IAMC Toolkit

Innovative Approaches for the Sound Management of Chemicals and Chemical Waste

Company XYZ

Innovation Assessment Report

Insert picture of the production process

Consultants
Contributor 1
Contributor 2
….

Company XYZ
Contributor 1
Contributor 2
….

Place, date

READ ME PLEASE

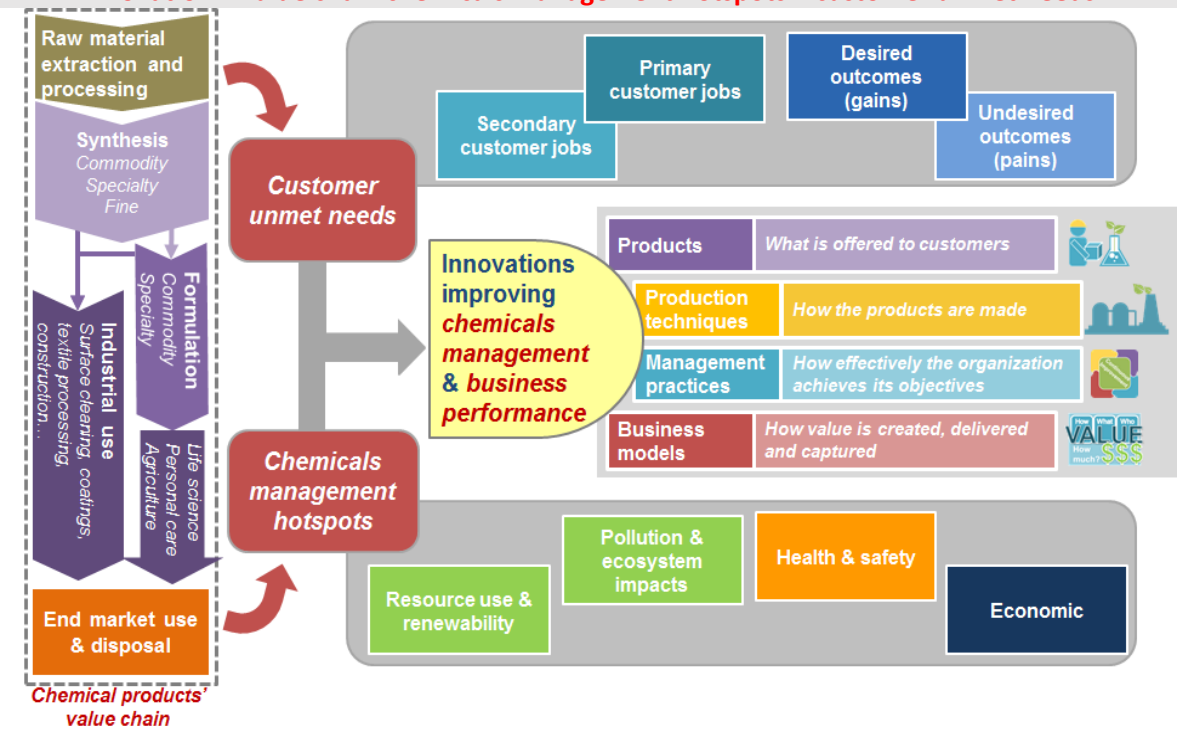
PROJECT OBJECTIVES

The objective of this approach is to support **manufacturers and industrial users of chemicals in using innovation to improve their sustainable management of chemicals while simultaneously improving business performance**. This means, identifying chemicals management hotspots and innovating ways to achieve the following across the value chain:

- ⇨ Improving overall business productivity and generating value for customers
- ⇨ Improving resource productivity (chemicals, water, energy, other materials)
- ⇨ Reducing pollution intensity, especially chemical waste
- ⇨ Improving health and safety of society and the environment by reducing risk of accidents and preventing exposure to chemicals with adverse acute or chronic impacts
- ⇨ Eliminating hazardous chemicals/processes or substituting them with safer and economically feasible ones
- ⇨ Substituting chemicals based on non-renewable resources with those based on renewable resources

Improved business performance is achieved by identifying the unmet needs of direct customers and end markets in the context of the chemicals management hotspots. The company can use the unmet needs in the value chain to address environmental, social and economic impacts while improving business performance through targeted innovations.

Innovation = value chain chemicals management hotspots + customer unmet needs



The targeted innovations for improving chemicals management performance along the value chain can be categorised as improvements in:

A. Goods & services (products)
B. Production techniques (i.e. more efficient and safer processes for making and providing the products)
C. Management and organisational practices (e.g. SHE systems, quality management, material efficiency programmes, etc.)
D. Business models (e.g. Chemical Leasing)

This company innovation assessment builds upon the results of the pre-assessment. The **main outputs of this innovation assessment** include:

1. Overview of the product portfolio and company's business strategy for growth
2. The most important chemicals management hotspots inside the company and along the value chain (e.g. use and end of life stages)
3. Unmet needs in the value chain that offer potential for new business opportunities for the company
4. Root causes of chemicals management hotspots
5. Prioritised options to be implemented
6. Implementation and monitoring plans
7. Review of implemented options
8. Programme for continuous improvement

HOW TO USE THIS TEMPLATE

This company innovation assessment template has been prepared by ISSPPRO and CSD engineers and contains guidance to support the National Cleaner Production Centre in carrying out the toolkit methodology.

The target audience for this report is the company, as well as UNIDO and therefore the report should contain enough information so that a reader unfamiliar with the company can understand the main outputs.

The headings in this outline provide a structure that is recommended for the innovation assessment report. The structure of the report follows the methodology used in the IAMC toolkit. Refer to the IAMC toolkit for additional guidance and technical information on specific innovations.

Throughout this document, guidance regarding the content in each section is provided in grey boxes like this one. The boxes should be deleted before submitting the final report to UNIDO. Standard text and tables are provided which can be used as a basis to summarise key data and outputs.

You can choose to submit this report to the company or provide them with summary report.

Text highlighted in yellow must be changed to the actual situation. Milestones or issues that must be decided mutually with the company management are highlighted in blue.
**Some sections provide added value but are not mandatory: these are indicated by the statement "(this section is optional)".

There are two phases foreseen to this assessment with each phase being submitted for feedback from the international expert (either ISSPPRO or CSD):
Phase 1: Assess the company's chemicals management hotspots and customer unmet needs to generate innovative options (from "Getting started" up to and including "Generation of innovative options")
Phase 2: Screen and select and develop the options to be implemented at the company and develop an implementation and monitoring plan (from "Selection of options" up to and including "Review & continuous improvement"

FINDING INFORMATION

Note: the information in the innovation assessment is to be filled out by the consultant, not the company. Once filled in, sections of the report can be provided to the company for confirmation. It is of course possible for a company to use the template for their own internal purposes.

The following points are recommended for getting important information:

1. **Focus on getting information required to generate the main outputs of the innovation assessment** (product portfolio and growth strategy; chemicals management hotspots inside and outside the company; unmet customer needs in the value chain). Make sure the information is specific enough to be actionable.
2. **Minimise the time invested by the companies.** First perform desktop research before contacting the company. In particular:
    a. Product portfolio: this information is usually on their website if they have it. If not, ask for a brochure or any other information they have. Summarise the information for their confirmation.
    b. Information on the production process: research first before and try to identify any chemicals of concern used in the process.
    c. Information on the chemicals management impacts: the company will only typically know its own impacts and maybe those of its customers. You will need to do more desktop research here.
3. **Arrange a site visit to**: a) confirm existing information, b) fill in important missing information. It might be helpful to bring a questionnaire with you to get the information.

GLOSSARY

Business productivity: is basically a measure of the effectiveness and efficiency of your organisation in generating output with the resources available.

Productivity = output / input and can be physical or financial. Labour and capital productivity are typical productivity indicators used by SMEs.

Chemical of concern (CoC): a chemical that is of moderate to high concern for ecotoxicity or human toxicity or presents a risk for accidents, but is not a chemical of high concern (CoHC). In the IAMC approach, a chemical is considered a CoC if it is not a CoHC but meets at least one of the following criteria:

a) has a GHS signal word of "DANGER",
b) is classified as an allergenic (respiratory or skin sensitization, category 1, 1A and 1B; containing H334 or H317),
c) is classified as environmentally hazardous, long-term effects (hazardous to the aquatic environment, chronic category 1 and 4: H410 or H413), or
d) is found on California's Candidate List (https://calsafer.dtsc.ca.gov/chemical/search.aspx)

You can search for substances in the EC ECHA 'Information on Chemicals' portal and view GHS classifications according to the CLP directive.
http://echa.europa.eu/information-on-chemicals

Chemical of high concern (CoHC): a chemical that meets any of the following criteria: i) carcinogenic, mutagenic, or toxic to reproduction (CMR); ii) a persistent, bioaccumulative and toxic substance (PBT); iii) endocrine disruptors or neurotoxins; iv) a chemical whose breakdown products result in a CoHC that meets any of the preceding criteria.

For the IAMC approach, a chemical is considered a chemical of high concern if it is listed on the ChemSec SIN List: http://sinlist.chemsec.org/

Operational excellence: is an integrated programme or management system for continuous improvement and safely creating long-term value.

Pollution intensity: pollution intensity is a measurement of how much pollution (air emissions, waste, wastewater) you generate per unit of product output. In measuring pollution intensity, waste and emissions are seen in relation to production. Pollution intensity = pollution / product output.

Product: a product is anything that can be offered to a market that might satisfy a want or need. Products can be a physical or tangible good (e.g. cotton yarn, IT programme), an intangible service (e.g. dyeing of cotton yarn to customer specifications), or a combination of goods & services (e.g. printing machine (good) with free optimization (service)).

Resource productivity: is a measurement that shows how much product you produce per unit of resource (material, water, energy) used. Resource productivity = product output / resource input. Resource productivity is a measure of how productively resources are being used to produce the desired products and/or services.

Sound management of chemicals: aims to prevent, and where not feasible, to minimise the potential for exposure of people and the environment to toxic and hazardous chemicals. This includes prevention, reduction, remediation, minimisation, and elimination of risks from chemicals during their value chain.

Chemicals management impact: economic, social or environmental impacts involving the management of chemicals. The impacts result from a cause or action and can be positive or negative.

