaltenegger, Ingrid (Joanneum Research)
- Leuschner, Cornelia (BMUB)
- Saecker, Steffen (SAFECHEM)

**Eröffnung**

Herr Blum eröffnete das Treffen des Arbeitskreises (AK). Zu Beginn stellten sich alle Teilnehmenden kurz vor.

In Abstimmung mit allen Teilnehmenden wurden die für den Nachmittag vorgesehenen Diskussionspunkte zu derzeitigen politischen Entwicklungen vorgezogen und das aktuelle Forschungsprojekt mit seinen Indikatoren und dem Tool für Chemikalienleasing (ChL) wurde am Nachmittag vorgestellt.

**Präsentation Herr Blum**

Herr Blum stellte aktuelle politische Entwicklungen im Bereich ChL und nachhaltige Chemie vor. Er ging dabei auf die Eröffnung und Rolle des International Sustainable Chemistry Collaborative Centre ($ISC_3$) ein.

Anschließend stellte er das aktuelle Forschungsprojekt „Chemikalienmanagement nachhaltig gestalten: Nachhaltigkeitskriterien für Chemikalienleasing weiterentwickeln und in Fallstudien anwenden“ (FKZ 3715 65 401) mit seinen Hintergründen und Zielen vor.

Des Weiteren verwies Herr Blum auf die neue ChL-Website, die nun auf der Seite des Umweltbundesamts zu finden ist. Die bisherige Seite www.chemikalienleasing.de leitet auf diese neue Seite weiter.

Abschließend wies Herr Blum noch auf die OECD-Aktivitäten im Bereich ChL hin, die das Geschäftsmodell bewerben und stärken will.

**Präsentation Herr Decker**

Herr Decker stellte das ChL-Toolkit vor, das unter http://chemicalleasing-toolkit.org/ zu finden ist. Das Toolkit ist Teil der IOMC Toolbox for Decision Making in Chemicals Management. Zusätzlich erwähnte Herr Decker, dass die ChL-Website der UNIDO http://www.chemicalleasing.org/ derzeit überarbeitet wird und in den nächsten Wochen online geht.

### Präsentation Frau Ehold

Frau Ehold nannte kurz verschiedene österreichische Aktivitäten zu ChL. Anschließend ging sie auf die „Joint Declaration“ von UNIDO, Österreich, Deutschland und der Schweiz zu ChL ein. Diese soll am 21. November in Wien unterzeichnet werden.

### Weitere Themen aus der Diskussion

Herr Joas wies darauf hin, dass die GIZ zunehmend Interesse an ChL zeigt und derzeit verschiedene Aktivitäten im Bereich der Textilindustrie anlaufen.

Die Teilnehmenden führten eine offene Diskussion zur Frage, ob ChL im Extremfall auch ohne Chemikalien möglich ist, solange die Funktion erfolgt und die Abrechnung auf dieser Basis erfolgt (Service-orientierte Bezahlung).

### Präsentation Frau Abraham

Am Nachmittag stellte Frau Abraham die im aktuellen Forschungsprojekt erarbeiteten Unterkriterien und Indikatoren für die ChL-Nachhaltigkeitskriterien vor. Die Teilnehmenden diskutierten diese anhand der Indikatoren-Checkliste und machten Vorschläge zur Anpassung. Diese wurden in die überarbeitete Liste aufgenommen.

### Präsentation Herr Bunke

Herr Bunke stellte Theorie und Praxis von SMART 5 vor, dem Tool zur Datenerfassung und Dokumentation der Indikatoren für ChL. Die Teilnehmenden diskutierten über Möglichkeiten zur Anpassung und Verwendung des Tools. Die Hinweise aus der Diskussion wurden in die neue Version des Tools aufgenommen.