Chemicals management hotspot: is a cause of one important or a group of many economic, social and environmental impacts. Hotspots can be at a company and/or across a chemical product's value chain. An example hotspot could be lead in paint which causes many health and environmental impacts over the paint's value chain.

Unmet need: an unmet need is a business need that is important to the customer and is not being met or fully satisfied by the current products being offered or available.

Value added: it represents the wealth created through the organisation's production process or provision of services. Value added measures the difference between sales and the cost of materials and services incurred to generate the sales.

Value added = sales – cost of purchased goods and services.

Innovation assessment summary

This section is the most important chapter and should provide a summary of the main project findings for management (you may choose to only provide this summary to management in the end). It can include:

- brief overview of the aim of the innovation assessment
- brief overview of the innovation assessment process and timeframe conducted by the consultant (e.g. site visits, desktop research, workshops, surveys, expert interviews, etc.).
- brief description of the company and its business (what products & services it sells, its main customers and markets)
- a description of the company's main activities and process units
- the most important chemicals management hotspots identified and why: inside the company and along the value chain (e.g. use and end of life stages)
- unmet needs in the value chain that offer potential for new business opportunities for the company
- root causes of chemicals management hotspots
- prioritised options to be implemented
- implementation and monitoring plans (just mention that they exist)
- review of implemented options
- programme for continuous improvement

Conclude with any next steps (follow up actions) recommended by the innovation team.

Contents

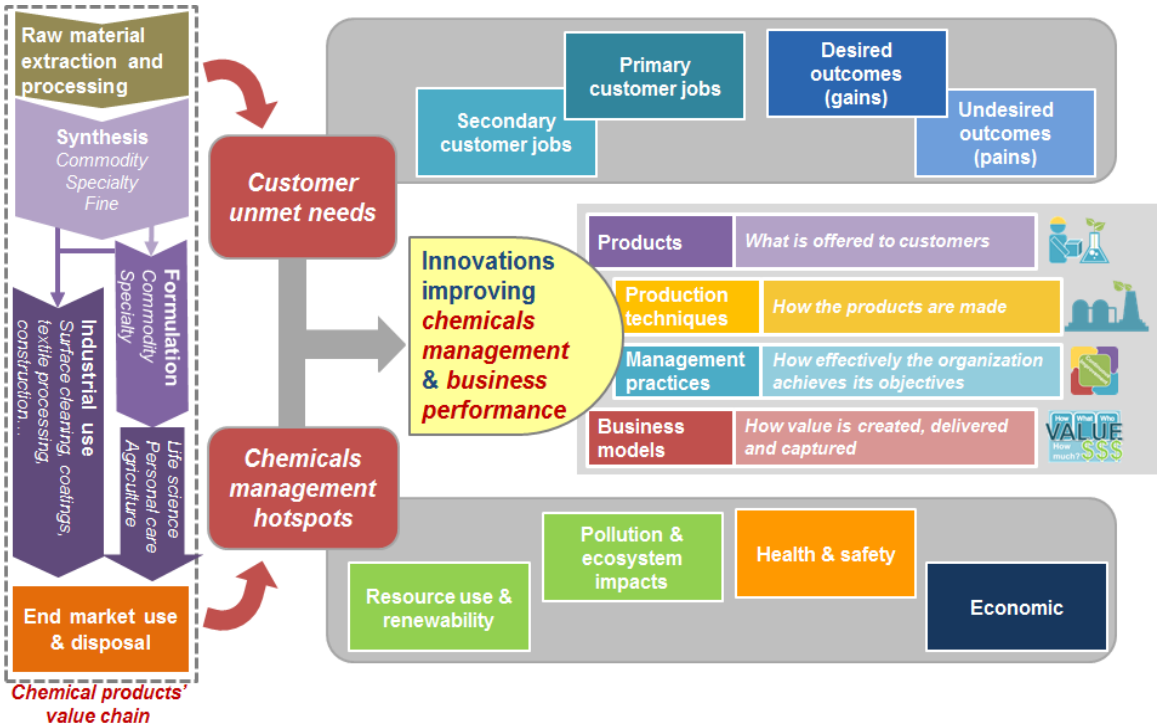
1 Introduction

1.1 Background

This innovation assessment report has been prepared as demonstration project under the joint UNIDO-UNEP Programme on Resource Efficient and Cleaner Production (RECP). The objective of the IAMC approach is to support manufacturers and industrial users of chemicals in using innovation to improve their sustainable management of chemicals while simultaneously improving business performance. This means, identifying chemicals management hotspots and innovating ways to achieve the following across the value chain:

- ⇨ Improving overall business productivity and generating value for customers
- ⇨ Improving resource productivity (chemicals, water, energy, other materials)
- ⇨ Reducing pollution intensity, especially chemical waste
- ⇨ Improving health and safety of the society and environment by reducing risk of accidents and preventing exposure to chemicals with adverse acute or chronic impacts
- ⇨ Eliminating hazardous chemicals/processes or substituting them with safer and economically feasible ones
- ⇨ Substituting chemicals based on non-renewable resources with those based on renewable resources

The approach serves the purpose of improving the local environment, occupational and public health and economic benefits for individual businesses (e.g. cost savings, increased competitiveness, access to new markets) and also the larger regional economy (e.g. overall improved competitiveness).



Improved business performance is achieved by identifying the unmet needs of direct customers and end markets in the context of the chemicals management hotspots. The company can use the unmet needs in the value chain to address sustainability concerns and increase business performance through targeted innovations.

The targeted innovations for improving sustainability performance along the value chain can be categorised as improvements in:

A. Goods & services (products)
B. Production processes (i.e. more efficient and safer processes for making and providing the products)
C. Management and organisational techniques (e.g. SHE systems, quality management, material efficiency programmes, etc.)
D. Business models (e.g. Chemical Leasing)

The consultant company name (and country) was established in 1999.

1.2 Objectives

The main outputs from the innovation assessment are:

- A description of the company and its business (what products & services it sells, its main customers and markets)
- A description of the company's experience with innovation and operational excellence
- A description of the company's main activities and process units
- Identification of the important chemicals management hotspots including supporting research: inside the company and along the value chain (e.g. use and end of life stages)
- Unmet needs in the value chain that offer potential for new business opportunities for the company
- Root causes of chemicals management hotspots
- Prioritised options to be implemented
- Implementation and monitoring plans
- Review of implemented options
- Programme for continuous improvement

2 Getting started

The purpose of this section is to provide the necessary background information on the company in order to understand how the company provides value to its customers.

This is an important step in order to support the company to innovate sustainably. Here you will:

- Characterise the company's strategy and product portfolio
- Characterise the company's experience with operational excellence, sustainability and innovation
- Set ambitions and form an innovation team

2.1 Description of company XYZ's value chain

Table 1. Basic company data

Company name	
Address, phone, contact email, website	
CEO	
No. employees	
Turnover [USD], if available	
Company type	Synthesis / Formulation / Industrial user of chemicals
Markets	e.g. Halogenated chemicals, printing inks, processed yarns and threads

2.1.1 Company product portfolio overview

This section provides an overview of the primary and secondary product lines the company offers to companies. Briefly complete the tables below.
Note: most information should already be available from the company screening template.

Product (good & service) offer:
Specify the primary product lines (goods & services) offered to customers. Be sure to describe both the goods and the services. Indicate which product lines are for domestic and/or export markets.

Product (good & service) use description - is the product:
(a) an end product for consumption? (b) integrated in an end market consumer product, or (c) an auxiliary chemical?
Specify use by type of customer (if relevant)

Market characterisation – provide information (if available) on:

- Market geography and respective volume (either total market or target market), and annual growth rate
- Market structure (supply or demand?; regulated; quickly changing) and type (e.g. low-cost or niche market, new or established market, high number of competitors, etc.)

Target customer segment:
Describe the main customer segments the product lines are sold to.

Table 2. Primary product portfolio

Product (good &service) offering	Product use description	Market characterisation	Target customer segment
Product xy			
…			

Table 3. Secondary product portfolio

Product (good & service) offering	Product use description	Market characterisation	Target customer segment
Product zz			
…			

2.1.2 Overview of trends affecting the company's business

Research the company's market in more detail to identify the potential risks and opportunities related to the sound management of chemicals. The results should be referenced (e.g. company, desktop research, survey, reports, etc.)

Structure your research according to the following trends:
Market trends:

- how is consumer demand or preferences, supply chain pressures, etc. affecting the company and its future? Are eco-labels being demanded by customers?
- are there social changes such as demographic change (e.g. aging population) or economic changes (e.g. financial crises) that are shaping the market?

Example: the LEED[1] certification (or similar green building certifications) offers new market opportunities to manufacturers of construction chemicals to produce e.g. formaldehyde-free resin-based products.

Regulatory/policy trends:

- how is law/regulation by national or exporting markets affecting product, production and sales?
- are policies (e.g. sustainable public procurement, renewable energies) a driver?

Example: REACH SVHC, Global Alliance to Eliminate Lead Paint.

Technology trends:

- What new technologies (production methods, materials, IT-solutions) are influencing the market?

Example: production of PLA-based polymers from renewable resources, process intensification, 3D printing, etc.

Market trends:

Insert here potential risks and opportunities with explanation.

Regulatory/policy trends:

Insert here potential risks and opportunities with explanation.

Technology trends:

Insert here potential risks and opportunities with explanation.

[1] Leadership in energy & environmental design. For more information: http://www.usgbc.org/LEED/

2.1.3 Company strategy for growth

The IAMC approach focuses on innovation to improve the sustainable management of chemicals by the company and improve business performance. Therefore, it is important to know the company's current growth strategy so that any recommended innovation is aligned with that strategy.

Choose at least one of the following strategies that the company uses or plans to use to achieve growth:

i. Market penetration (increase market share with existing products)
ii. Product development (new products in existing market)
iii. Market development (new markets with existing products)
iv. Diversification (new markets with new products)

⇨ **Describe each strategy for growth in 2-3 sentences.**

Go here for more information:
http://www.quickmba.com/strategy/matrix/ansoff/

2.2 Company XYZ's experience with operational excellence, sustainability and innovation (this section is optional)

The purpose of this section is to provide an overview of the company's level of experience dealing with sustainability, innovation and operational excellence.

This will influence the level of ambition the company has for the first year of the project and identify what management systems may be prioritised.

2.2.1 Experience with operational excellence

Operational excellence:

- Is there an integrated programme or management system for continuous improvement and safely creating long-term value[2]? Does it have a clearly stated mission and role in the company?
- Are key performance indicators (KPI) used to drive business operations and decisions? Which type of KPIs? (These could be sustainability indicators, profitability indicators, etc.) How are they reported and reviewed (daily/weekly/monthly operational review)?
- Does the company have the following?:
  - SHE management system (safety, health, environment): e.g. updated risk assessment and management system, chemical storage rules, management of change, emergency response plan, identified responsibilities, behaviour safety rules, etc.?
  - Overall improvement programmes: quality management (e.g. ISO9000), Lean Six Sigma, total quality management, EMS (e.g. 14001), etc.
  - Functional improvement programmes: reliability and maintenance improvement, energy or water conservation, value stream mapping, etc.

[2] Operational excellence typically has the following benefits: improved SHE performance, reduced risk, improved productivity and business effectiveness, improved capital effectiveness, improved reliability and reduced variation.

KPIs used for strategic and operational decision-making	Some example indictors: • Sustainability: number of chemicals of concern; material productivity, energy productivity, water productivity, pollution intensity, etc. Total productivity: labour and capital • Sales & value: profit margin, value added-to-sales ratio, delivery-on-time, defect rate • Labour: labour cost competitiveness • Capital: overall equipment effectiveness, capital intensity •
SHE management systems	• Enter systems and experience here
Overall improvement programmes	• Enter programmes and experience here
Functional improvement programmes	• Enter programmes and experience here

2.2.2 Experience with sustainability

Sustainability:

- What does the company understand under the term "sustainability"? (i.e. economic, environmental and social aspects)
- What are the top 2 sustainability improvements undertaken by the company in the last 4 years?
- Does the company include sustainability in its strategy? If so, how? (e.g. does it have KPIs for environmental and social aspects?)
- Does the company integrate sustainability aspects in its operations? If so, how? Operations include: purchasing, sales & marketing, logistics, production, R&D (new product development), human resources, etc. For example, does the company practice "green procurements"?
- Do they measure and report water, carbon, or environmental footprint of production?
- Does the company look at the sustainability impacts of its business operations over its products' entire value chain? If yes, how?
- According to the company understanding of "sustainability", what are the main issues / challenges the company is facing?

Briefly describe the top 2 sustainability improvements in last 4 years	Insert experience here
How is sustainability included in the company's strategy?	Insert experience here
How is sustainability included in the company's operations?	Insert experience here
How does the company look at the sustainability impacts of its business operations over the entire value chain	Insert experience here

2.2.3 Experience with innovation

Innovation:

- Is there an R&D department? What are the 2 most important projects they have done in the last 4 years?
- Is there an existing innovation team? Which departments are on the team?
- What top 2 innovation projects have been implemented in the last 4 years? What category of projects? For example, good housekeeping, process optimisation, product modification, business model improvement, etc.
- How successful were the innovations? How was the success measured?
- What was learned? How has the knowledge been included in the innovation process at the company?

R&D department	• Describe the role of the R&D department at the company • Briefly state the 2 most important projects done in last 4 years
Innovation	• Describe the role of the innovation team at the company • Briefly state 2 most important projects done in last 4 years and category of innovation
Innovation management	• State how does the company measure success? • State how lessons learned are incorporated into the innovation process

2.2.4 Summary

Use the preceding answers to complete the following table and determine the company's level of experience.
How to fill out the table: based on the information collected, choose one level for each column and summarise with a short explanation.

Finally, identify management systems or programmes that would greatly benefit the company in the next 1-2 years. These can be included in the list of options for continuous improvement.

Table 4. Level of experience in OE, sustainability and innovation

Experience level	Operational excellence	Sustainability	Innovation
Low			
Medium			
High			

Table 5. Recommended improvements in areas of OE, sustainability and innovation

Operational Excellence	Examples: • Organisational: for example, integrate sustainability into the company by building and using KPIs to guide strategic and operational decisions • SHE: update risk assessments using IAMC toolkit, implement management of change
Sustainability	• Enter recommendations here.
Innovation	• Enter recommendations here.

2.3 Ambitions and innovation team

Depending on the experience of the company, company management should set a starting ambition as to what level of sustainability performance should be achieved in the next year. The ambition should be increased as the company becomes more experienced.

Some examples of ambitions include:

Increasing ambition

- Establish good practice hazard management of chemicals on-site and minimize the risk of exposure and accidents
- Improve resource efficiency and reduce
- Improve safety of products and processes by using safer alternative chemicals
- Incorporate life cycle thinking in the design of products & services to improve sustainability performance over the product's complete life cycle
- Improve the product's life cycle sustainability performance with new business models (e.g. Chemical Leasing)

Secondly, an innovation team should be formed to lead and coordinate the programme. The team should include colleagues:

- who understand the whole facility, the value chain, and key partners and stakeholders (such as customers, suppliers, local authorities)
- decision makers from different departments such as: marketing & sales, purchasing, finance, legal, logistics, production, R&D, quality control, HSE, etc.
- with different ways of approaching problems and collaboration: e.g. creative, seeing connections, organising ideas, motivating, etc.

Ambition for year 1 of the IAMC approach: state the ambition here.

Table 6. Innovation team

Name	Organisation (company or consultant)	Position at organisation	Role in team

3 Assessment of chemicals management hotspots

Innovation in the sound chemicals management (SCM) comes from integrating chemicals management hotspots with the unmet or underserviced needs of direct and end market customers.

The goal of this section is to finalise the chemicals management hotspots across the value chain with high impacts on human health and the environment

- **Confirm the impacts and hotspots** identified during the pre-assessment and fill in any critical missing information gaps.
- **Propose activities** that should be considered **for continuous improvement** (e.g. installing process measurement equipment, performing a risk assessment, conducting customer surveys)

Chemicals management impacts can be categorised as follows:

- **(RU) Resource use and renewability** (chemicals, energy, water, other materials), e.g.:
  - How efficiently are the resources used?
  - Are the resources renewable?
  - What happens to the materials at end of life: are they reused, recycled, landfilled, incinerated, etc.?
- **(PE) Pollution and ecosystem impacts**, e.g.:
  - Are there wastes or end of life products?
  - Do emissions by the company or along its products' value chain impact local or regional ecosystems?
  - Is the product biodegradable at end of life?
  - Does the degradation of chemical product at end of life have negative impacts?
- **(HS) Health and safety** (supply chain workers, consumers, society)**:**
  - Is there potential for exposure to toxic and hazardous chemicals (CoC or CoHC) during production or in the use and/or disposal of the chemical products?
  - Is there is potential for accidents during production at the company or during use by customers or during disposal at end of life?
- **(EF) Economic factors**:
  - Are there factors causing high costs or low profits at the company or in the value chain (e.g. its customers or end market?)
  - Is there a risk to availability of critical raw materials?
  - Are there impacts due to market conditions and competition?

3.1 Map of the main chemicals management impacts at the company

3.1.1 Summary of Chemicals of Concern

The subsection summarises the chemicals of concern (CoC) and chemicals of high concern (CoHC) used at the company.

Characterising chemicals: make sure that you have information on the chemicals used in the products and processes and type of waste produced before starting.

- Use the company's chemical inventory to screen for chemicals of concern (CoC) and chemicals of high concern (CoHC).
  - If the company does not have a chemical inventory, then research typical types of hazardous chemicals used in this industry (should also have seen this in section 2.1.2 and look for them during the pre-assessment audit
- Refer to the glossary for definitions of CoC and CoHC.

Table 7. Overview of chemicals of concern used at the company

Identifier (CAS#, chemical name)	CoC or CoHC[1]	GHS Signal Word & hazard classification & hazard statement[2]	Purpose of use (ingredient, processing chemical, auxiliary)[3]	Functionality (what properties it has, why it is used)	Amount [kg/month]
CAS#, chemical name	CoHC	Danger / Warning carc. cat 1A, H350 – may cause cancer			

[1]**CoHC or CoC determination:**
Chemical of high concern (CoHC): found on the SIN LIST (http://sinlist.chemsec.org/)
Chemical of concern (CoC): Not a CoHC and meets at least one of the following criteria:
a) has a GHS signal word of "DANGER",
b) is classified as an allergenic (respiratory or skin sensitization, category 1, 1A and 1B; containing H334 or H317),
c) is classified as environmentally hazardous, long-term effects (hazardous to the aquatic environment, chronic category 1 and 4: H410 or H413), or
d) is found on California's Candidate List (https://calsafer.dtsc.ca.gov/chemical/search.aspx)

N/A: not applicable. Neither a CoC nor a CoHC. Has a harmonised GHS signal word of "WARNING" or has "no hazards classified".

[2]**Comments under GHS classification:**
No harmonised classification: This means that there is no official harmonised classification under the EC CLP regulation.
REACH dossier consensus on classification by majority of submissions: There is no official harmonised CLP classification, however hazard classifications are available from the REACH dossiers provided by companies or consortiums of companies. Use these classifications if the REACH dossiers submitted by the companies have a general consensus on the classifications.
No hazards classified: This means the substance has been evaluated under REACH and there are no hazards according to the majority of notifications provided by companies to ECHA in CLP notifications, no hazards have been classified. This means that the chemical can be considered non-hazardous and safe to use.

[3] **Purpose of use**: ingredient in final product, process chemical (e.g. solvent or detergent used for cleaning a product or equipment), or auxiliary chemical (e.g. refrigerant for cooling that does not come into direct contact with product)

The following chemicals are considered **chemicals of concern (CoC)**:

...		

➲The hazards for these chemicals should be well understood and protective measures should be undertaken to prevent: a) the exposure of workers in the case of health hazards, b) risk of fire or explosions in the case of physical hazards, and c) the release to the environment in the case of environmental hazards.

The following chemicals are considered **chemicals of high concern (CoHC)**:

...		

➲ These chemicals should be eliminated or substituted as soon as possible where economically and technically possible. If it is not possible to eliminate or substitute the CoHC with a safer alternative, high levels of protective control measures must be implemented to minimise the risk of exposure of workers at the company and in the supply chain as well of consumers and society in general.

3.1.2 Description of production processes

This section contains a general description of the production line(s) at the company. At least a half page is required to provide an adequate description.