## 10.4 Letter of invitation for the workshop on 19 October in Munich (in German)

Sehr geehrte Damen und Herren,

das Umweltbundesamt lädt Sie gemeinsam mit BiPRO und Öko-Institut herzlich ein zum

**Workshop**
**Nachhaltiges Chemikalienmanagement durch Chemikalienleasing**
**Erfolge realisieren und messen**

**am Donnerstag, den 19.10.2017**
**von 10.00 bis 16.00 Uhr**
**Werinherstraße 79, 81541 München**

Die Veranstaltung richtet sich an alle Interessierten aus Unternehmen, Verbänden, Behörden oder Forschungseinrichtungen. Ziel ist es, die Teilnehmenden über Chemikalienleasing zu informieren, Möglichkeiten zum Messen der Erfolge aufzuzeigen und Erfahrungen auszutauschen. Dazu werden die Indikatoren und das Instrument „SMART 5" zusammen mit Ergebnissen von Fallstudien vorgestellt.

Wir bitten um eine Anmeldung bis zum 30. September 2017 per Email an dirk.dekoepper@uba.de und veronika.abraham@ramboll.com.

Weitere Informationen erhalten Sie per Email sowie unter www.chemikalienleasing.de im Laufe der nächsten Wochen zusammen mit der detaillierten Tagesordnung sowie einer Wegbeschreibung.

Wir freuen uns über Ihr Kommen und eine vielfältige Diskussion!

Mit freundlichen Grüßen

Dr. Christopher Blum und das Projektteam

Umwelt Bundesamt
Dr. Christopher Blum
IV 1.1 International Chemicals Management
Sustainable Chemistry Scientific Officer
Chemical Leasing German Focal Point
www.chemikalienleasing.de

Umweltbundesamt
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RAMBOLL

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Institut für angewandte Ökologie
Institute for Applied Ecology
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**Hintergrund und Ziel**

Chemikalienleasing ist ein innovatives, serviceorientiertes Geschäftsmodell, das entscheidend zur Entwicklung einer nachhaltigen Chemie und zu den globalen nachhaltigen Entwicklungszielen der Agenda 2030 beitragen kann, indem es u.a. für die beteiligten Akteure Anreize zur Verringerung des Chemikalienverbrauchs sowie zur Optimierung und Substitution schafft. In Deutschland und weltweit existieren in verschiedenen Branchen zahlreiche erfolgreiche Chemikalienleasing-Anwendungen. Die fünf Nachhaltigkeitskriterien für Chemikalienleasing haben sich auf nationaler und internationaler Ebene zu einer wichtigen Voraussetzung für die Akzeptanz, Qualitätssicherung und weitere Verbreitung des Geschäftsmodells entwickelt.

Neben diesen Erfolgen konnte sich das Geschäftsmodell bisher nicht flächendeckend ausbreiten. Gleichzeitig sind viele der bestehenden Kooperationen nicht ausreichend quantifiziert.

Das Umweltbundesamt führt daher zusammen mit der BiPRO GmbH und dem Öko-Institut e.V. ein Forschungsprojekt zu Chemikalienleasing durch. In diesem Projekt werden die Nachhaltigkeits-kriterien für Chemikalienleasing weiterentwickelt und in Fallstudien angewendet. Mit dem Instrument „SMART 5" wurde eine standardisierte Methode zur Evaluierung von Chemikalienleasing-Anwendungen entwickelt, die Chemikalienherstellern, -anwendern oder anderen Akteuren die Einführung und vor allem Dokumentation ihrer Chemikalienleasing-Anwendungen erleichtern soll.

Darüber hinaus möchten wir uns mit Ihnen zu aktuellen Entwicklungen im Bereich Chemikalienleasing austauschen. Wenn Sie ein Thema oder Informationsangebot haben, dass Sie gerne bei dem Treffen präsentieren wollen, können Sie uns dies gerne bis zum 23.09. übermitteln.