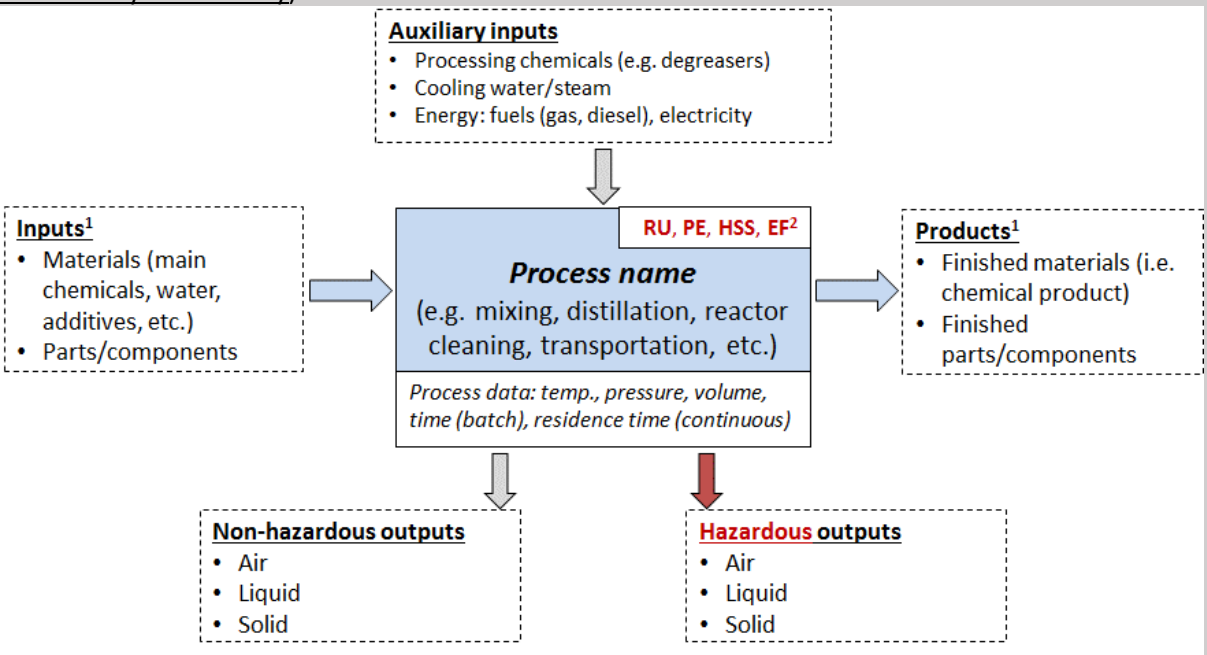
To understand the production, be sure to briefly describe:

- The products being produced on each product line. State if multiple products are produced on the same equipment. State if there are multiple equipment used for the same process (e.g. 3 mixers, 2 filters, one filling station, etc.).
- The full production process: from receiving orders, purchasing raw materials, receiving of raw materials, storage…. until the final production steps, quality control, and delivery to customer. Also describe the pollution control equipment, on-site recovery (e.g. distillation), and any cleaning and maintenance procedures that are done as part of production.
- level of automation and process control

The text should refer to the plant layout and block flow diagram (see below)

Block flow diagram

Draw the main processes with inputs and outputs, as follows (the processes can be drawn either horizontally or vertically):



Legend:

[1] Indicate materials that are hazardous or contain hazardous substances with a '*HSS' as superscript.

[2] Impacts listed in this box refer to the following categories of sustainability impacts that are used throughout this approach:

- (RU) Resource use and renewability (chemicals, energy, water, other materials), e.g.
  - How efficiently are the resources used (in particular chemicals)?
  - Are the resources renewable?
- (PE) Pollution and ecosystem impacts, e.g.
  - What waste is emitted from the company?
  - What are the impacts of air emissions, wastewater or chemical waste?
  - Is there ecosystem degradation?
- (HS) Health and safety, e.g.
  - What are the chemicals of concern and chemicals of high concern? What are their impacts across the product's value chain?
  - Is there potential for exposure to toxic and hazardous chemicals during production (including handling) of chemicals?
  - Are there risks to supply chain workers, consumers and society?
  - Are there risks of accidents during production?
- (EF) Economic factors, e.g.
  - high costs, low profits
  - availability of supply
  - low-cost market

Tips:

- Be sure to indicate hazardous substances or materials containing hazardous substances with a '*HS' in superscript.
- Include all processes that have impacts (e.g. purchasing, loading/unloading chemicals, storage, cleaning of reactors, maintenance, auxiliary processes, etc.) in addition to the main production processes.
- Naming convention: recommend using numbers for inputs/outputs (e.g. 1, 2, ..) and E1, E2, E3… for equipment.
- Consider the whole product system (e.g. consider also the plastic bottle used to package the detergent)
- Inputs & outputs should be normalised (e.g. based on production unit).
- Draw each path to its complete end (e.g. what happens to the hazardous waste? How is it treated? Any social/environmental impacts?)
- Draw on large flipchart papers first

Insert plant layout here.

Figure 1. Plant layout of company XYZ.

Insert production block flow diagram here.

Figure 2. Production block flow diagram. Product lines produced on this production line are: product group ZZ, product group QQ, and ...

3.1.3 Summary of resource use and productivity

The following summarises the level of resource use (i.e. how efficiently the company produces its products) and productivity at the company.

The following indicators are based on the UN Publication 'Enterprise-level Indicators for Resource Productivity and Pollution Intensity'. Refer to this publication for more details. http://www.unido.org/en/resources/publications/energy-and-environment/industrial-energy-efficiency/resource-productivity-guide.html

If the resource productivity values are not known:

1. Focus on the most important chemicals;
2. Estimate using rules of thumbs, mass balances, or educated guesses;
3. Follow-up later with more detailed analysis or measurements if the resource stream is selected as a chemicals management hotspot.

Table 8. Overview of material productivity (excluding water). Values are a monthly average from the period month 1 to month? (at least 4 months are recommended) .

ID	Stream description	unit	value	Material productivity [X product / kg material consumed or used]
5	Processing chemical: H_2SO_4 @ 96% for pickling	ton	XX	20 m^2 pickled steel surface / kg (96%) H_2SO_4
9	Ingredient: Zn in hot acid-Zn bath			70 m^2 Zn-plated steel surface / kg Zn
	Total			

Table 9. Overview of water productivity. Values are a monthly average from the period month 1 to month? (at least 4 months are recommended).

ID	Stream description	unit	value	Water productivity [kg product / kg water consumed]

Table 10. Overview of energy productivity. Values are a monthly average from the period month 1 to month? (at least 4 months are recommended).

ID	Stream description	unit	value	Energy productivity [kg product / kJ]
	Natural gas	e.g. MJ		
	Diesel			
	Electricity			

Factors affecting productivity

The following summarises productivity performance at the company. It aims to identify the main production bottlenecks. Bottlenecks can be:

- equipment (e.g. capacity too small, unplanned outages (equipment failure or problems);
- inputs (e.g. inadequate supply of raw materials, quality problems of raw materials, electricity supply problems);
- staff (e.g. not enough workers, not properly trained, etc.)
- management systems (e.g. production is much less than production capacity because much time is lost changing between orders for different products, difficult to forecast orders and plan production optimally, etc.)

Table 11. Overview of productivity bottlenecks

Does the company have a productivity measure? If yes, what is it?
Equipment bottlenecks: enter description.
Inputs bottlenecks: enter description.
Staff bottlenecks: enter description.
Management system bottlenecks: enter description.

3.1.4 Summary of main waste impacts

The subsection summarises the main waste streams. Be sure to include the location and cause of the pollution. For example, is there waste due to bad product quality? Poor storage practices?

If the values are not known:

1. Focus on the most important waste impacts;
2. Estimate using rules of thumbs, mass balances, or educated guesses;
3. Follow-up later with more detailed analysis or measurements if the waste stream is selected as a chemicals management hotspot.

Table 12. Overview of main pollution streams. Values are a monthly average from the period Month 1 to Month ?.

ID	Stream description	unit	value	Intensity [kg output/kg product]
	Emissions (e.g. VOC)			
	Hazardous waste			
	wastewater			

The main sources of pollution occur here and are caused by ….

3.2 Map of chemicals management impacts over the product's value chain

This section provides an overview on how to map the product's value chain for each of the following value chain stages:

- Chemical product manufacturing (includes input chemicals)
- Transportation, distribution& retail
- Direct customer; end market customer; End of Life

Notes:

1) Choose one of the most important product groups. Importance can be determined by company revenue, strategic importance, or chemicals management impacts.
2) it is not necessary to include steps in the value chain before the company unless there are significant impacts.
3) The most important impacts will be summarised in the chemicals management impacts summary table in section 3.3.

Recommended method:

- Choose one of the most important product groups. Importance can be determined by company revenue, strategic importance, or chemicals management impacts.
- Draw the value chain diagram from left to right. Start writing the main stages of the value chain at the top. You can modify or include additional stages.
- Use the same procedure that was used to characterise the company level. Use the same method for process description, and inputs & outputs. Use the same method for indicating important impacts (e.g. *RE, *HS, etc.)
- Do not redraw all processes from the preceding company analysis; combine processes together where appropriate and draw only **main** inputs & outputs, and the **main** impacts
- Consider the whole product system (e.g. consider also the plastic bottle used to package the detergent or if the product is integrated in another end product)
- Base the value chain analysis on the "functional unit" of the product. Define the basis for the analysis.
  - Example: the function of an anti-corrosive paint is to keep a surface protected. The functional unit for a paint system may be defined as XXm^2 unit surface protected for 10 years.
- Could any chemicals be recycled or be replaced by chemicals based on renewable resources?
- Impacts of chemicals used along the value chain:
  - What chemicals do upstream and downstream actors use because of your products? Are they hazardous? Should they be eliminated or substituted? How could safety be improved?

Some tips:

- Start with the company and move up and down the value chain until it is completed.
- Use as many processes as necessary (combine where practical) in each stage to represent the value chain accurately. Include all processes that have impacts (e.g. cleaning of reactors, maintenance, auxiliary processes, etc.) in addition to the main production processes.
- Consider the different Uses and End-of-Life scenarios for different customer segments (e.g. an ABS resin could be sold to manufacturers of phone parts or car parts. Both end products would have different Use impacts and different End of Life impacts).
- Draw each path to its complete end (e.g. what happens to the hazardous waste? How is it treated? Any social/environmental impacts?)
- Draw on large flipchart papers first

Important: not all information will be known by you or by the company. Identify if critical information is missing in order to identify the most important chemicals management hotspots. Brainstorm ways to obtain this critical information (desktop research & estimations, interviews, customer contact, trade association, etc.).

Table 13. Overview of CoC and CoHC at company XYZ and over the value chain of product group ZZ, QQ, ….

	At Company	In Value chain[2]
Chemicals of concern (CoC)[1]		
Chemicals of high concern (CoHC)[1]		

[1] for each chemical: state chemical name, reason for concern, and functionality.
[2] specify where in the value chain this chemical is found.

Insert product's value chain here

Figure 3. Value chain map for product groups ZZ, QQ, and …

3.3 Chemicals management hotspots

The goal of this section of the innovation assessment is to identify chemicals management hotspots in the company and over the product's value chain. Identify at least one hotspot inside the company and one outside the company.

Chemicals management hotspots are the causes of economic, social or environmental impacts where the:

- Impact in one or more phase is much larger than the other impacts
- Impacts cover more than one phase of the value chain and/or impact category
  - e.g. lead in paint has toxicity and resource efficiency impacts during the raw material extraction, pigment production, paint formulation, industrial use, consumer use, and end of life phases.
- Impacts are strategically important to the company's current or future business performance

Other examples include:

Cosmetics industry

Use of chemicals of concern in beauty salons cause serious health problems for workers and customers:

- Dibutyl phthalate: makes nail polish pliable. Interferes with reproductive hormones, cause irritation eyes, mouth and throat in production and use. Suspected of bio-accumulation in end of life.
- Banned from cosmetics in the EU. No restrictions in the US as of yet.

Textile industry

- Approximately 25% of all chemicals are used in the textile value chain (from agriculture to production to washing/dry-cleaning)
- Chemicals of concern are detected in finished clothes and in wastewater in production and have led to the zero discharge of hazardous chemicals (ZDHC) initiative by Brands

Table 14. Summary of chemicals in company XYZ product's value chain recommended to be eliminated or substituted by safer chemicals and/or chemicals based on renewable resources.

CoC/CoHC used by company to be eliminated or substituted by a safer alternative	
CoC/CoHC used in value chain to be eliminated or substituted by a safer alternative	
Chemical to be recycled from end of life or to be substituted by a chemical based on renewable resources	

Table 15. Overview of chemicals management hotspots inside company XYZ

Hotspot description	Impacts	Possible solutions

Table 16. Overview of chemicals management hotspots outside company XYZ and in the value chain of product group XX

Hotspot description	Impacts	Possible solutions

4 Assessment of customer unmet needs

The goal of this section of the innovation assessment is to identify unmet needs of the company's direct customers and end market customers. Innovation in the sound management of chemicals comes from integrating chemicals management hotspots with the unmet needs of direct and end market customers, thereby creating ways to simultaneously improve chemicals management and improve business performance.

Select the most important product offerings (goods & services mix), and describe the unmet needs for the direct customer and end customer segments by filling out the table below. Describe their key jobs, pains and gains and rate their respective importance.
** Be sure to be specific and brief when describing the jobs, pains and gains.

Optional: In order to help you fill in the tables, you can use the value proposition canvas also shown below.

Customer segment description (most information should already be available in section 2.1):
- What is the market description of the customer segment?
- What are the customer segment's goals and values?

Key customer jobs questions:
- What functional jobs is the company helping its direct customers get done?
- What functional jobs is the company helping the customers of its customers (end market) get done?
- Are there additional social or emotional jobs that direct or end market customers need help getting done?
- How do jobs differ between the direct customers and the end market customers?

Customer pains questions:
- What are possible negative outcomes or problems faced when doing their key jobs?
- What are the main risks and obstacles related to doing their key jobs?
- What keeps them customers awake at night?

Customer gains questions:
- What positive outcomes do the customers expect and require?
- What benefits (expected, desired, unexpected) are customers looking for?

4.1 Overview of customer segments (this is optional)

Table 17. Overview of company XYZ's direct and end market customer segments for product groups XX, QQ….

Direct customer segment 1: State segment name	Description: e.g. market, position in value chain, their customers. Goals: what are the goals of the customer segment? Values: what do customers value more than price (e.g. quality and functional performance, reliability of supply, innovation improving the customers quality/reliability, etc.). Differentiation: how is this customer segment different from others?
Direct customer segment 2: State segment name	Description: e.g. market, position in value chain, their customers. Goals: what are the goals of the customer segment? Values: what do customers value more than price (e.g. quality and functional

	performance, reliability of supply, innovation improving the customers quality/reliability, etc.). Differentiation: how is this customer segment different from others?
End market customer segment 1: State segment name	Description: e.g. market, position in value chain, their customers. Goals: what are the goals of the customer segment? Values: what do customers value more than price (e.g. quality and functional performance, reliability of supply, innovation improving the customers quality/reliability, etc.). Differentiation: how is this customer segment different from others?
End market customer segment 2: State segment name	Description: e.g. market, position in value chain, their customers. Goals: what are the goals of the customer segment? Values: what do customers value more than price (e.g. quality and functional performance, reliability of supply, innovation improving the customers quality/reliability, etc.). Differentiation: how is this customer segment different from others?

4.2 Value Proposition Canvas (this is optional)

The following figure is the value proposition canvas for enter product group and the enter customer segment .

PRODUCT OFFERS (GOODS & SERVICES) ##	**GAIN CREATORS** ##		**GAINS** ##	**CUSTOMER SEGMENTS** ##
	PAIN RELIEVERS ##		**PAINS** ##	

Table 18. Overview of the unmet needs for company XYZ's direct and end market customer segments (product groups XX, QQ….)

	Direct customer	End market customer	Does the product offering help customers with jobs, pains and gains? How?[2] Highlight unmet jobs, pains, gains in red.
Customer jobs[1]	1. Job XX 2. Job YY 3. …	1. Job QQ 2. Job ZZ 3. …	
Customer pains: bad outcomes, risks and obstacles[1]	1. Pain XX 2. Pain YY 3. …	1. Pain QQ 2. Pain ZZ 3. …	
Customer gains[1]	1. Gain XX 2. Gain YY 3. …	1. Gain QQ 2. Gain YY 3. …	

[1] Prioritise each job, pain and gain with numbers.
[2] Highlight unmet jobs, pains, gains in red.

Table 19. Overview of the unmet needs and possible solutions (Note: unmet needs are customer and end market jobs, pains and gains that are not currently being met).

Unmet needs	Unmet need characterisation	Possible solution
Unmet need XY	How is the unmet need currently overcome? Why has the unmet need not been satisfied?	
Unmet need PQ	How is the unmet need currently overcome? Why has the unmet need not been satisfied?	
Unmet need …		

5 Generation of innovative options

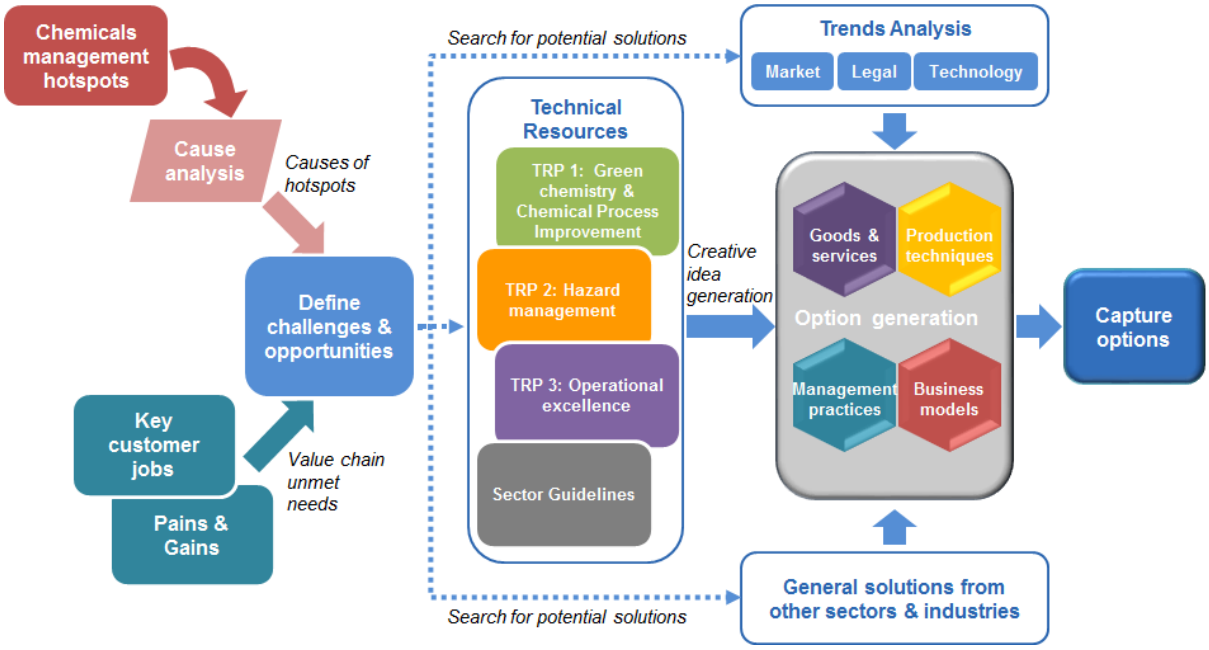
The goal of this section of the innovation assessment is to generate and capture innovative options to improve chemicals management and fulfil customer needs in the value chain.

It involves the following steps:
1. Fill in critical information gaps
2. Summarise challenges and opportunities for improvement
3. Generate innovative options based on chemicals management hotspots and unmet needs
4. Capture options

For step 1, 'Fill in critical information gaps', fill in information gaps for both the priority chemicals management hotspots and the customer unmet needs. To fill in the information gaps, you may need to:
- Perform a more detailed and targeted audit of the company
- Contact and survey customers or end market customers
- Contact and survey material suppliers and technology suppliers
- Survey national or international experts
- Contract consultancy companies or access proprietary databases

The goal of this section of the innovation assessment is to generate and capture innovative options to improve chemicals management and fulfil customer needs in the value chain and consists of the following steps which are illustrated in the subsequent diagram:

1. Defining the challenges and opportunities by summarizing the chemicals management hotspots and the unmet needs in the value chain.
2. Searching for potential solutions according to the hotspots identified (e.g. chemicals of high concern, risk of accidents, water pollution, etc.).
    - Referring to the technical resource packages (TRPs) of this toolkit
    - Analysing market, legal and technological trends
    - Generalising the problem and look for solutions in other sectors and industries
3. Investigating how different dimensions of innovation can lead to improvements
    - Goods & services
    - Production techniques
    - Management practices
    - Innovative business models
4. Capturing the option and how it can improve chemicals management and fulfil customer needs.