## 10.5 Agenda of the final workshop (in German)

**Workshop**

# Nachhaltiges Chemikalienmanagement durch Chemikalienleasing

## Erfolge realisieren und messen

**am Donnerstag, den 19.10.2017**
**von 10.00 bis 16.00 Uhr**
**Werinherstraße 79, 81541 München**

| | |
|---|---|
| 10:00 | Registrierung und Kaffee |
| 10:15 | **Cornelia Leuschner, BMUB**<br>Grußwort und Eröffnung des Workshops |
| 10:25 | **Dr. Christopher Blum, UBA**<br>UBA Aktivitäten zu Chemikalienleasing und nachhaltiger Chemie |
| 11:00 | **Dr. Reinhard Joas, BiPRO**<br>Chemikalienleasing im Kontext von REACH, SAICM und nachhaltiger Entwicklung |
| 11:30 | **Emina Alic, UNIDO** *tbc*<br>Aktuelle Entwicklungen zu Chemikalienleasing auf internationaler Ebene |
| 12:00 | *Mittagspause in der Kantine* |
| 13:30 | **Prof. Dr. Dirk Bunke, Öko-Institut**<br>Indikatoren für Chemikalienleasing und das Instrument SMART 5 |
| 14:00 | **Veronika Abraham, BiPRO**<br>Umsetzung von Chemikalienleasing in verschiedenen Branchen |
| 14:30 | *Kaffee* |
| 15:00 | **alle Teilnehmenden**<br>Moderierte Diskussion zu Erfolgsfaktoren, weiteren Möglichkeiten und Hemmnissen für Chemikalienleasing |
| 15:50 | **UBA**<br>Schlussworte und Ende des Workshops |

Umwelt Bundesamt

Dr. Christopher Blum
IV 1.1 International Chemicals Management
Sustainable Chemistry Scientific Officer
Chemical Leasing German Focal Point
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## 10.6 Protocol of the workshop on 19 October in Munich (in German)

### Teilnehmende

| Name | Vorname | Organisation |
|---|---|---|
| Abraham | Veronika | BiPRO |
| Alic | Emina | UNIDO |
| Barth | Friedrich | ISC3 / GIZ |
| Blum | Christopher | UBA |
| Bunke | Dirk | Öko-Institut |
| Doll | Constanze | BMWi |
| Joas | Reinhard | BiPRO |
| Leuschner | Cornelia | BMUB |
| Oldenburg-Nazaruk | Karin | BMW |
| Saecker | Steffen | SAFECHEM |
| Schulte | Jorma | Ramboll |
| Senoner | Florian | BiPRO |
| Stein-Schaller | Brigitte | BMW |

### Themen und Diskussionsergebnisse

Eintreffen der Teilnehmenden und Begrüßung

Vortrag „UBA Aktivitäten zu Chemikalienleasing und nachhaltiger Chemie“ (C. Blum)

- Nachhaltige Chemie, Bezug zu den Sustainable Development Goals
- Kurzvorstellung Chemikalienleasing (ChL) und Nachhaltigkeitskriterien
- Zusammenhang von ChL, Nachhaltiger Chemie und nachhaltiger Entwicklung
- UBA Aktivitäten zu ChL und Nachhaltiger Chemie

Vortrag und Diskussion „Chemikalienleasing im Kontext von REACH, SAICM und nachhaltiger Entwicklung“ (R. Joas)

- ChL trägt wesentlich zur Erreichung verschiedener politischer Ziele (z.B. SAICM) und zur Einhaltung der Chemikaliengesetzgebung bei (REACH)
- Aktuell laufen die Vorbereitungen für die Klima-COP 23[33] in Bonn; ChL kann auch für die Erreichung klimapolitischer Ziele einen Beitrag liefern
- Side Events auf der COP 23 finden sowohl vom ISC3 als auch von UNIDO statt; im Rahmen von beiden bestehen Möglichkeiten für die Einbindung von ChL
- ISC3 plant Kurzfilme rund um Nachhaltige Chemie, die bestehenden Filme über ChL könnten hierfür (teilweise) verwendet werden; z.B. ein Film zur Wasseraufbereitung bei der Ölförderung