5.1 Option generation

Define challenges and opportunities

Making a matrix combining the chemicals management hotspots and the customer unmet needs throughout value chain offers a holistic way to integrate customer value within innovation in chemicals management.

To summarise the chemicals management hotspots and customer unmet needs in the following table as a basis to brainstorm innovative options:

1. Complete the simplified value chain in the middle of a flipchart, including only the most important value chain stages.
2. Briefly state the economic, environmental and health & safety hotspots above the value chain diagram.
3. Briefly state the priority jobs as well as desired and undesired outcomes below the value chain diagram.
4. Brainstorm new innovations to improve chemicals management hotspot, create more value for the company and/or its customers.

The following matrix combines the chemicals management hotspots and the customer unmet needs throughout value chain offers a holistic way. This is used to integrate customer value within chemicals management innovation. The chemicals management hotspots from section 3 and the customer unmet needs from section 4 are summarised in the matrix respectively.

Table 20. Summary of chemicals management hotspots and customer unmet needs in the value chain for product group XYZ

Key customer jobs					
Desired outcomes					
Undesired outcomes					
Value chain stage	**Synthesis/formulation/industrial use (e.g. company XYZ)**	**Direct customer use (specify market, e.g. metal fabricators & coating companies)**	**Transportation, distribution & retail**	**End market use (industrial/consumer)**	**End of life**
Resource use & renewability (RU)					
Pollution and ecosystem impacts (PE)					
Health and safety (HS)					
Economic factors (EF)					

5.1.1 Cause analysis and search for potential solutions

Use the following cause analysis worksheet to summarise the root causes of identified chemical management hotspots AND unmet needs

⇨ Also consider using the '5 Why's' tool to get at the root cause of the identified challenges.

Search for potential solutions to the identified challenges:

- Refer to the technical resource packages of this toolkit:
  - Green Chemistry & chemical process improvement for how improve resource efficiency, reduce pollution, use and make safer chemical products
  - Hazard management for how to make processes safer and reduce risk for workers and downstream users
  - Operational excellence for how to improve business performance and minimise impacts to the environment and human health by implementing operational excellence and innovative business models
- Revisit and analyse sector trends identified in phase 1 'Get started'.
  - Market (consumer), legal and technological trends can point to ways of improving chemicals management hotspots and creating more value for customers

- Generalise the problem and look for solutions in other sectors and industries. Similar or related problems are often already solved and can be adapted to specific situations.
- **Remember to address unmet needs at the company, at the direct customer or in the end market**

You can deliver a workshop with the company to get feedback on potential innovations and come up with new ones.

Note: Although the aim is to generate innovative options and not low-level RECP measures, keep identified low-hanging fruit in the list (e.g. repair condensate return). Typical good housekeeping measures can be grouped together as part of an operational excellence programme which would be considered innovative.

When developing options, consider each of the four dimensions of innovation:

1. **Products (goods and services) and applications -** What is offered to customers:
   - Input material change: substitution of ingredients with non-toxic chemicals, renewable feedstock, secondary (recycled) raw materials and materials with a longer service life-time
   - Product modification: modification of product characteristics to minimise impacts to the environment and human health over its value chain
   - Upgrading of by-products: transformation of waste or low-value by-products into materials that can be sold on the market
   - New applications: e.g. using materials for new applications such as replacing steel by polymers or carbon composites

⇨ Refer to TRP 1, topic C1 'Green Chemistry'

2. **Production techniques** - How the goods and services are made:
   - On-site recycling or recovery: recover and reuse waste material (e.g. solvent)
   - Process change: replace or modify process (e.g. new synthesis route) or processing sequence to improve resource productivity, decrease risk and pollution intensity
   - Equipment modification: replace or modify chemical processing or infrastructure equipment to achieve higher resource productivity and reduce pollution and risk
   - Optimization of process control and process conditions: control existing processes to optimise their performance and minimise adverse environmental, health and economic impacts

⇨ Refer to TRP 1, topic C2 'Chemical process improvement'

3. **Management practices** - How effectively the organisation achieves its objectives:
   - Occupational health and safety management system (e.g. risk assessment, chemical storage rules, workplace rules, emergency response plan)

⇨ Refer to TRP 2 'Hazard management'

   - Overall improvement programmes like ISO 9000 (quality management)

- Functional improvement programmes such as reliability and maintenance, value stream mapping, standard work, chemical transitions and production planning

⇨ Refer to TRP 3, 'Operational excellence'

4. **Business models** - How value is created, delivered and captured:

There are many types of sustainable business models that can be considered:

- Technological: maximise resource efficiency, create value from waste and substitute with renewable and natural processes
- Social: deliver functional rather than ownership, adopt a stewardship role and encourage sufficiency
- Organization: repurpose for society/environment: develop scale-up solutions

Table 21. Cause analysis worksheet and listing of options

Chemicals management hotspot / unmet need	Cause	Innovative option
1. Description of waste stream 1	a. Cause 1 of the waste stream	Option 1 to cause 1 of waste stream 1
		Option 2 to cause 1 of waste stream 1
	b. Cause 2 of the waste stream	Option 1 to cause 2 of waste stream 1
		Option 2 to cause 2 of waste stream 1
2. Description of chemical consumption		
3. Description of chemical of high concern used in product XYZ		

4. Description of accidents related to chemicals handling		
5. Description of ink waste generation and productivity problems at the customers sheet fed printing processes.		

5.2 Capture options

In this step, the option is briefly characterised to explain how it can improve chemicals management and fulfil customer needs. This information feeds into the next section 'Select options'

Briefly fill out the following table for innovative options only. Low-level RECP options (e.g. improve insulation on boiler, repair condensate return)may be grouped together to form an innovative option (e.g. management practices/functional improvement: implement energy efficiency programme). If the low-level RECP options cannot be grouped together, just leave them listed in the 'Cause analysis worksheet' for the company's reference.

- ⇨ Innovative options, not low-level RECP options, are not the focus of this assessment.
- ⇨ The goal here is not to generate the maximum number of low-level options but rather to generate high quality innovative options (i.e. fewer options, higher level of innovation).
- ⇨ Also keep in mind what is feasible for SMEs and the markets in your region.

Note on filling out the template below: only qualitative or approximate values are necessary at this time. You should only need **10mins** to fill out each option description. A more detailed analysis may be necessary in 'Select options'

The options are also classified according to the four dimensions of innovation, each with subcategories:

1. **Products (goods and services) and applications -** What is offered to customers:
   - Input material change: substitution of ingredients with non-toxic chemicals, renewable feedstock, secondary (recycled) raw materials and materials with a longer service life-time
   - Product modification: modification of product characteristics to minimise impacts to the environment and human health over its value chain
   - Upgrading of by-products: transformation of waste or low-value by-products into materials that can be sold on the market
   - New applications: e.g. using materials for new applications such as replacing steel by polymers or carbon composites
2. **Production techniques** - How the goods and services are made:
   - On-site recycling or recovery: recover and reuse waste material (e.g. solvent)
   - Process change: replace or modify process (e.g. new synthesis route) or processing sequence to improve resource productivity, decrease risk and pollution intensity
   - Equipment modification: replace or modify chemical processing or infrastructure equipment to achieve higher resource productivity and reduce pollution and risk
   - Optimization of process control and process conditions: control existing processes to optimise their performance and minimise adverse environmental, health and economic impacts
3. **Management practices** - How effectively the organization achieves its objectives:
   - Occupational health and safety management system (e.g. risk assessment, chemical storage rules, workplace rules, emergency response plan)
   - Overall improvement programmes like ISO 9000 (quality management)
   - Functional improvement programmes such as reliability and maintenance, value stream mapping, standard work, chemical transitions and production planning
4. **Business models** - How value is created, delivered and captured:

There are many types of sustainable business models that can be considered:

- Technological: maximise resource efficiency, create value from waste and substitute with renewable and natural processes
- Social: deliver functional rather than ownership, adopt a stewardship role and encourage sufficiency
- Organisation: repurpose for society/environment: develop scale-up solutions

There are three levels of innovation, with the amount of investment, risk and potential impact on chemicals management and profit increasing as one goes up the innovation level, from incremental to radical:

- **Incremental innovation** is a change that builds on a firm's existing expertise; it is a refinement and continuous improvement of existing aspects of its business and is unlikely to significantly change business performance and carries little risk. Incremental innovation typically focuses on the company's own processes. Examples include: best practice storage of chemicals, process optimization, small equipment modification.
- **Substantial innovation** provides greater potential for improving chemicals management hotspots and increasing value added for the company but also requires more investment and time to implement and carries more risk. Substantial innovations typically concentrate on production techniques (e.g. recovery and recycling of solvents) which significantly improves the company's performance or new products (goods & services) which improve chemicals management impacts at the customer, end market or end of life phase. Examples of substantial innovations in products include substitution of heavy metals in anticorrosion paint, formulation of low VOC paints.
- **Radical innovation** provides for the highest potential gains and risks, and generally requires significant investment in capital and/or personnel. The examples include Chemical Leasing or other innovative business models, chemical recycling of end of life plastics, new green chemistry synthesis process, products with significant impacts across its value chain.

In total, number, e.g. 7 innovative options were generated during the innovation assessment. A brief description of each option is shown in the following tables.

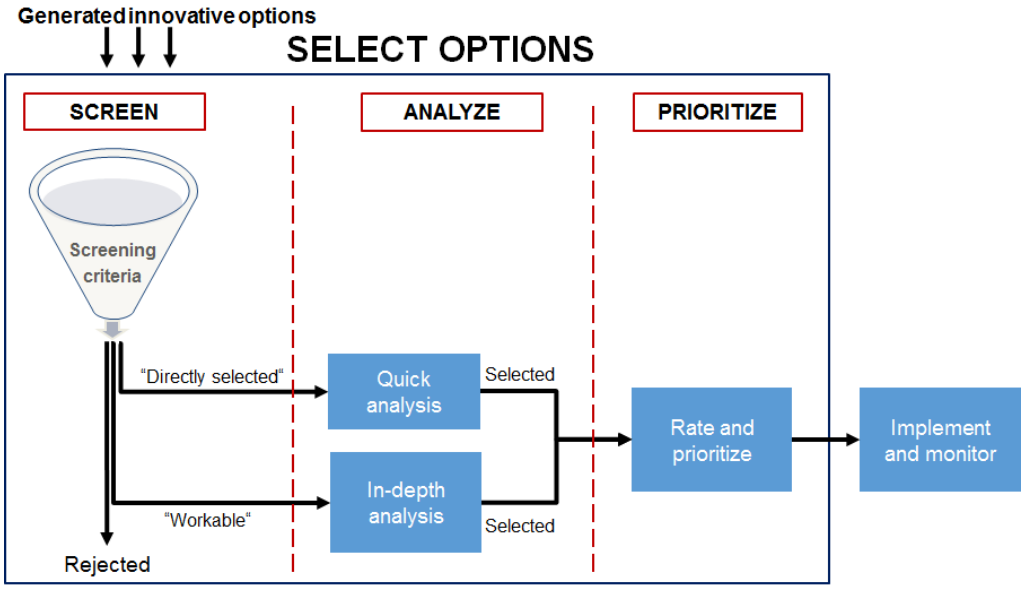
Table 22. A short summary of option number, e.g. 3: name the option

Innovation category[1]	e.g. production techniques: on-site recycling and recovery
Innovation level[1]	Incremental / substantial / radical
Main concept	in 3 sentences or less
Important partners	Who could help you in the know-how gap to develop and implement the option
Value added to customers	
Key customer/end market jobs	Which key customer and end market jobs, if any, does the option address? How important are jobs to the customer?
Expected outcomes	Which desired and undesired outcomes for the direct customer, the end market and the company does the option address? How important are they?
What's innovative?	Is it pioneering, offering something new or unique to the target market?
Chemicals management impacts	
Resource use	How is resource use improved (e.g. decreased resource use, more renewables used)?
Pollution and ecosystem impacts	How are ecosystem impacts due to pollution improved (e.g. decreased environmental impact caused by the company and its products)?

Health and safety	How is health and safety improved (e.g. reduced risks of accidents, elimination of toxic chemicals)?
Economic factors	How are economic factors improved (e.g. added value to customer and end market, growth potential, increased profitability for company)?
Financially viable?	(e.g. being reasonably affordable)? If not, what is preventing the option from being financially viable?
Technically viable?	If not, what is preventing the option from being technically viable?
[1] See the description of the four dimensions of innovation and the levels of innovation in the preceding section.	

6 Selection of options

The innovative options generated in 'Generate options' were categorised according to different types of innovation. These options have been screened, analysed and prioritised for implementation.



6.1 Screen options

The generated options were screened and grouped into:

- **Directly selected**: options where benefits and drawbacks are easily evaluated and which do not require additional in-depth trials or studies
- **Workable**: options which require additional in-depth analysis to determine the benefits and drawbacks
- **Rejected**: options where the drawbacks clearly outweigh the benefits

In total, XX options were rejected; XX were directly selected and XX were categorised as workable and require further analysis.

Use the table below to organise the results of the screening process. A short explanation/comment should explain the grouping of each option. Reasons for rejecting options can be:

- Technical or organisational constraints
- Ecologically not feasible, e.g. because of excessive additional consumption of energy or use of other environmental critical (raw-) materials, etc.

An option should not be rejected just because it cannot be implemented for a certain time period (e.g. can only be implemented next year).

Notes:

1) Although the aim is to generate innovative options, also keep low-hanging fruit in the list. They could be grouped together as part of an operational excellence programme.
2) Keep the same option ID (number) and name (title) constant through the whole report.

The table below shows examples of innovative options and the result of the screening process.

The options which belong to "workable" need further analysis; they will be analysed in the next section.

Table 23. Screening results of identified options

ID	Option name	Dimension[1]	Category[1]	Innovation level[2]	Directly selected	Workable	Rejected	Comments / explanations
1	Substitute lead-based pigments with safer alternatives	Products	Input material change	Substantial		x		Replacing lead-based pigments will require modification of product formulation and will require a feasibility study to evaluate the technical, environmental and financial feasibility of alternatives. Collaboration with key account customers necessary to maximise value offered by the new product.
2	Chemical Leasing BM for heat set ink dispensing units to SME print shops	Business models	Technological business model	Radical		x		A new BM offering SME customers the ability to lease efficient ink dispensing equipment together with heat set inks requires a feasibility study, including a market study.
3	Implement good chemical storage & handling practices	Management practices	Occupational health & safety	Incremental	x			Risk of explosion or fire can be immediately and significantly reduced with little capital investment. Better practices will also slightly reduce hazardous waste generation by 15 kg/month. Training of staff will be required.
4	Replace exhaust textile dyeing process with continuous process	Production techniques	Equipment modification	Substantial			x	Company is still small to economically justify the purchase and operation of continuous textile processing equipment.
5	Upgrading of fuming HCl to a safer and economically viable product	Products	Upgrading of by-product	Substantial		x		Technical and market research required to determine the "best" upgraded product for the regional market. Lab-scale and pilot tests required before commercial implementation can proceed. A feasibility study is required.
6	Energy efficiency improvement programme (e.g. Repair condensate return, boiler insulation, variable speed drives, etc.)	Management practices	Functional improvement	incremental	x	x		This option requires only 20 working hours to implement and will reduce fuel consumption. Feasibility of variable speed drives must be further analysed. Additionally, an energy audit must be conducted.

[1]**Products:** Input material change / product modification / upgrading of by-products / new applications;
Production techniques: On-site recycling or recovery / process change / equipment modification / optimisation of process control and process conditions;
Management practices: Occupational health and safety / overall improvement / functional improvement;
Business models: Technological / focial / Organisation.
[2] **Innovation level**: incremental / substantial / radical.

6.2 Analyse options

The options that are not rejected outright ("directly selected" and "workable") have been analysed according to the following criteria:

- Economic feasibility
- Environmental benefits (resource use, pollution and ecosystem impacts)
- Social benefits such as health and safety
- Technical and organisational viability
- Time required for option implementation: short-term or long-term (0-2 months, 2-6 months, 6-12 months, more than 12 months, etc.)

6.2.1 Quick analysis of directly selected options

Table 24. Analysis of "directly selected" options

ID	Option name	Economic feasibility		Environmental benefits	Health & safety benefits	Technical & organizational viability	Implementation time
		Investment	Savings				
6	Energy efficiency improvement	20 working hours	XX USD / year	XX kg fuel oil per year saved = XX kg of CO_2 avoided per year	Proper insulation of condensate return piping protects personnel against burns	Technical viability Standard tools and supplies (insulation) required to repair leaks Organizational viability Personnel have necessary skills	0-2 months

6.2.2 In-depth analysis of workable options

The purpose of the evaluation step is to compare the benefits and feasibilities of the workable options in order to set priorities for the implementation of the most feasible ones. The rating scale is found in Appendix A.

To prioritise the generated options, it is necessary to set up a workable and clear rating scale that is acceptable to the innovation team and management. An example for such a scale is provided in Appendix A. Depending on the company size and local requirements, the figures in the table should be adjusted by the innovation-team.
For each feasibility criteria (e.g. technical feasibility), the evaluation should follow the description.

In order to understand the calculations done (e.g. by an external person or also for a later monitoring of the befit of the option) it is of importance that the sources of the data used are declared (e.g. estimations, benchmark information (literature source), proposal from technology supplier etc.).

You can use the template below to perform the in-depth analysis of workable options.

6.2.2.1 Option no 1: Substitute lead-based pigments with safer alternatives

Chemicals management hotspot definition

Describe the observations of the present situation, which could be improved (cause analysis).
For example: “Today the 200 m steam pipes are not insulated and at least three steam leaks were observed” or “The spent liquor from dying contains a high amount of dyestuff and is discharged directly to the sewer”.

Option description

Write a clear description of the innovative option.
One example: Installation of one 5 m^3 insulated tank to collect the sterilization water from cleaning of fermenters in section xy. The sterilisation water will be used for the first hot rinse in subsequent cleanings and thereby save energy and water.

Technical and organizational feasibility

The technical and organisational feasibility can be divided into "requirements" and "advantages/disadvantages". **The evaluation score should be indicated at the end of this section.**
For the first part, the following requirements should be considered:

- Description of technical changes or installations of equipment
- Assessing the complexity of the required installation or changes (organizational measure, standard technology to be implemented, new and complex technical change)
- Close-down-time during installation
- Maintenance requirements
- Needs for training
- Needs of additional labour

In the second part the advantages or disadvantages of the options compared to the present situation can be discussed:

- Impacts on product quality

- Impacts on production capacity
- Impacts on production logistics (e.g. gaining time, easier handling etc.)
- Space requirements
- Occupational health and safety aspects

Environmental feasibility

The environmental feasibility should be divided into "drawbacks" and "benefits". Drawbacks can e.g. be higher electricity consumption; and benefits can be expressed as reduced amounts of e.g. of solid waste, emissions, raw material, or energy consumption.
Necessary calculations or estimations should be stated in detail so that persons not involved in the project can follow them also. Reference to the source of information should be provided here (proposal, literature, benchmark, estimations).
The evaluation score should be indicated at the end of this section.

Health & safety feasibility

The health and safety feasibility should be divided into "drawbacks" and "benefits". Drawbacks can e.g. that an alternative solvent, while less toxic, is more flammable thereby increasing the risk of fire and explosion.
Necessary calculations or estimations should be stated in detail so that persons not involved in the project can follow them also. Reference to the source of information should be provided here (proposal, literature, benchmark, estimations).
The evaluation score should be indicated at the end of this section.

Economic feasibility

The economic feasibility should be considered under three sub-headings: "investments", "operational costs and savings", and "payback period". Also here the source of information (estimation, price indication of a supplier, proposal etc.) should be clearly stated.
The evaluation score should be indicated at the end of this section.