[33] 23. “Conference of the Parties” (COP) der UN Framework Convention on Climate Change (UNFCCC)

- ChL hat für die Autorisierung von TRI[34] unter REACH Vorteile, wie längere Zulassung (bis 7 Jahre), u.a.
    - durch freiwillige Selbstverpflichtung zur Umstellung auf ChL,
    - damit einhergehend sind Risiko- (z.B. auch Einsatz weniger gefährlicher Chemikalien) und Mengenreduktion,
    - Expositionsmessungen beim Kunden als Selbstverpflichtungen,
    - Training und Tools zum Umgang,
    - ⇨ Mainstreaming von ChL; z.B. sind mittlerweile ca. 90% der SAFECHEM-Kunden auf ChL umgestellt
- Pestizideinsatz in der Landwirtschaft: hierzu wurde im Projekt ein ChL-Fallbeispiel angestoßen welches auch einen Versicherungsschutz für Fehlberatung in der Pestizidanwendung beinhaltet
- Hemmnisse für ChL sind: Normen, fehlendes Know-how beim Anbieter, Zulassungen z.B. im Bereich der Pharmaindustrie, Kombination aus Vielzahl von Lieferanten und schnell wechselnden Prozessen z.B. in der Textilfärbung; Chemikalienverwendung ist Kernprozess des Unternehmens und es besteht die Gefahr von Know-how Verlust

Vortrag „Aktuelle Entwicklungen zu Chemikalienleasing auf internationaler Ebene“ (E. Alic)

- Überblick über UNIDOs ChL 4.0 Projekt
- UNIDO ist im Austausch mit der Ellen MacArthur Foundation zu ChL
- Awareness Raising für ChL im Rahmen von den insgesamt ca. 30 Side Events von UNIDO auf der COP 23; außerdem soll ChL auch auf der General Conference der UNIDO im November thematisiert werden
- Wesentliche Elemente des Awareness Raisings: Award 2018, neues ChL Buch mit Beiträgen auch aus Deutschland, Österreich und der Schweiz; Joint Declaration of Intent

Vortrag „Indikatoren für Chemikalienleasing und das Instrument SMART 5“ (D. Bunke)

- Vorstellung von Checkliste und Instrument SMART 5 für die Erfassung der ChL Nachhaltigkeitskriterien
- SMART 5 ist auch für die Planung eines ChL-Vorhabens denkbar, wenn z.B. Abschätzungen hinsichtlich Einsparungen gemacht werden

Vortrag „Umsetzung von Chemikalienleasing in verschiedenen Branchen“ (V. Abraham)

- Vorstellung verschiedenen ChL-Fallstudien aus den letzten Jahren zusammen mit einigen ihrer Ergebnisse
- Diskussion zur Verwendung von ChL in der Automobillackierung: in hochkomplexen und -optimierten Lackierprozessen in der deutschen Automobilindustrie bzw. in Industrieländern im Allgemeinen ist ChL nicht denkbar; jedoch für Metallteilreinigung, evtl. Vorbehandlung der Karosserie und für Kühlschmierstoffe

Moderierte Diskussion zu Erfolgsfaktoren, weiteren Möglichkeiten und Hemmnissen für Chemikalienleasing

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[34] Trichlorethylen

- Vorteile durch ChL müssen besser kommuniziert werden: Branchendialoge zusammen mit dem ISC3 wären ein mögliches Mittel; z.B. in Kooperation mit Cefic als Start auf europäischer Ebene und Industrievertretern z.B. aus der Autoindustrie
- Neben den Aktivitäten wie dem Award können Anreize aus dem Markt heraus die Verbreitung von ChL fördern; diese können z.B. über Roundtables und lokale Dialoge generiert werden
- Smart Cities sind ein möglicher Bereich zur Weiterentwicklung mit viel Potenzial für die Zukunft; Chemikalien in Städten sind bereits Thema unter GEF
- BMWi kann auch zur Verbreitung beitragen, u.a. durch Einbindung in bestehende Gesprächsformate wie Branchendialoge, bei denen es 2018 z.B. um Innovation geht

Die Präsentationen wurden bereits separate an das UBA übermittelt.

## 10.7 Information material for ACEA

ACEA, Brussels

# Chemical Leasing support material provided by BiPRO to the members of ACEA as follow-up of the meeting and discussions on 12 Sep. 2017 in Brussels

21 September 2017

bipro

Part of Ramboll Environ

# Chemical Leasing background and definition

## In a nutshell

- ✓ Chemical Leasing is an innovative business model, that shifts the focus from selling volumes to selling the function or service rendered by chemicals.
- ✓ The application of Chemical Leasing leads to process optimisation, economic benefits for chemical supplier and user, improved business relationships and environmental and health benefits.
- ✓ Chemical Leasing is promoted and supported by UNIDO[1] and the governments of Austria, Germany, and Switzerland; more countries are expected to sign the "Joint Declaration"

## Official definition

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 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.

## 5 sustainability criteria

i. Reduction of adverse impacts for environment, health, energy and resource consumption caused by chemicals and their application and production processes
ii. Improved handling and storage of chemicals to prevent and minimize risks
iii. No substitution of chemicals by substances with a higher risk
iv. 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
v. Monitoring of the improvements needs to be possible


[1] United Nations Industrial Development Organization

## Global Chemical Leasing Award

- Acknowledges successful Chemical Leasing applications and related activities worldwide
- Presented by UNIDO and the governments of Austria, Germany, and Switzerland
- 3 successful Chemical Leasing Awards since 2010
- Next Award ceremony: 6 November 2018, Vienna, Austria
- Further information will soon be available here
- In 2014, a Chemical Leasing application for anti-corrosion in the automotive sector from Colombia won the Gold Award
- Applications

## Chemical Leasing toolkit

An online toolkit for companies and policy makers to learn about and implement Chemical Leasing:
http://chemicalleasing-toolkit.org/

**Highlights**

- Case studies from different sectors, e.g. metal parts cleaning in the automotive industry
  http://chemicalleasing-toolkit.org/sites/default/files/chl_casestudy_serbia_auto2.pdf
- Implementation of Chemical Leasing in 3 steps
  http://chemicalleasing-toolkit.org/node/11
  - Preparation
  - Development and Implementation
  - Monitoring and Evaluation

## Homepages, reports and further information

**International Chemical Leasing website**
http://chemicalleasing.org/

**Chemical Leasing websites in German**
Germany:
https://www.umweltbundesamt.de/chemikalienleasing-portaleinstieg#textpart-2
Austria:
https://www.bmlfuw.gv.at/greentec/chemikalien/chemikalien-leasing-und-gruene-chemie.html

**Chemical Leasing video**
https://www.youtube.com/watch?v=Dst2PMreujc

**Reports (examples)**

- OECD 2017: The Economic Features of Chemical Leasing
- UNIDO 2016: Global Promotion and Implementation of Chemical Leasing Business Models in Industry, including an overview of the activities between 2005 and 2015 and the way forward
- UNIDO 2016: Chemical Leasing info sheet

- UNDIO 2015: Chemical Leasing within industrial and service sector cleaning operations, including reviews of 5 Chemical Leasing applications from the automotive and aerospace industries
- UBA 2014: Resource efficient businesses in practice by applying the alternative business model Chemical Leasing, potentials and challenges in Germany
- Scientific papers, press and book articles
    - Environmental Science and Pollution Research 2015: Chemical Leasing in the context of sustainable chemistry
    - "The Guardian" 2014 article on Chemical Leasing

## Contact

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