Payback period (P):

$$P = \frac{Investment}{Savings} = \frac{Investment}{Cash_{in} - Cash_{out}}$$

with $Cash_{in}$ as annual savings (earnings) and $Cash_{out}$ as annual operational cost

The average capital cost can be included in the cashout as:

$$r * \frac{Investment}{2}$$

With r as interest rate, e.g. 0.08 corresponding to 8% p.a.

For more capital intensive options, use return on investment (ROI):

$$ROI = \frac{\text{Profit}}{Investment} = \frac{Earnings - \left(Operational\ \text{cost} + \frac{Investment}{Lifespan} + r * \frac{Investment}{2} \right)}{Investment}$$

6.2.2.2 Option no ?: title option…

Observations

….

6.3 Prioritise and schedule options

The following table summarises the rating of all selected options and prioritises them for implementation. The options are classified as high, medium and low priority.

You can assign weighting factors to economic, environmental and social impacts in order to come up with a total:

- The sum of all weighting factors should equal 1
- Each company should decide on their own weighting system depending on their priorities.
- Rate economic, environmental and social benefits on a scale of 1 to 5 according to the completed option analysis.
- Appendix A provides rating criteria which companies can adapt to their own requirements.
- Use the rating table to calculate the total score of each option.
- Classify each option as either high, medium or low priority.

The prioritisation should be done with company management.

Table 25. Summary of the options' sustainability impacts, viability and overall priority for implementation.

	Weighting	0.4	0.3	0.3	1.0	0.6	0.4	1.0		
ID	**Option / weighting**	**Environmental rating (1-5)**	**Social rating (1-5)**	**Economic rating (1-5)**	**Overall sustainability (1-5)**	**Technical viability (1-5)**	**Organization viability (1-5)**	**Overall Viability (1-5)**	**Time to implement**	**Priority (low /medium /high**
6	Energy efficiency improvement	3	2	5	3.3	4	5	4.4	1 month	medium
Overall sustainability = Environmental rating * Env. weighting factor + Social rating * Social weighting factor + Economic rating* Econ. weighting factor Overall viability = Technical viability * Technical weighting factor + Organisational viability * Organisational weighting factor										

7 Implementation & monitoring

Before implementing an option, clearly define the benefits expected from implementing the option. You can compare the implementation results to the expected benefits to measure your progress and to learn how to improve.

The following examples show expected results from implementation of various innovations.
Economic benefits and costs:

- Capital investment costs = $25,000, training costs = $1,000
- Material savings = $15,000 p.a., operational savings = $2,000 p.a.

Environmental benefits:

- Reduction of used-solvent waste from 150 kg per tonne of product to 25 kg

Social benefits:

- Eliminate the exposure of workers to VOCs during cleaning operations
- Decrease the chance of severe accidents by a factor of 10

Furthermore, it is important to monitor the implementation and communicate the successful progress to upper management and the company on the innovation projects being implemented. This provides motivation for continuous improvement.

Table 26. Summary of the options' expected results upon implementation

ID	Option	Innovation category	Implementation costs	Economic benefits	Environmental benefits	Social benefits
		e.g. upgrading of by-products				

7.1 Implementation action plans

In this chapter the action plan should be presented. The aim of the action plan is to push the implementation of the innovative options and to define the monitoring tasks of implemented measures. It basically represents a 'to do list' defining tasks, responsibilities and deadlines for the works. It is advisable to set the targets as milestones of the action plan together with the management of the company.
The action plan should cover all the directly implementable options and the selected feasible options. It basically answers the four questions: what, who, when, how:

- What to implement?
- Who is responsible for the implementation of each option?
- When should each option to be implemented (deadline)?
- How to monitor the improvements (e.g. reduced consumption of electricity)?
- Finances and manpower requirements for carrying out the activities can also be addressed in the action plan.

Furthermore, the action plan can also be used to fix deadlines for tasks as:

- Carrying out feasibility study for remaining options;
- Carrying out additional measurements for the layout of new equipment; inquire for detailed proposals;

- Control of progress of the implementation of directly implementable options;
- Carrying out the next innovation assessment.
- Recurring tasks, e.g. when the innovation-team should meet and how often the management should review key-figures from monitoring

The action plan should be discussed and approved by the management.

A possible worksheet for action planning of each option is given in the table below. The innovation-team (mainly the representatives in the team from the companies) are responsible for the introduction of the action plan (check deadlines!).

7.1.1 Implementation of the action plan for option X: option name

Innovative option	No. XX: short description of option		
Main responsible	Ms. Musterfrau	**Implementation period**	XXX to XXX
Main resources	Labour: XY working hours Total investment: XY USD	**Training requirements**	For employees on how to safely and efficiently manufacture the new lead-free paint.
Team members and roles	Mr. Musterman – R&D for lead-free paint development …		

Specific action	Responsible	Resources	Deadline	Comments

7.1.2 Implementation of the action plan for option X: option name

Innovative option	No. XX: short description of option		
Main responsible	Ms. Musterfrau	**Implementation period**	XXX to XXX
Main resources	Labour: XY working hours Total investment: XY USD	**Training requirements**	For employees on how to safely and efficiently manufacture the new lead-free paint.
Team members and roles	Mr. Musterman – R&D for lead-free paint development …		

Specific action	Responsible	Resources	Deadline	Comments

7.2 On-going monitoring

A plan for on-going monitoring should be made for all innovative options, which are going to be implemented. To avoid too much work: "what to monitor", "how to present results" and "who needs the information" should be considered. For most companies the following parameters are most probably routinely elaborated:

- Consumption figures for electricity, fuel/coal, and water for the whole company
- Production data

In many cases there will be a need for a more detailed monitoring program. The only way to continuously improve housekeeping is to monitor the consumption of resources, and to present the results to management and employees. The management should approve the plan for on-going monitoring.

Table 27. Plan for on-going monitoring at the company level

What to monitor?	Who is responsible for the monitoring?	When to monitor?	How to monitor?	Reporting to employees	Reporting to management
Product (or product group) 1	Name	After each shift (daily)	Supervisor keep track of the production	Summarised on a curve for the whole year	Figures and graphs for daily and weekly production
Electricity	Name	Weekly	Reading of main meter	As above + compared with production	Weekly curve compared with weekly production
Coal	Name	Weekly	Tons of delivery + estimate of amount in local storage	As above	As above
Water	Name	Weekly	Reading of main meter	As above	As above
Material 1	Name	Daily	Workers register number of boxes used	On a monthly curve compared with production	As above
Material 2	Name	Weekly	Storage department keep track of the supply to the production	As above	As above
Accidents	Name	Daily	Supervisor	On a monthly curve and safety instructions	Weekly figures

8 Review & continuous improvement

8.1 Review of results and lessons learned

After implementing each option, the company can improve its ability to innovate by asking questions like:

- How do the achieved results compare to the target results?
  - Were the targeted results achieved?
  - What challenges were overcome? Could they have been avoided?

- What did you learn during the option implementation?
  - What would you change to make implementation more effective?
  - What would you change to make the option more sustainable?
  - Did you discover any ideas for new options which could improve the company's sustainability performance?

8.1.1 Review of implemented options

After implementing each option, the company can improve its ability to innovate by asking questions the following question for each implemented option.

General questions:

- How do the achieved results compare to the target results?
  - Were the targeted results achieved?
  - What challenges were overcome? Could they have been avoided?
- What did you learn during the option implementation?
  - What would you change to make implementation more effective?
  - What would you change to make the option more sustainable?

Chemicals management:

- Did you discover any ideas for new options which could improve the company's sustainability performance?
- Were the chemicals management hotspots addressed the most important ones? How could they be measured more accurately?

Offering value to customers:

- Are the customer profiles from phase 2b accurate? Are the job statements and outcome statements accurate and correctly prioritised? How can you test and validate the customer profiles?
- Would a customer profile for the end market, if not already established, present added value? Can you use your innovation network to help create a realistic end market customer profile?
- Did you discover other value chain actors with new or unexpected unmet needs?

8.1.1.1 Review of implemented option no. X: option name

8.1.2 Recommendations to improve innovation management

Based on the results from the implemented options, summarise the lessons learned and make recommendations for improving innovation management.
Consider:

- Applying the lessons learned to other on-going implementation projects
- Formally integrating lessons learned into the company structure (e.g. standard operating procedures, etc.)
- Communicating the success to management and fellow employees to help maintain momentum

8.2 Continuous improvement programme

The IAMC approach is a circular methodology that helps the company to continuously improve its sound management of chemicals and its ability to innovate sustainably.

Recommend elements of a programme for continuous improvement to the company that has a longer term perspective (e.g. up to the next 5 years).

The continuous improvement programme can include:

- Redefining company goals
- Establishing critical KPIs to measure performance and guide decision making across all company operations
- Identifying activities to support continuous improvement (e.g. lean and six sigma management practices, etc.)
- Developing a roadmap of the continuous improvement activities

<u>Redefining company goals</u>
During the IAMC process, the company will have learned much about the impacts of its operations and products across the value chain, customer unmet needs and market trends.
You will want to revisit the basic information collected in phase 1 'Get started' and update company goals:

- How are the trends (market, regulatory/policy, technology) (re)shaping the market?
- Is the current business strategy for growth consistent with the updated trends and customer profiles? How could the strategy be improved to achieve higher positive environmental, social and economic impacts?
- Are there new opportunities that were previously 'unseen'?
- Are there new opportunities for collaboration within the innovation network?

<u>Establish critical KPIs to drive improvement</u>
KPIs should:

- Be SMART – scalable, measureable, achievable, relevant and time-bound
- Be essential for making decisions and measuring progress
- Accurately represent overall strategic goals and not those at a sub-system level
- Be meaningful and create clear understanding of company goals for all departments throughout the organization
- Have valid and reliable measurement systems
- Be actionable so that changes can be made to improve and achieve the company goals

9 Literature

In this chapter the sector specific technical literature used for conducting the innovation assessment is listed. Also reference to internet sources can be mentioned; e.g. for case studies) and reference to sources for international benchmark information shall be provided.

Appendices

The following annexes could be relevant:

- Rating scale
- Map/layout of company
- Detailed production flow diagrams
- Water consumption records
- Energy consumption records
- Results from effluent monitoring
- Price list of materials/chemicals
- Log sheets on production
- Feasibility scoring tables
- Innovative option evaluation sheets (discussion sheets, rating scale) if not included in the

Appendix A: Possible rating scale for sustainability impacts and option viability

Refer to Toolkit

Appendix B: