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Table of Contents

1. Executive Summary .............................................................................................................. 4
2. Introduction .......................................................................................................................... 6
   2.1 Purpose of this report ....................................................................................................... 6
   2.2 Considerations when designing KPIs for water management ........................................ 6
      2.2.1 What do we mean by Key Performance Indicator (KPI)? ...................................... 6
      2.2.2 What is the purpose of a KPI .................................................................................... 7
      2.2.3 The life cycle of a KPI .............................................................................................. 8
      2.2.4 Design of KPIs ......................................................................................................... 9
      2.2.5 KPIs that promote sustainability .............................................................................. 11
   2.3 Water management KPIs: Breakdown of water saving targets from corporate to site level – general principles ................................................................. 12
3. Existing frameworks .......................................................................................................... 14
   3.1 CEN Workshop Agreement (CWA 17031) on “Sustainable integrated water usage & treatment in process industries” ..................................................................................... 14
      3.1.1 Driving forces ............................................................................................................ 14
      3.1.2 Risk management ................................................................................................... 14
      3.1.3 Industrial symbiosis ............................................................................................... 15
   3.2 Environmental management ISO 14001 ........................................................................ 15
   3.3 Reporting frameworks .................................................................................................... 15
      3.3.1 Global Reporting Initiative (GRI) .......................................................................... 15
   3.4 European Water Partnership ........................................................................................... 17
   3.5 Scarcity evaluation ......................................................................................................... 19
      3.5.1 Indicators in the WRI Aqueduct tool ...................................................................... 20
      3.5.2 Indicators in the WWF water risk filter .................................................................. 20
      3.5.3 Tool for water risk monetization .......................................................................... 21
   3.6 The MORE project on resource efficiency, ..................................................................... 21
   3.7 Indicators and water management at the site-partners in INSPIREWATER..................... 23
      ArcelorMittal .................................................................................................................... 23
      Clariant ............................................................................................................................. 23
      Sandvik ............................................................................................................................. 25
   3.8 Short summary of KPIs in existing frameworks ............................................................... 25
4. Description of KPIs in the water management framework .................................................. 27
4.1 Initial approach and tactics for deciding relevant KPIs........................................27

4.2 Determining process-relevant KPIs ........................................................................... 27
  4.2.1 Example of streamlined LCA results................................................................. 29
  4.2.2 Detailed decision trees ....................................................................................... 30

4.3 KPI design depends on the roles in the organisation ................................................. 33
  4.3.1 Interactions with corporate level, site level and supply chain ......................... 33

4.4 KPIs in the step-by-step model ................................................................................. 34
  4.4.1 Overview of the step-by-step model: ................................................................. 34
      1. KPI design when setting the scope and identifying initial, current and future drivers and barriers: .................................................................................. 35
      2. Assure engagement: ............................................................................................. 35
      3. Map current situation including external and internal factors ........................... 36
      4a. Refine drivers and barriers.................................................................................. 37
      4b. Define the strategy on different levels ................................................................. 37
      4c. Set-up the water management system (WMS) ..................................................... 37
      4d. Define correct/appropriate KPIs ......................................................................... 37
      5. Implementation, evaluation and improvement of the WMS and the KPIs ............. 37

4.5 Water management step-by-step and KPIs on operational site level ..................... 38
  4.5.1 Introduction ......................................................................................................... 38
  4.5.2 KPIs related to WMS on overall site level .......................................................... 38
      KPI set up on water intake ...................................................................................... 39
      KPI on outlet water: ................................................................................................ 40
  4.5.3 WMS broken down to specific water users (level2) .......................................... 41
  4.5.4 WMS on process level (level 3) ......................................................................... 44
  4.5.5 Design of KPIs on operational site ..................................................................... 46

5. Plans for further work in WP1 ..................................................................................... 49

6. References ................................................................................................................ 50
1. Executive Summary

The EU funded project INSPIREWATER works for increasing water and resource efficiency in the process industry. This is done by technical innovations as well as by new solutions for water management systems (WMS) as both are needed for increased water efficiency. An important part of a water management systems are parameters to follow up the performance. This document describes how to establish an efficient indicator system with key performance indicators (KPIs) to support the WMS implementation. The content of this document and its methodology will be tested within INSPIREWATER for further improvement.

There are mainly three purposes of KPIs:

- Control of operations/processes to stay within certain limits
- Reporting for internal/external reports and benchmarking
- Improvements within the organisation

A well designed KPI will also increase the motivation of the employees.

When designing a KPI there are a number of questions to consider:

- What is the purpose of the KPI?
- Who will use the KPI?
- What information is necessary for the users of the KPI to fulfil the purpose?
- How does the KPI need to be defined to fulfill its purpose?
- How should the KPI be presented?
- What data is needed to collect the information and how will it be gathered assuring data quality?

There are also requirements such as that the KPIs should be straight forward and easy to use and be objective rather than subjective. More recommendations can be found in the report, including typical pitfalls such as aggregated KPIs where it is not clear how different elements influence the parameter.

There are a number of existing frameworks for water management and many companies have already established KPI systems within their water management. KPIs are used for reporting purposes such as the Global reporting initiative, or within the environmental management framework (ISO 14001), they can be used for scarcity evaluation as in the WRI Aqueduct tool or the WWF water risk filter, for evaluation as in the European Water Partnership or within other tools.

Elements to consider for a successful water management are:

- Driving forces for water management such as cost aspects, water scarcity combined with water supply risks, and changes in water quality will influence the choice of KPIs.
- Many companies use standardised reporting models, such as GRI and the KPIs that are defined within them. Many of these have a clear external perspective, i.e. targeting water withdrawal and emissions from the plants. This should be reflected in the KPI design.
• Many companies also have water related KPIs as part of their corporate reporting, which can be more water specific, e.g. by water footprint, or more as part of sustainability reporting. KPIs have to be chosen carefully depending on the purpose in order to really show the performance that they measure. Different purposes for having water related KPIs exist on corporate and site levels.

• For evaluating scarcity aspects there are a number of tools that may be used, e.g. Aqueduct or WWF Water risk filter. These can give a good overview on a regional (or water basin) scale and are used to identify risk areas. Such local assessment is often needed as the water risk situation may vary also within these regions.

• There is an interaction between different stakeholders and different roles, which means that KPIs need to be formulated from different perspectives. This can be within a company (corporate level/site level), between companies (e.g. industrial symbiosis) or between companies and external stakeholders. It must be possible for all important stakeholders to act upon the information that the KPI gives.

• Definition of KPIs should involve the relevant stakeholders. Depending on company culture, strategies can vary how much is defined on the corporate level and how much the site-level influences, also for corporate level KPIs

Within companies, the sites and the processes at the sites play a crucial role in water efficiency optimisation. This document provides the INSPIREWATER KPI guidance to support the right choice of KPIs on the site and process levels. It is based on the elements mentioned above as well as on a life-cycle approach.
2. Introduction

The INSPIREWATER consortium consists of 11 partners from seven different countries. The objective of the project is to improve water efficiency and to test and implement new technologies for treatment of industrial waters in real industrial environments and integrating these new solutions into existing ones.

The INSPIREWATER project develops a holistic water management framework to be used by the process industry aiming at increasing water and resource efficiency in their processes. The framework includes pre-requisites to be integrated into existing management systems and to facilitate innovative technology uptake. The framework is designed to be combined with existing management structures in companies, taking drivers and barriers for innovations in resource efficient water treatment into account.

2.1 Purpose of this report

In the non-public report D1.1 of INSPIREWATER, “Proposed framework for holistic water and resource management”, the development and implementation of a step-by-step model for a water management system (WMS) were described targeting the different levels of an organisation, their respective roles and interactions as well as a hands-on WMS manual for the site level.

In this report we will describe and discuss how to establish an efficient indicator system to support the WMS implementation. The main conclusions from a short review of the current status of Key Performance Index (KPI) on water as part of INSPIREWATER are presented under section 3 “Existing frameworks” in this report.

2.2 Considerations when designing KPIs for water management

In this section some considerations about establishing KPIs are given. If a KPI is relevant and well-designed it can be a good tool to guide an organisation to better performances. If not, it may be misleading or even contra productive. Apart from the experiences from this project as reported in the milestone report and the CEN Workshop Agreement, CWA SUSTAINWATER, many conclusions and recommendations in this section are taken from a recently finalised project within the Swedish research program “Produktion2030” entitled “Sustainable and resource efficient business performance measurement systems” (SuRE BPMS). Some figures are also used by courtesy from the project management. This project has also released a handbook that can be downloaded from: http://publications.lib.chalmers.se/publication/252816-sustainable-and-resource-efficient-business-performance-measurement-systems-the-handbook.

2.2.1 What do we mean by Key Performance Indicator (KPI)?

A performance indicator is not a strategic goal in itself. Rather, it should reflect an important state of an organisation, a process or a situation. It can be a measure from a measurement activity, but often
it is a compiled value based on several measured data. When a KPI is based on a set of measures it is very important to really understand the functions of each part of the structure that builds the KPI. In figure 1 an example of how a comprehensive KPI, in this case OEE (Overall equipment effectiveness), which is a commonly used KPI in industrial organisations. The example is taken from the SuRE BPMS handbook (2017).

2.2.2 What is the purpose of a KPI

There are mainly three purposes of a KPI; to control, to report and/or to improve.

The KPI (or set of KPIs) used for control will help the organisation at different hierarchic levels to secure that a process stays within acceptable limits, e.g. that the water usage does not exceed available resources, leading to risk for the production stability or quality, or to secure that a water treatment operation is functioning well and emission levels are not exceeded. Such a KPI should be measured with sufficient frequency to secure that actions can be taken quickly enough.

A KPI used for reporting is measured to give information to other parts of the organisation (e.g. corporate functions), authorities or public reports, or internally for benchmarking. Such a KPI is not necessarily used for internal control, but can be based on the same elements (e.g. emission levels from waste water treatment). The measurement intervals can be longer for a KPI used for reporting than one used for control.

A KPI used for improvement should reflect the achievements in an improvement program (e.g. increased water efficiency at optimisation of equipment). It can be a KPI that is used for continuous
improvements, which should be measured continuously and be a part of the overall performance indicator program, while a KPI used during an improvement project can be implemented for only a limited period.

Often, the same KPI can be used for all three purposes, while others are specifically designed for one of them.

A well-designed KPI will also serve to increase motivation for the people in the organisation. Breaking down of KPIs to make them relevant for every level in the organisation is one way to achieve this. It should also be well coordinated with other management systems (such as Environmental Management Systems, like ISO 14001), in order to strengthen the execution and not to create confusion.

2.2.3 The life cycle of a KPI

Changes are frequently occurring in the production strategy, methods, equipment etc. and the KPIs should also reflect this dynamic. As described in the report D1.1 the driving forces for working with water management can be several; both external, such as regulatory requirements, water stress or sensitivity of recipients, and internal, such as quality requirements, new process set-up, changes in production etc.

This means that KPIs can experience a “life cycle”, which is illustrated in Figure 2, where it is initiated based on the actual manufacturing strategy, which in turn can be based on these driving forces, the objectives and goals will be formulated and the KPIs designed to support these.

A KPI may be more or less permanent. If its purpose is to control or report on regular operations, it can be rather static, which also may be beneficial if the organisation want to have traceability in historic data and long term trends. However, if the KPI is used for a more short-term project, e.g. to follow a change activity, the lifetime is shorter and it should be revised more frequently.

In general, the KPI set up should be revised with some regularity, as it is a general tendency in many organisation to create new KPIs, but seldom remove old ones. This may increase complexity over time and be time consuming for the organisation. The estimated time used for production control and KPI follow up at the partners in the SuRE-BPMS project varied between 0.5 up to 2% of the total working hours.
2.2.4 Design of KPIs

When designing a KPI it is therefore important to focus on the purpose of why this KPI is important; is it for reporting, for control or for improvement? So the first two questions to ask are who needs this information and for what reason? Figure 3 illustrates a “pull approach” to defining KPIs: starting with the decision on why something must be measured and identifying the person or organisation that needs the information the KPI is intended to provide; what kind of decision will that person take based on the information? Then it becomes more clear what this information will show, how it is presented, how the KPI should be designed and what data is needed, what kind of measurements should be made etc.

The need for information of different stakeholders inside and outside of the organisation has to be adapted to meet the need of each one of them; therefore the KPI should be possible to break down into elements that provide the right information in both a top-down as well as bottom-up approach. E.g. an overall KPI on total water usage for a site is important information to plant management, but not for the personnel at a specific water consuming operation, in their view a set of data reflecting the water flows in the process should be more useful for optimisation, control and improvement.

As mentioned above the KPI can be a comprehensive KPI based on several elements. These elements may also be a KPI in itself, for some part of the organisation, who have specific influence on this particular measurement, e.g. a data on water usage at non-production time (stand-by loss) can be followed-up and controlled on local level and will have an impact on an efficiency KPI designed as...
water usage per produced unit, since this water usage is not related to production volume. It is a common pit-fall that the KPI is designed from many elements that “live their own life” and it becomes unclear what is really influencing the value.

Figure 3: The recommended pull approach to design KPIs (adapted from SuRE BPMS Handbook (2017)).

In the SuRE BPMS handbook, the requirements for a KPI are summarised as following:

“KPIs should:

- Be related to the company’s objectives and manufacturing strategy
- Support the comparison with organisations, which are in the same business.
- Acknowledge differences between departments, sites and circumstances
- Be under control of evaluated organisational unit.
- Provide fast feed back
- Stimulate continuous improvement rather than simply monitor
- Be selected through discussions with people involved (customers, employers, managers)
- Have a clear purpose
- Have clearly defined data collection and calculation methods.
- Be simple and easy to use
- Preferably be ratio-based and not absolute
- Preferably be objective and not subjective”

The goal of a well-designed KPI can be said to provide data to give information that supply knowledge to the relevant stakeholders that in turn creates understanding of the activities going on in the organisation:

DATA ➔ INFORMATION ➔ KNOWLEDGE ➔ UNDERSTANDING

Another important aspect is the frequency of measurement and presentation of data to KPIs. Depending on the objective this has to be designed to meet the purpose, i.e. a KPI for control of a process reporting may need much higher frequency than a KPI for reporting in an annual report.

It is also recommended that the KPI is presented as a time-trend rather than instantaneous values. It is not uncommon that a dashboard is shown at management meetings showing red, yellow and green signs if the KPIs are on or off target and that this is followed by a discussion on the yellow and red ones, not acknowledging the possibility that it may be temporal random occasion or if it is a long-term trend. Such a trend may also be hidden in a KPI that for the moment looks green.
To conclude, some common pit-falls that should be avoided are summarised below:

- Comprehensive aggregated KPIs where it is not clear how the elements interacts
- Unclear definitions that creates a risk that different persons reports and understands the data differently
- Efficiency KPIs (e.g. value/production) reported while the value does not have a direct link to production (e.g. constant water usage, not related to production volume)
- Measuring what is possible to measure, not to give the right information
- KPIs reported to persons that has no influence
- KPIs shown as instantaneous value and/or mean values, not reflecting trends and spreading (instability or random occasions).
- Using common KPIs not being relevant in the specific situation.

2.2.5 KPIs that promote sustainability

When looking at a typical set of KPIs for an operational unit we often find a long list of measures under headlines like financial, human resources, improvements, productivity, quality, flexibility, delivery, equipment, supply chain etc. and in the very end of this list, we may find a general headline: sustainability. Here there are some KPIs on work environmental matters - typically reported accidents - and there may be one or two specific environmental aspects. Most often on energy saving, waste, sometimes water and legal requirements, and it is within the responsibility of an appointed environmental coordinator to report this to the management. It is a good thing to highlight these aspects, but this add-on approach often makes it difficult to integrate the environmental aspects into the overall operation and to get focus from management and employees on all levels in the company.

However, it is important to note that by taking a closer look at the other KPIs in the business performance measurement system we will find many aspects that correlate with the environmental performance, especially if we have a resource efficiency approach. Here are some examples and the reader of this document can probably provide more:

**Financial** KPI: manufacturing cost - cost per unit: scrapping and other waste, energy usage, water usage, cost for water treatment etc. add to production cost

**HR**: Training: include environmental aspects in training material.

**Improvements**: also environmental goals in improvement work, use Kaizen approach to activities pointing towards, energy or water savings. SS normally always promotes increased environmental standard.

**Productivity**: Resource efficiency, throughput rate (e.g. first time through) reduces rework that reduces waste of all kinds.

**Equipment**: Overall equipment efficiency and other equipment related KPIs can also be applied on water treatment equipment (and other equipment for pollution control). An efficient preventive maintenance program on many production systems reduces the risk for interruption, leaks in equipment and emissions due to this.
Quality: everything that promotes quality in the sense that wastes are avoided also reduces the non-value added resource input and output (e.g. rework, scrapping, unnecessary processing etc.). Water quality may have an impact on the product quality.

Supply chain: delivery and quality as noted above, but also important to note that suppliers are an integrated part of the environmental footprint of the products produced in the plant.

Conclusion: Being aware of that resource efficiency and environment - including water management - are closely linked to many other KPIs in an operation, many of these other KPIs can be used to support the environmental performance. It is thus a good idea to highlight this interrelation and this will increase the awareness and facilitate the environmental achievements in the organisation.

2.3 Water management KPIs: Breakdown of water saving targets from corporate to site level – general principles

Both a top-down as well as a bottom-up perspective is always recommended when KPIs are to be designed and the KPIs may have different design and depending who and for what reason the KPI is to be used. In the following section this is illustrated on the case of KPIs used for water management.

In general terms it is the role of the corporate functions in a large organisation to set the overall strategies and targets for the corporation as a whole, support the local initiatives and receive and evaluate reports on the result. However the concrete actions for water management are performed at local sites and thus needs a bottom-up perspective, but are much enhanced by a clear top-down commitment. This is also reflected in the formulation of KPIs as a KPI from corporate needs to be broken down and sometimes reformulated to be useful by the local organisation.

The level of commitment from corporate level on water saving varies between companies. In a base level the corporate function requests reports annually according to some of the reporting frameworks (e.g. GRI) for the annual report. For corporations that have put water issues on their environmental strategy agenda it is rather common practice to set an overall target on water saving, often as a KPI in relation to the production volume (which is a KPI design that must be verified to be relevant). A special focus on operations located in water scarcity areas is rather common and this may be evaluated by using some of the scarcity evaluation tools (e.g. Aqueduct or WWF). Local water situation may also be an issue when investment decisions are taken on corporate level or when suppliers are selected.

The next level of commitment is to give support to the operational sites on knowledge transfer, e.g. by setting up internal networks for knowledge sharing or having common R&D activities to find solutions that may be used globally. At some corporations a staff of internal auditors is also supporting the sites by on-site inspections and advises.

However, it is the bottom-up activities that give the concrete water saving and apart from the corporate strategies the driving forces are often local regulatory demands and risk mitigation to secure a stable production. The initiatives are also supported by the site’s environmental management program (according to e.g. ISO 14001). Therefore many water management activities and target setting are performed on a local site level with or without support from the corporate level.
A substantial part of the water footprint from production may occur at suppliers. Here both corporate initiatives, like environmental demands on suppliers, as well as demands from the site on local suppliers may be a part of the overall water management. It is not uncommon that contractors are operating water treatment facilities and it is then normally up to the site organisation to safeguard that the output is according to requirements. However this shared responsibility may sometimes be an obstacle to improvement activities, but on the other hand improvements can also be enhanced by the expertise in the contactors organisation.
3. Existing frameworks

In order to enable systematic work with water-related issues, systems for water management have been developed and are now used. To enable measurement and reporting water usage, sets of indicators have also been developed. In this chapter, a number of indicators used within some of these frameworks are presented.

3.1 CEN Workshop Agreement (CWA 17031) on “Sustainable integrated water usage & treatment in process industries

As a conclusion of the previous project E4water (Economically and Environmentally Efficient Water management in the European Chemical Industry) within the FP7 Framework Program, a workshop was held in May 2016 resulting in the CEN Workshop Agreement (CWA 17031) on “Sustainable integrated water usage & treatment in process industries – a practical guidance”, which sets a framework and guidance for working on water management. This framework, which defines driving forces for water management, risk management related to water, and industrial symbiosis opportunities can serve as a guide to identify the need and use of relevant water-related KPIs.

3.1.1 Driving forces

In the document several driving forces are proposed:

From the **industry** perspective: “doing the right thing”, i.e. activities within the company’s sustainability program

- Protection against water related risks
- Legislation on water usage and discharge,
- Lack of water supply or discharge infrastructure,
- Cost or other business opportunities.

From other **stakeholder’s** perspective, e.g. municipality, neighbours, environment and catchment aspects, driving forces are

- Water availability and water stress,
- Emission and catchment sensitivity etc.
- Water quality aspects.

3.1.2 Risk management

Risk management is also mentioned as reason for developing a water management and KPIs. Driving forces and opportunities are listed, e.g. dependencies on availability of water resources including seasonal variations to 10 or 50 years draught or flooding events, future legislation, policies and permits, business opportunities, economic aspects and reputation. The assessment must also be performed on the local scale as water issues are very much related to the local situation. It must also
take into consideration the probability for occurrence, consequences, prevention measures and cross-effect to other risks.

3.1.3 Industrial symbiosis

The document also describes opportunities and hurdles for an integrated water management where water is supplied and recovered between several users within an industrial area. In this context KPIs related to quality parameters are focused. One of the hurdles identified is that regulatory requirements still often are left in a more linear thinking model and when water crosses the border between two organisations with individual permits the requirements may not match.

3.2 Environmental management ISO 14001

Today it is common practice to implement an environmental management system, most commonly according to the ISO 14001 standard. Recently the standard has been updated with more elaborated requirements than in the previous version.

In the Environmental management system the environmental aspects of the organisation shall be identified, ranked and an environmental program shall be in place to meet these aspects. However the standard does not set any specific requirements or proposal for KPIs. This is up to the organisation to develop and implement.

3.3 Reporting frameworks

For external and internal communication purpose and as a way to support the way forward, towards a sustainable water usage (as well as and general resource efficiency) standardized reporting methodologies are often used. Examples of these are the Global Reporting Initiative (GRI), Dow Jones sustainability index (DJSI) or Carbon disclosure Project (CDP). Within these frameworks several KPIs are required.

3.3.1 Global Reporting Initiative (GRI)

The purpose of the GRI is mainly to provide criteria and support to the sustainability report from the organization, to set a framework for criteria, comparison and transparency. It covers all three aspects of sustainability; environment, social and economic sustainability. Within the environmental framework the aspects are energy, material usage, water usage, biodiversity, emissions to air, water and waste, transport related, product related, compliance and costs for environmental related investments. Thus water appears as both a resource issue and as an emission parameter. The indicators on water usage are:

- Total water withdrawal by source (“Disclosure 303-1”). KPI is total volume.
  - i. Surface water, including water from wetlands, rivers, lakes, and oceans;
  - ii. Ground water;
  - iii. Rainwater collected directly and stored by the organization;
  - iv. Waste water from another organization;
The reporting organization should: Include the abstraction of cooling water; report whether these calculations are estimated, modelled, or sourced from direct measurements and, if estimation or modelling has been used, report the estimation or modelling methods.

- Water sources significantly affected by withdrawal of water (“Disclosure 303-2”)
  Total number of water sources significantly affected by withdrawal by type:
  - i. Size of the water source;
  - ii. Whether the source is designated as a nationally or internationally protected area;
  - iii. Biodiversity value (such as species diversity and endemism, and total number of protected species);
  - iv. Value or importance of the water source to local communities and indigenous peoples.

Standards, methodologies, and assumptions used.

The GRI-standard also states that: “When compiling the information specified in Disclosure 303-2, the reporting organization shall report water sources significantly affected by withdrawal that meet one or more of the following criteria:

2.2.1 Withdrawals that account for an average of five percent or more of the annual average volume of the water body;
2.2.2 Withdrawals from water bodies that are recognized by professionals to be particularly sensitive due to their relative size, function, or status as a rare, threatened, or endangered system, or that support a particular endangered species of plant or animal;
2.2.3 Any withdrawal from a wetland listed in the Ramsar Convention or any other nationally or internationally proclaimed conservation area, regardless of the rate of withdrawal;
2.2.4 The water source has been identified as having high biodiversity value, such as species diversity and endemism, or total number of protected species;
2.2.5 The water source has been identified as having a high value or importance to local communities and indigenous peoples. “

- Percentage and total volume of water recycled and reused (“Disclosure 303-3”)
  - Total volume of water recycled and reused by the organization.
  - Total volume of water recycled and reused as a percentage of the total water withdrawal as specified in Disclosure 303-1.
  - Standards, methodologies, and assumptions used.

As a guide to the KPI on how to “calculate the volume of recycled/reused water based on the volume of water demand satisfied by recycled/reused water, rather than by further withdrawals” the standard gives the following example: “if an organization has a production cycle that requires 20 m³ of water per cycle, the organization withdraws 20 m³ of water for one production process cycle and reuses it for an additional three cycles, then the total volume of water recycled and reused for that process is 60 m³.”
The full standard can be downloaded from the GRI homepage: [https://www.globalreporting.org](https://www.globalreporting.org)

It is thus KPIs to a high extent related to the boundaries of the site, i.e. mainly an external stakeholder perspective. Many of the other reporting systems, i.e. DJSI, CDP etc. are to a large extent using the GRI reporting principles.

### 3.4 European Water Partnership

The EWS Standard is a step-by-step risk management assessment formed by 49 indicators that enables companies to assess and manage water-related risks as well as verifies and communicate their responsible Water Stewardship practices. [www.ewp.eu/ews](http://www.ewp.eu/ews).

The indicators in the standard are organized through 4 principles, 15 criteria and 49 indicators related to the criteria and principles. Some of these are set as major and some as minor. After an audit process it is possible for the organization to achieve a certificate on Bronze, Silver or Gold level, provided that all major indicators are met and 50, 70 or 90% respectively of the minor.

The four principles are:

Principle 1. Achieve and maintain sustainable water abstraction in terms of water quantity.

Principle 2. Achieve and maintain good water status in terms of chemical quality and biological elements.

Principle 3. Restore and preserve water-cycle related High Conservation Value (HCV) areas.

Principle 4. Achieve equitable and transparent water governance.

Examples of indicators related to these criteria are:

**Principle 1: Achieve and maintain sustainable water abstraction in terms of water quantity.**

- Water volume and documentation of abstraction quantities and contribution of water discharge, where a “major contributor” is defined as “when discharged water accounts for more than 40% of the water abstracted”.
- Impact of water abstraction; i.e. abstraction from water bodies that are recognized as sensitive and define periods of water stress, which shall be linked to abstraction and discharged rates. In cases where abstraction is not defined by legal authorities, the standard requires the organisation to define the water stress levels, e.g. by a water stress index (WSI). The standard defines a major abstractor if “water withdrawal accounts for an average of 5% or more of the renewable freshwater resources”
- Actions taken to improve water efficiency, reduce water losses and mitigate detected and potential impacts of water abstraction shall be described and implemented.

**Principle 2: Achieve and maintain good water status in terms of chemical quality and biological elements.**

- The total inputs on site shall be disclosed and the total effluent quality shall be determined, monitored and documented. Including a classification of used substances e.g. as “hazardous”
or “priority” etc. Indicators are also related to quality parameters of the water as discharged or re-cycled/reused.

- Impact on destinations that are affected by the production sites’ effluents shall be identified and described. Measures shall be set in place to mitigate these impacts. Indicators are if these are high-risk areas, description of all destinations and criteria to classify in terms of sensitivity and impact, such as biodiversity, other environmental impacts, socio-economic impacts, regional population affected.

- Actions taken to mitigate detected and potential impacts of water discharge shall be described and implemented. All actions should be integrated in the Water Management Strategy (Criteria 4.8). Indicators are to show actions taken to mitigate. Also to evaluate the performance on external waste water treatment if the contribution is higher than 50% of the volume treated in that plant.

**Principle 3: Restore and preserve water-cycle related High Conservation Value (HCV) areas.**

- High Conservation Value (HCV) areas in a 25km radius around the production site, water sources and points of discharge are identified and described. Indicator is that these are listed and protection goals defined.

- Impact on water status, ecological processes, and social values in HCV areas shall be identified and evaluated. Indicator is that these are identified, described and, if possible, quantified.

- Actions taken to mitigate detected and potential impacts of HCV areas shall be described and implemented. All actions should be integrated in the Water Management Strategy.

**Principle 4: Achieve equitable and transparent water governance.**

- The water management shall ensure compliance with all legal requirements linked to water use. Indicators are related to the organisation; persons responsible and procedures.

- Water management in the supply chain shall be evaluated on long term. The purchase of products and material from water sustainable suppliers shall be achieved over time according to the possibilities of the organization. Supplier’s location and transparency as well as their own certifications are evaluated as indicators.

- Water use shall be managed in an integrated approach taking the management of other resources into account. Indicators can be e.g. energy usage related to water.

- Efficiency of water consumption shall be increased by water recycling, higher water savings and the reduction of water losses. Indicators are water volume recycled, identified losses, and water consumption per unit.

- Sustainable Water Management shall be achieved by internal and external transparency and raising awareness. Major indicators are procedures and impacts in the management of incidents. Other indicators are transparency of the water management internally as well as externally, e.g. by water reports.

- Continuous improvement of Sustainable Water Management shall be achieved on operational and River Basin level by implementation of Best Management Practice’s (BMP)
and by innovation and development on long term. Indicators relates to the “BMPs, if these are recognised by the organisation or if they have identified own relevant BMPs.

- Transparency on economic aspects of water management shall be ensured. Indicated by investments and an environmental cost analysis.
- A water resources management strategy shall be available at the production site as it is a crucial tool to integrate all activities related to water use. It initiates and supports management decisions on water management performance and facilitates the public and internal transparency. This is indicated by the organisations water resource management strategy and appointed organisation.

To conclude the European Water Stewardship also has a quite clear “external” focus, i.e. on water withdrawal and effluent from the plant, and indicators that relates to this. Many indicators are also related to organisation of water management (e.g. strategy in place, procedures, persons appointed etc.), apart from pure metrics, such as m³/hour etc. The evaluation and the certificate will thus reflect that there is a confidence that the organisation has the ability to deal with the water topic, while the design of the internal water management is up to the organisation.

3.5 Scarcity evaluation

The design of the water management must be adapted to the local situation, which will guide the priorities; i.e. shall the focus be directed to water saving or more on emission control or zero discharge. On corporate level it is also of interest to follow up and set requirements and support to sites with water scarcity.

Thus, as has been seen both in the GDP and in the EWS-framework, important indicators are how the water usage is set into relation of the surrounding conditions, like availability, water quality and effluent issues. To be able to evaluate the potential risks at the geographical area where the plant is located several tools and models have been developed and are available on line. These tools address risk on water withdrawals as well as risks related to discharge. In one case (WRI Aqueduct tool) prospects for future risk (2020, 2030 and 2050) have been estimated for some areas. Normally the level of detail in information is on regional water basin data. Two examples of these often used are:

- Water Risk Filter tool: Developed by WWF together with DEG (German Insurance Company). This allows to review water use and availability, and the resulting environmental, reputational, policy and social risks associated with an organizations’ water use. [http://waterriskfilter.panda.org/](http://waterriskfilter.panda.org/)

- WRI Aqueduct tool: It allows companies to explore the complexity of geographic water risk with a high level of detail, as it combines sophisticated hydrological modeling and a robust analytical tool that uses up-to-date and publicly available data to help understand critical dimensions of water risk. [http://www.wri.org/our-work/project/aqueduct](http://www.wri.org/our-work/project/aqueduct)” (CWA 17031 p21)

The different tools are to some extent using similar approaches, but there are differences in data sources and resolution.
Although most of these tools use regional water basin as input data it is important to realise that it may happen that the situation on a specific site can deviate from the rest of the area, so a local assessment on a case-by-case basis should be performed as well.

3.5.1 Indicators in the WRI Aqueduct tool

- Aqueduct Global Maps include indicators of water quantity, water variability, water quality, and public awareness of water issues, access to water, and ecosystem vulnerability. They use 12 indicators to evaluate the overall water risk. However, the indicators work best on a regional, or catchment basin scale and give an indication of the risk situation, but they are not sufficient to assess a specific site. The methodology is reported in a report from WRI: Gassert, F., M. Luck, M. Landis, P. Reig, and T. Shiao. 2014. “Aqueduct Global Maps 2.1: Constructing Decision-Relevant Global Water Risk Indicators.” Working Paper. Washington, DC: World Resources Institute. Available online at http://www.wri.org/publication/aqueduct-globalmaps-21-indicators
- Overall water risk is an indicator to identify areas with higher exposure to water-related risks and is an aggregate measure of all selected indicators from the Physical Quantity, Quality and Regulatory & Reputational Risk categories. This is expressed as a ranking from 0 (low risk) to 5 (extremely high risk)

3.5.2 Indicators in the WWF water risk filter

The Water risk filter is based on a large set of indicators related to basin risk and company risks. Data are collected automatically from databases or as response on a number of questions. On their web page the methodology is described: “In principle, each risk indicator has 5 potential answers, and each answer will result in a score from 1-5: 1: No or very limited risk, 2: Limited risk, 3: Some risk, 4: High risk, 5: Very high risk. Each single indicator and each risk type (Physical, Regulatory and Reputational) have weightings and physical risks are even subdivided further in sub-weightings. There is no scientific background for the weightings; therefore they have gone through a peer review process with experts.”

The indicators are collected under the headlines:

- Physical risk Quantity (scarcity)
- Physical risk Quality (Pollution)
- Physical risk - Ecosystem threat
- Physical risk - Dependence on Hydropower
- Regulatory risk
- Reputational risk
- Physical risk - Supply Chain (specific for company related risk)
- Benchmarking & Comments

The full set of indicators and questions in the questionnaire can be downloaded from: http://waterriskfilter.panda.org/Content/Documents/Risk%20Indicators.pdf
3.5.3 Tool for water risk monetization

Cost indicators related to water usage is rather common. However, the cost for a site related to water may often not be high enough to justify investments in water saving. But, often the risk for cost increase, risks on revenue or cost for quality issues are not included in the calculation. The Water Risk Monetizer from Ecolab is a tool for assessing water-related business risks in order to understand the gap between the cost for water and the potential costs of water risks. The tool can be downloaded from http://www.waterriskmonetizer.com/. By entering the water usage, requirements on effluent, location, forecast for upcoming regulations and other facility data the cost for water risk related to quantity and quality will be calculated. The water risk data are evaluated on a water basin level. The Water Risk Monetizer uses the Baseline Water Stress metric from the WRI’s Aqueduct Tool (WRI, 2016) to assess quantity risk and user inputs to assess quality risk.

3.6 The MORE project on resource efficiency,

In the EU-funded R&D project “Real-time Monitoring and Optimization of Resource Efficiency in Integrated Processing Plants” (MORE) principles for the definition of real-time Resource Efficiency Indicators (REIs) were defined and a number of indicators useful to integrated chemical plants were proposed. The project has published a step-by-step guide book for implementation of indicators for several resource efficiency parameters as energy, materials and environmental indicators, such as climate change aspects and water. (D6.6. Step-by-step guidebook on “How to succeed in the identification and implementation of real-time or near real-time Resource Efficiency Indicators for your plant or industrial sector”). As water is an important resource, considerations and findings from the project are also relevant in this context.

The guide is based on specific guiding principles:

“Gate-to-gate approach”: As the entity of interest is a production site, a plant or a process unit, the boundary of the analysis is the limit of the respective entity, as only this can be influenced in real-time.

Indicating technical performance independently of market fluctuations: The flows of material and energy are not to be related to real-time economic indicators; technical performance is separated from the economic performance.

Based on material and energy flow analysis: The resource efficiency indicators are based on the physical flows and conversion of raw materials and energy to products and flows into the environment as objective characteristics of a production process.

Resource and output specific potential for meaningful aggregation: Within the system boundaries, the indicators need to be directionally correct, i.e. improvements of the indicators should demonstrate better process performance. All net flows of raw materials, energy, and products that cross the boundaries of the system under consideration must be determined without aggregation. Based on a material and energy flow analysis, process specific REIs should be defined with respect to the resources and the products. The indicators can be defined either as intensities or as efficiencies depending on the user preference. The definition of resource intensity is shown below. This version of the indicator simplifies the aggregation over different contributions due to having the same basis (product output). The corresponding indicator defined as efficiency is obtained by inverting the intensity indicator:
Such a resource and product specific (RPS) REI by itself does not indicate whether the process is operated well. It must be compared with a reference value obtained from historical or model data in order to evaluate the plant resource efficiency change:

\[ REI_{\text{norm}} = \frac{REIRPS}{REIRPS_{\text{best case}}} \]

**Considering storage effects:** To realise “real-time” REI calculations, the choice of the temporal aggregation interval is crucial. The interval should be short enough to allow the derivation of operational decisions. Ideally a hold-up change is considered in the consumption or production figures. Long-term effects such as catalyst degradation or fouling must be defined in a suitable manner.

**Include environmental impact:** The impact on the environment must be taken into account separately in order to measure the ecological performance. Emission of pollutants to air, water and soil can be used as separate indicators.

**Hierarchy of indicators:** From the whole production site to a single apparatus Production processes are interconnected. Analysing an individual apparatus may be misleading because resource utilization can be shifted to other units by different local operational policies. Generic resource efficiency indicators must be defined on a scale on which the net effect on the resource efficiency can be measured through a bottom-up aggregation.

**Extensible to life-cycle analysis:** For reporting and assessment purposes, an extension to a Life Cycle Assessment should be possible using the aggregation scheme and adding a relevant weighting value to feed streams. “ (MORE 2016)

It points out the importance of defining and anchoring the indicators both in a bottom-up as well as top-down process and the importance of defining the **Why’s, Who’s and How’s** when setting these. They also make a distinction between generic and specific indicators. The **generic** indicators can be applied to every plant and can be used for comparison of different units in “a consistent evaluation framework”, whereas the **specific** indicators measures unit specific effects and cannot always be aggregated.

As mentioned in the guiding principles a reference value is important to make the efficiency indicators relevant. When defining these, a baseline calculation is needed. In doing so the authors describes two approaches: 1. **Best demonstrated practice**, i.e. a good example based on historical data and 2. **Best achievable practice**, which is an optimum computed from a theoretical analysis. When defining these baselines and also for understanding of how the indicator works it is also important to distinguish between “influencable factors”, i.e. parameters that can be controlled by the operators or the organisation and “non-influencable factors”, e.g. weather conditions, cooling water temperature etc. If these are not taken into account they state that “comparing different operation points becomes very difficult”. They also point out that: “Different people in a hierarchy have different decision authorities and influence on a plant and thus their baselines may reflect different influenceable and non-influenceable factors.”

Based on these principles a **three step model** for defining, anchoring and implementation of REIs is proposed: 1. **Selection and definition** of the plants and units under consideration, 2. **Identification** and selection of potential REI’s and 3. **Implementation** of the selected real-time REIs. The guide can be downloaded from the MORE project homepage: [http://www.more-nmp.eu/outcomes/deliverables/](http://www.more-nmp.eu/outcomes/deliverables/).
3.7 Indicators and water management at the site-partners in INSPIREWATER

To determine the reference situation, information was collected by questionnaire to prepare for online meetings with the industry partners where additional knowledge of their water management work was gathered. The objective was to understand the current situation regarding water management, i.e. how the industry site partners work with water issues, what the plans are for water management in the near future and which drivers and barriers they see.

ArcelorMittal

ArcelorMittal works with two water-related issues: the amount of water used and how to reduce it; and how they manage wastewater so it doesn’t cause a problem with pollution. ArcelorMittal has operations in more than 60 countries (www.myarcelormittal.com) with around 400 production sites. They monitor its use of water at all their production sites. On global level the metrics “Water intake (steel)” and “Water net consumption (steel)” are followed up and also disclosed on the website. The interview was focusing the site in Asturias. However, the water experts in Spain (from R&D department) give support all around the world at ArcelorMittal sites with water management and technical solutions for water treatment. AM has not established any global targets on water usage.

Regarding emission levels, AM follows local, regional and global environmental policies. There is no general water scarcity situation at this site and there is no restriction on water usage from authorities. The cost for incoming water is also rather low. Main problems are suspended solids (TSS) in incoming water (as it may block nozzles in the cooling, with poor product quality as consequence), corrosion and scaling. TSS is not a KPI, though, but it is indirectly measured through turbidity. The site makes some pre-treatment on incoming water for specific purposes; ion exchange on water to boilers, and preparations on drinking water. Also the cost for effluent water treatment is moderate. The effluent treatment plant is operated by external contractor (GE). The KPIs that they are reporting are related to the emission permit and there is a maximum amount set on effluent volumes. If they are not met a penalty can be requested from the contractor, but this has not happened yet. KPIs are reported monthly from GE and it is on the levels on conductivity, metal content, and suspended solids in the effluent.

The most important metrics and KPIs are quality parameters on the recirculated cooling water.

It is thus quality aspects that are the main driving forces and where KPIs are established. Normally water management gets the most attention in situations when quality in production becomes an issue.

Clariant

Clariant is a multi-national company with operations at ca. 130 sites. Clariant addresses water and waste water management issues at different levels in the organization. At site level, the management is responsible for ensuring regulatory compliance and for adhering to Clariant stipulated standards, which are defined in the corporate guidelines. At corporate and regional management levels, environmental data are collected on an annual basis from all production sites and regular audits are performed e.g. for ISO 14001 compliance check.
A water saving target has been set on corporate level: a 35% decrease in relation to goods produced from 2013 to 2025 and a reduction of waste water by 40%. Regular meetings of the Target 2025 team - functional specialists from business units, corporate and the service units are held, to discuss strategies for achievement of the reduction of water consumption and waste water reduction. This has initiated several activities on site level, e.g. water recycling, leakage minimization, rainwater harvesting etc. Recycled water, besides the continuously optimized process internal recycling, is today mostly used for gardening and sanitary purposes. As a long term objective Clariant is looking for opportunities for implementing zero discharge technologies.

Ca. 80% of all wastewater is treated in own treatment plants and 20% goes is discharged to public industrial or municipal treatment plants.

All sites have been evaluated towards water risk. This is performed in two steps: In step one Clariant is using the Aqueduct methodology to identify sites at risk areas. The overall water risk score (which is a combination of the physical risk quantity, physical risk quality and the regulatory/reputational risk) of facilities is considered and the facilities that fall into the categories "Extremely High risk" "High risk" and "Medium to high risk" are shortlisted. It is to be noted that none of the facilities fall under the "extremely high risk" category. In step two, the sites located in “High” to “medium to high risk” are shortlisted and evaluated in a more detailed local water risk assessment. Ca. 33% of all production facilities may be subject to overall water risk; however most of them are small or have rather low water consumption. In general the larger sites are not located in the water risk areas in the first place.

However, there have been isolated situations where special requirements had to be fulfilled by sites due to regulatory changes or local authority requests. For e.g. a site in India had to reuse large amounts of waste water to set an example for other industrial sites in the area.

Clariant is reporting sustainability from corporate level according to GRI guidelines. Clariant is also listed in the Dow Jones Sustainability Index (DJSI) list and is reporting to the Carbon Disclosure Project (CDP) since 10 years. As the GRI criteria have remained stable over the last years, Clariant finds it advantageous to use this reporting standard, as it is easy to compare historical data.

Clariant has developed global guidelines for environmentally compatible and safe business operations, which are regularly audited. They see considerably potentials for savings related to environmental parameters through optimization of processes. The guideline describes e.g. technical requirements on water treatment and monitoring procedures, but has not set any limit values on specific parameters. This is up to the business areas and sites to decide upon mainly based on the respective local permit requirements.

On the product side Clariant is active in “Clariant’s Portfolio Value Product Program” to review and classify their products in terms of sustainability. Products with high standard on sustainability may receive an “Ecotain” label, which is a based on a third party evaluation with a “gate-to-gate” approach.

Clariant is an ISO 14001:2015 certified company.
Sandvik

Sandvik is a global company with production related operations at ca. 125 units worldwide. The largest site is in Sandviken, Sweden. On corporate level Sandvik is working with sustainability targets with the ambition to be achieved by the end of 2020. One of these objectives concerns water and is formulated as to achieve significant improvements in areas where Sandvik’s operation have a significant environmental impact. The business areas within Sandvik Group are working with identifying and implementing Environmental Improvement Actions. The approach is based on a bottom-up involvement where the local production units identify their opportunity of water saving actions. The local initiatives will then be consolidated on a group level as a decrease in water consumption from water saving actions. The local action plans are reviewed annually and the progress is followed up on a quarterly basis. An EHS council comprising of EHS-managers from each business area is coordinating environmental topics on corporate level. Sandvik is reporting according to the GRI-standards and is also listed on the Dow Jones Sustainability Index. Major sites with production, services and warehouses have certified management systems according to ISO 14001. A water stress review has been performed and plants in India and USA have been identified as potentially water stressed.

The majority of the water used at site Sandviken (30 000 000 m³/year) is industrial water which consist of cooling and storm water that is collected in a cooling pound and reused after oil separation and filtration. Site Sandviken also uses 1 000 000 m³ water of drinking water quality annually supplied from Sandviken Energy (municipal supplier) for process and sanitary use (ca 300 000 m³/year). Recently Sandvik has replaced some of the drinking water usage with locally extracted groundwater. The Site holds a permit to withdraw 320 000 m³ ground water (1200 m³/day) and the current usage is about 100 000 m³/year. Drivers for improved water management are several such as productivity, decrease dependency to external water supply and minimizing the environmental impact on the recipient. Actions are taken to reduce drinking water used in production, improve capacity and quality of industrial water and decrease the discharge to the recipient. Alteration or investments in production triggers measures on water efficiency.

In production water is used for steam, cooling, pickling baths, rinsing and cleaning. Which type of water used is based on quality requirements such as purity, temperature and capacity

The site is operating 2 waste water treatment plants; one biological treatment for sanitary water and one comprising neutralization for process waste water (acid/alkaline water). Spent emulsion is treated separately in a UF/RO and discharge together with the treated process waste water.

Guideline and limit values on water emissions are set by the authorities in their permit for operation. The parameters are metals (mainly Cr, Cr⁶⁺, Ni, Cu), COD, BOD Suspended solids, fluorides and total phosphorus expressed as mg/l. There is also a limit value on maximal annual amount on Cr, Ni and phosphorus (25, 250 and 230 kg respectively).

3.8 Short summary of KPIs in existing frameworks

Many companies are already today working with water management. Water management is today incorporated in a number of existing management structures, such as the ISO 14000 series for environmental management. There are several frameworks for setting targets and definition of KPIs
related to water, several of them targeting reporting on a corporate level. A closer look at current
to frameworks and practices reveals a number of important key elements to consider for a successful
water management:

- Many companies use standardised reporting models, such as GRI and the KPIs that are
defined within them. Many of these have a clear external perspective, i.e. targeting water
withdrawal and emissions from the plants.

- Many companies also have water related KPI as part of their corporate reporting, which can
be more water specific, e.g. by water footprint or more as part of sustainability reporting. KPI
have to be chosen carefully depending on the purpose in order to really show the
performance that they measure. Different purposes exist on corporate and site level.

- For evaluating scarcity aspects there are a number of tools that may be used, e.g. Aqueduct
or WWF Water risk filter. These can give a good overview on a regional (or water basin) scale
and is used to identify risk areas. Often a local assessment is also needed as a complement,
as the water risk situation may vary also within these regions.

- Driving forces for water management are important and can be different, such as cost
aspects, water scarcity combined with water supply risks, changes in water quality etc. This
means that the set of KPIs will differ depending on the main driver.

- There is an interaction between different stakeholders and different roles, which means that
KPIs needs to be reformulated from different perspectives. This can be within a company
(corporate level/site level), between companies (e.g. industrial symbiosis) or between
companies and external stakeholders. It is an important aspect of KPI that it must be possible
to act upon the information that the KPI gives to ensure engagement of all important
stakeholders.

- There are different strategies between companies on setting KPI on corporate level. Some
have efficiency KPI, such as usage/produced volume, other have just put water on the
agenda and leaves it to local functions to define their own KPIs.
4. Description of KPIs in the water management framework

4.1 Initial approach and tactics for deciding relevant KPIs

In report D1.1 a proposal for a water management system and a step-by-step model for implementation was presented, where KPI are a part. Some aspects about KPIs were also described briefly. In this section we will go deeper into the KPI-design when implementing the model system.

In an industrial operation water is used for many purposes; such as water usage in specific production processes, for cooling, for domestic purposes or as a part in the product etc. Without secure supply of water of the right quality production will not be possible. As mentioned in the previous sections the driving forces for working with water management can differ, and so will the KPIs. If water scarcity is in focus, KPIs on water usage and water withdrawal will be needed, when the issue is emission parameters due to high legal requirements or sensitive recipients, then focus can be on emission levels. Sometimes quality parameters for the production processes are also an issue. Therefore all parameters mentioned in this section may not be applicable to all operations. It is generally a good thing not to have too many KPIs in order to keep focus on the most important ones. On the other hand we must also acknowledge the fact that KPIs must be relevant for the persons or functions in the organisation that are expected to react on the information.

The initial steps when deciding on suitable KPIs are a) to determine process-relevant KPIs and b) to determine how and who each KPI is intended for. These two steps need to be performed in parallel and are described in 4.2 and 4.3, respectively. After the completion of these steps, the work merges into one, described in section 4.4 and onwards throughout chapter 4.

4.2 Determining process-relevant KPIs

As discussed previously, different indicators can be used to evaluate and control the environmental impacts in general and specific the impact on water. To evaluate the adequate KPIs, different frameworks, tools or standard procedures can be used, e.g.

- life cycle assessment (LCA) to evaluate the relevancies,
- legislation,
- best available technologies (BAT), to check possible improvements and
- science based targets (SBT) to complete the KPIs according to global boundaries.

In these days and age, a process should not only follow the legal restrictions, for example legal concentration of pollutants per m$^3$. Other parameters, which might have a significant environmental and economic impact, need to be considered as well. Hence, decision trees to find adequate KPIs will be designed during the INPIREWATER project. The first decision tree, see Figure 4, is based on LCA information to evaluate the relevant impacts. The decision tree is designed to improve the understanding of the environmental impact of the processes, giving a first estimation of significant factors. The following decision trees, designed for process responsible, see Figures 8-11, should primarily be helpful to find the relevant KPIs, in addition to the used ones if they already have a set of KPIs and secondary stimulate the way of acting and thinking.
Is a KPI found with the help of the decision tree, the followed steps are proposed:

- All legislation has to be met (e.g. restrictions, legal amount and concentration of additives in the country)
- Further, regarding the BAT we question the possibilities and chances of a case site, to improve their environmental impacts. A summary of all different kind of technologies supports this step.
- As a last indicator to evaluate the success, the KPI should be connected with the results of other scientific researches. The SBT is oriented to the future and evaluates the situation under consideration of science, sustainability and continuity

The mentioned steps propose a holistic and comparative evaluation and have the advantage that individual adaption on each process or site is possible. The starting point is the evaluation of the relevancies by a streamlined LCA. Supporting aid to do this streamlined LCA with limited sources will be developed in WP 1 (LCA). The following decision trees are a first draft and have to be developed during the project and checked by applying to the case studies.

![Basic tree diagram]

**Figure 4:** Basic tree
Instructions:

• For each evaluation, first the basic tree has to be worked through, serving as an initial selection.
• The first level of the decision tree is based on a streamlined LCA.
• The 5% mark has to be determined and is not cogent yet. The boundary could also be lower or higher.
• Will you arrive on a check out box in bold you have to continue on the mentioned next tree.
• The next tree will be more specific and helps to figure out further details of your possible KPI.
• Bold words mean continue otherwise the last box indicates your possible KPI.

4.2.1 Example of streamlined LCA results

Figure 5 shows a schematic diagram of the mass and energy flows of a process or a production site. Every flow is linked with environmental impacts. Concerning the selection of the KPI’s it is important to know the relevancies of the different flows.

![Basic tree. Schematic mass and energy flow of a process or production site](image)

**Figure 5:** Basic tree. Schematic mass and energy flow of a process or production site.

Figures 6 and 7 give the results of the streamlined LCA of two different processes in two different production sites with different water scarcity. It shows that for process a in site A water production taking into account the local water scarcity has the highest impact followed by the additives for the WWT. For process b in site B water scarcity is not relevant but the used additives are crucial. These examples show that KPI have to be specific.
4.2.2 Detailed decision trees

Here specific decision trees for different components are shown.
Figure 8: Specific tree, water related sludge and solid waste.

Figure 9: Figure 6. Specific tree, additives.
**Figure 10.** Specific tree, energy.

**Figure 11.** Specific tree, water.
4.3 KPI design depends on the roles in the organisation

In a large corporation water management will be a topic for all levels in the organisation, however the roles and driving forces differ. Also suppliers have an impact on the overall water footprint, not at least from a life cycle perspective. In this section the interactions and driving forces will be described. Figure 12 shows an overview.

**Figure 12:** Roles and interactions in water management

4.3.1 Interactions with corporate level, site level and supply chain

The main role of the corporate function is to set a global policy, strategy and target on water management as well as to provide follow up and supporting activities. On this level general standards and requirements can be formulated for all entities, e.g. minimum standard for emission levels from a site that shall be fulfilled, regardless if the local legal requirements are less stringent or not. On this level KPIs that support overall targets and strategies are formulated, e.g. total water usage or maximum levels of emission parameters. As the staff on a corporate function normally cannot have a detailed knowledge of all activities on the sites, the reporting from the organisation should not be too much focused on metrics and KPIs. For example efficiency KPIs must also come with an analysis of how water usage is related to production. Also information of concrete improvement actions or plans from the sites is needed to put the KPIs into context.

From corporate level environmental performance, such as water usage, is also reported to external stakeholders, e.g. in annual reports. This requires information and reports from each site. Standardised methods, such as the GRI standard can be recommended and are also easier to communicate. Decision on large investments are also taken on this level and water matters can be one important input to such decisions, e.g. risk for delivery problems due to water scarcity, therefore KPIs related to water availability can be formulated.

The interactions with suppliers from this level are on topics like standards and environmental requirements on suppliers from the corporate purchasing organisation, which will be an input to the
selection of preferred suppliers to the company. The suppliers can be requested by the organisation to report on KPIs in a similar way as the company’s own sites.

On the site level the actual water management work is done. It is here water is used and changes can be made. For the site management it is important to follow up on KPIs that are related to and ensures compliance with legal demands.

It is up to the site to test, decide and invest in the specific technical solutions for water management. In these projects specific KPIs are used during the project phase.

Reporting to corporate on global KPIs related to water is also required from the site level.

Local purchasing of commodities that are not purchased from central organisation will also be a part of the water footprint.

4.4 KPIs in the step-by-step model

4.4.1 Overview of the step-by-step model:

In Figure 13, the model is outlined. The suggested steps are described in the light blue boxes and below is an illustration of the top down as well as and bottom up interactions between the different parts of the organisation. The Water Management model is described more in report D1.1. and will be further elaborated on in a later report by INSPIREWATER.

The steps are:

- Set the scope and assure engagement, identify initial current and future drivers and barriers
- Map current situation including external and internal factors
- Refine drivers and barriers.
- Define the strategy on different levels
- Set up the water management system (WMS)
- Define correct/appropriate KPIs (Key Performance Indicators, some are specific for each site and process)
- Implementation of the WMS
- Follow-up and improvement of the WMS
Figure 13: A step-by-step model of the process to implement a WMS, showing the roles and interactions between stakeholders in the organisation and supply chain. (Grey boxes are external stakeholders)

1. KPI design when setting the scope and identifying initial, current and future drivers and barriers:

The need for a more elaborated WMS can arise from any or a combination of the driving forces mentioned above, both from external factors, like legal requirement, water stress etc. but also internally, e.g. changes in production, cost efficiency, quality reasons. These driving forces will be an input to the scope setting, so a first step is to identify and evaluate these. On corporate level this is made by setting water issues as strategically important and communicate this in the organisation, on site level the local water situation and compliance matters will be guiding. On supply chain level water induced dependencies along the supply chain will be the drivers.

The design of KPIs should relate to the key questions:

- Is water an important topic for the company or for the site?
- What is the amount of water used?
- Does the company or site have or can foresee water related (or water induced) problems?
- How critical is water for production volume or quality?
- What are the opportunities for water savings and efficiency improvements?
- What are the costs for water treatment and what are the opportunities for cost reductions?
- Are there specific needs for reporting?

It is also important to get the same overview of the situation at key suppliers.

2. Assure engagement:

The next step will be to assure engagement, which starts by creating awareness in the organisation. Information and engagement activities are planned directed to employees and more in-depth training to those who have a direct influence on water usage and water treatment. Activities must
also be prepared for contractors active on the site, if their activity can be expected to have an influence on water usage. This is also an important aspect of KPI design, as a well-designed KPI is relevant for people in the organisation and reflects results of improvement activities. KPIs that people cannot influence or understand may have the opposite effect.

This information is also of importance for the corporate functions in order to establish common strategies, standards and support activities, e.g. provide training material that can be used by the organisation.

It is also possible to design KPIs that reflects engagement, e.g. by measuring awareness and engagement through employee surveys or questionnaires. Proposals for improvement activities from the staff and records of training activities can be a used as KPI.

3. Map current situation including external and internal factors

As the awareness of the importance of the matter now has been raised, it is time to increase the knowledge and map the situation as it is at this point. It is time to determine the basic conditions in more detail both from an external and internal perspective. It is also time to collect more information and to initiate measurements of important parameters. This is the real starting point of setting KPIs as it is at this stage we are getting to learn the situation and the needs to measured and followed up.

**External conditions** and environmental considerations that have to be determined are:

- Local and regional water resources, seasonal variations. In this analysis also future situation must be addressed, e.g. how climate change may influence on surface water temperature, availability or risk for flooding. Water scarcity models can be useful at this stage, but a local assessment may also be needed. The reporting parameters such as those described in the GRI standard may be useful as well.
- Upstream and downstream users (how our organisation have impact on other users in the area) and how other users may limit our water situation.
- Recipient sensitivity, outlet water quality parameters and downstream treatment. I.e. how residual contaminants in emission in waste water may affect the environment. A downstream treatment may be e.g. a municipal WWT. Normally parameters are set by legal demands, but also a set of control parameters on treatment equipment should be relevant.
- Regulatory compliance aspects

**Measure as is:** with the awareness of the external factors the next step is to look into the internal requirements for a sustainable and secured production. Important parameters, which can be used as KPIs are:

- Total water usage (in relation to availability)
- Water demand for processes (Flow and quality parameters)
- Water demand for domestic purposes
- Water demand for cooling
- Water demand for other purposes (e.g. gardening)
- Cost for inlet water (grid costs and/or need for treatment prior to usage)
- Total wastewater volume
- Emission parameters
Cost for water outlet treatment (including cost for handling of residues from the treatment, e.g. sludges, concentrates etc.)

4a. Refine drivers and barriers
With this initial analysis at hand it may be necessary to revise the analysis of drivers and barriers and also to revise the KPIs used so far based on new knowledge and insights.

4b. Define the strategy on different levels
Setting corporate level strategy and targets:
With the awareness given from the situation at the various production sites and the knowledge of other corporate strategies a corporate strategy on water related issues can be developed. Now appropriate KPIs related to the target can be formulated. Either it can be formulated as efficiency KPIs (provided that the relationship with production is fully understood), total volume or as an action program. This top-down perspective is important in order to give the local management the support needed for giving priority and to allocate resources to improvement activities. A special focus should be applied when major changes in production or other investments are planned in order to get the best solutions implemented from start, e.g. as a KPI on water saving results from the project.

However a corporate strategy must have the flexibility to allow each specific site to prioritise according to their need in order not to drive costs by requesting unnecessary actions (e.g. a very general water saving focus may not make sense at a site with very good and secure water supply).

Setting site level strategy and targets:
Determine the available volume and quality as related to the present and future need; set strategy to safeguard production, fulfil stakeholder requirements and eliminate environmental impact. Increased economic efficiency and reducing energy consumption are also targets that should be considered in relation to water efficiency.

4c. Set-up the water management system (WMS)
Based on the analysis of driving forces a draft water management system can be formulated. Also some initial key performance indicators (KPI) can be designed although they may need to be refined later as the work on water management proceeds. See section 4.4 below.

4d. Define correct/appropriate KPIs
A starting point now is to establish an overall site level KPI, i.e. a set of KPIs that determine that the site is operated within the acceptable window (e.g. m3/time not exceeding sustainable usage).

5. Implementation, evaluation and improvement of the WMS and the KPIs
Coming this far the WMS is implemented and the organisation is expected to get a much better overview of the water situation. On corporate level this means a good overview of the situation as a whole and a special focus on specific sites that have been addressed to need more attention. This overview also gives information on which KPIs to be used at which site. Most likely some of them can be left out in order to keep attention on the most relevant.
On site level all pre-requisites are determined, the as-is situation is described and action plans are in place. These plans will be followed up on regular basis e.g. in a PDCA cycle (Plan-do-check-act), incorporated into the environmental management system and in the general continuous improvement program.

On the supplier side the water status is assessed and the dialogue is on-going, followed up by revisions and information sharing. The dialogue may now also include knowledge sharing and technology development, if appropriate.

As the information is compiled and the first results are reviewed it is most likely that topics for improvements are identified and these are implemented in regular revision of the WMS.

### 4.5 Water management step-by-step and KPIs on operational site level

#### 4.5.1 Introduction

In this chapter guidance for a step-by-step approach for implementation of KPIs at site level is proposed as an overview of how KPIs related to water management can be used.

#### 4.5.2 KPIs related to WMS on overall site level

On the overall site level a water balance over the site, that may include several plants, is the starting point for the WMS and the as is situation should be analysed as described above. On this level the KPIs are designed to reflect the external prerequisites for production, and the whole plat is regarded more or less as a “black box”, i.e.: Determine the available volume and quality as related to the present and future need; set strategy to safeguard production, stakeholder requirements and eliminate environmental impact. This can be a one time job and described by rather simple KPI’s, if no real issues are identified, but may need annual update if there are. However a regular review and update should be foreseen, as especially up and downstream uses might change and this information may not reach the site management automatically.

Increases in economic efficiency and reducing energy consumption chemical usage, effect on water quality due to incoming materials/substrates are also a part of the strategy and target setting that should be considered.

It is also common that it is KPIs on this level that are requested for reporting to corporate level in the company and to regulatory authorities.
**Figure 14.** Overall water balance over a site – level 1 (inlet flows to the left and outlet to the right.

**KPI set up on water intake**

The inlet water flows should be determined by source, as described in Figure 14:

- Grid
- Well
- Surface water
- Reused water from external sources (e.g. treated municipal waste water)
- Rain water recovery

**Measure flow on each source of water:**

- Total flow source by source ($F_{1i}$, $F_{2i}$, $F_{3i}$, $F_{si}$, $F_i$, and $F_{ri}$ in figure 12 measured in in m$^3$/h).
- Quality parameters, e.g. pH, conductivity, suspended solids etc. on each source and relate it to the intended usage. Identify need for internal water treatment prior to usage (see level 2 KPI)
- Costs: purchase cost and cost for pre-treatment due to quality aspects.
- Flow related to plant activity, e.g. m$^3$/produced unit or m$^3$/employee or working hour (relevant parameter for domestic water usage).

Please note that the relation with production volume may not be directly correlated. This KPI must therefore be analysed in detail, e.g. there may be a baseline usage unrelated to production volume. It may be premature to do this analysis at this stage. Instead this KPI can be formulated based on analysis made in the water management plan and the KPIs selected for level 2 or 3 below. Correctly formulated this KPI will be useful at follow up on improvements in water management activities at the site.

**Cooling water ($F_{ci}$):**

Cooling water parameters are very dependent on the cooling method, e.g.:

- Case 1: Intake of cold water from surface water and deliver back, uncontaminated, to same source: Analyse if the $\Delta T$ is an issue for the recipient. KPI: Flow (m$^3$/h) $\Delta T$ outlet and (if feasible) in recipient.
Case 2: open (one-through or hybrid) cooling tower: follow water intake (m$^3$/h) and quality parameters, flow and quality parameter on bleed

Case 3: closed loop cooling tower: low water intake (m$^3$/h)

Storm water (F_{sw1}):

If storm water is harvested the amount of water to the rain water harvesting tank set in relation to the weather situation in the area (annual rain fall; seasonal variation, normal down fall (mm/h); e.g. at monsoon periods. The question is how to design and utilize the harvesting method, tank size etc. How much of the annual rain fall is harvested and how much is to be found in the storm water run-off.

- Use of harvested water (see F_{sw2} in the figure above).
- Recovered water from external sources (F_{ri}): In the area where the plant is located there may arise opportunities to use recovered waters from external sources, e.g. treated water from municipal water treatment plant or treated water from other users nearby, provided that this recovered water meets the quality requirement for any usage within this plant.

KPI on outlet water:

On the outlet side the volume flows and qualities have to be measured from the emission points (e.g. water treatment plants, surface water run-off, overflow). Also the amount of water lost through evaporation or delivered with outgoing products should be estimated.

On the overall site level the selected set of KPIs has to allow a monitoring methodology and assessment that secures that the site is operated within the predefined window. Normally legal requirements are also determining the KPI set up on outlet water.

Below is an example:

In this model two sewage treatment plants are included. These are treating waters from different sources based on contaminant composition, treatment method etc. The domestic water is not treated in the same plant as industrial. More plants can be used based on the processes in the production. In some case a treatment of storm water run-off may be needed due to site contamination or regulatory requirement.

Water to recipient (F_{w4o}, F_{w5o} and F_{wso}):

- Flow in m$^3$/h.
- Environmental quality parameters; regulatory demanded and other parameters of relevance for recipient, e.g. contaminants, pH, temperature etc.
- Amount and classification of residues from the waste water treatment, e.g. sludge, concentrates, etc.

Based on analyses of the water quality after sewage treatment it should be investigated whether this water can meet quality requirements for some of the water using activities within the plant. If so this is an option for recycling, possibly after some further polishing operation (“industrial symbiosis”). It can also be possible to increase the recycling after making a review of the chemical usage and make adjustments by substitution of problematic products.
Normally evaporation of water is very high (this may be followed by calculating the difference between intake of water and water outlet flow). Water, cost and energy may be saved by measures to recover this water, thus $F_{in} - F_{out}$ may be a KPI to follow (in this balance there may also be some amount of water in waste fractions and in the product that needs to be taken into account).

4.5.3 WMS broken down to specific water users (site level2)

The next step is to get a view of the processes and water users inside the factory and make a water balance on each one of these and measure (or as a start estimate):

- Water use in processes (divided and eventually broken down to each process and operation)
- Water use for domestic purposes
- Water use for cooling
- Water for other activities
- Other water flows, e.g. storm water

Figure 15 below shows an example of a procedure for defining a process specific water management system. With this it is possible to identify and quantify main users and start creating action programs with focus on:

- Large users
- “Low hanging fruits”
- Stand-by losses

Analyse how water usage correlates with activity (e.g. production volume) and set targets on each user.

**Figure 15:** Water management approach for specific plants, users or departments (level 2.2). The steps in the WMS development process are marked blue, specific activities coupled to the steps are grey and the green squares indicates where the KPI setting activity should be implemented. The small boxes indicate that the same procedure can be applied on other water users inside the plant as well (here: user 2 and user 3)
With this information the overall targets and strategies can be reviewed, as new awareness and opportunities may have been identified. It is also possible to start execution of the WMS by broken down water management plan for selected operations, setting metrics related to targets and define relevant KPIs on level 2 and start finding improvements through engagement (including directed training activities), Technology scouting (to find BAT solutions) etc.

**Example**

In Figure 16 an example of this is shown. This is a generic model of a factory with 3 different water consuming production processes, water for domestic usage (lavatory, locker rooms, canteen etc.) and water used for gardening on the premises.

- Process 1 is a closed loop system with well-defined usage of chemicals and internal recycling and high demand on water quality
- Process 2 is an open loop process with a mixture of chemicals and contaminants
- Process 3 has a high amount of evaporation, it may be e.g. spray process with high temperature, an open cooling, scrubber, paint spray booth or alike

In reality any process may have parts of all these aspects; i.e. quality requirements on inlet water, evaporation, partly recycling etc. Each of these needs specific designed KPIs for follow-up, control and improvement activities.

**Figure 16.** A generic model of a factory with three water consuming processes.

**Examples of relevant KPIs on process 1:**

Measure flow in water balance:
- Intake in m³/h and quality parameters, e.g. pH, conductivity, susp etc.
- Water need (and intake) to the process and quality parameters after pretreatment and the internally recycled water flow (Fᵣᵢ₁)
- Energy usage during production as well as non-production
Determine parameters to control process baths (including chemical usage) and need for removal of used water ($F_{\text{out1}}$)

- Parameters for control of recycling equipment.
- Flow and quality of water to Sewage treatment plant (STP)1 (including review of chemicals used and how they can have an impact on treatment result and other process parameters)
- Volume, content, cost and classification (legally controlled) of residues from the treatment, e.g. sludge, concentrates etc.
- Costs: purchase cost and cost for pre-treatment and recycling due to quality aspects.
- Flow related to production, e.g. m$^3$/produced unit. However, again please note that the relation with production volume may not be directly correlated. This KPI must therefore be analysed in detail, e.g. there may be a baseline usage unrelated to production volume. This KPI can be formulated based on analysis on more detailed data made at level 3 below. Correctly formulated this KPI will be useful at follow up on improvements in water management, process optimisation and to analyse stand by losses.

**KPIs on process 2:**

Measure flow in water balance:

- Intake in m$^3$/h and quality parameters, e.g. pH, conductivity, susp etc.
- Determine parameters to control process baths and need for removal of used water ($F_{\text{out1}}$)
- Energy usage during production as well as non-production
- Flow and quality of water to STP1 as above.
- Costs: purchase cost and cost for wastewater treatment in STP1.
- Flow related to production, e.g. m$^3$/produced unit (as described for process 1).

**KPIs on process 3:**

Measure flow in water balance:

- Intake in m$^3$/h and quality parameters, e.g. pH, conductivity, susp etc.
- Water need (and intake) to the process and quality parameters after treatment in STP1 (and additional polishing if needed) ($F_{\text{in2}}$)
- Determine parameters to control process baths and need for removal of used water ($F_{\text{bleed}}$)
- Energy usage during production as well as non-production
- Flow and quality of water to STP1
- Costs: purchase cost and cost for pre-treatment and recycling due to quality aspects.
- Flow related to production, e.g. m$^3$/produced unit, as described for process 1
- Water, cost and energy may be saved by measures to reduce evaporation or to recover this water, thus $F_{\text{in}} - F_{\text{out}}$ should be a KPI to follow.

**KPIs on STP1:**

- Flow and quality parameters on intake to the STP
- Flow and quality parameters on outlet to recipient or external treatment and amount to reuse within the plant. For water to external treatment or recipient a control program is normally required by authorities.
- For water to internal reuse the quality requirements and flow is set by the receiving process, which may be less stringent than the requirements for outlet to recipient. This may give opportunities for simplified treatment methods or just changes in methodology.
- Content and amount of waste fraction.
- All relevant control parameters needed to run the plant.
This plant may have separate treatment lines for the process water from process 1 and 2, this will normally give an improved treatment and facilitate reuse of the treated water.

- Costs: e.g. equipment, additives, waste handling, energy, analyses, people.

**KPIs on domestic water use:**

**Measure flow in water balance:**

- Intake in m^3/h and quality parameters, e.g. pH, conductivity, suspended solids, drinking water standards etc.
- Flow and quality of water to STP2
- Costs: purchase cost and cost for wastewater treatment in STP2. E.g. equipment, additives, waste handling, analyses, people.
- Flow related to plant activity. For domestic water m3/employee is normally the most relevant parameter.

**KPIs on STP2:**

In this plant only water from “biological sources” are treated. The sludge and treated water should not have residues from process chemicals used in the plant. This will most likely increase the opportunities for reuse of this water, e.g. in gardening or in processes where it may live up to the water quality requirements.

- Flow and quality parameters on intake and on outlet. Amount to recipient or external treatment and amount to reuse within the plant.
- For water to external treatment or recipient a control program is normally required by authorities.
- For water to internal reuse the quality requirements and flow is set by the receiving process.
- When used for gardening it is important to avoid any contaminants that may be accumulated in the soil.
- Content and amount of sludge fraction.
- All relevant control parameters needed to run the plant.
- Costs: e.g. equipment, additives, waste handling, analyses, people.

Based on an analysis of the water quality after sewage treatments it should be investigated if this water can meet quality requirements for some of the water using activities within the plant. If so this is an option for recycling, possibly after some further polishing operation. It can also be possible to increase the recycling after making a review of the chemical usage and make adjustments by substitution of problematic products.

As the work progresses several loops of information, coordination between processes and other water users, internal loops on water usage etc. may be identified and implemented into the management program. As such opportunities are identified new targets will set and measurement methods and KPIs will be revised as a part of the improvement program.

**4.5.4 WMS on process level (level 3)**

To get really in depth and find the real opportunities for water optimisation and improvements metrics and KPIs on detailed operational level (level 3) should be formulated. As every process is unique, this has to be done in close cooperation with the process expertise and operational
personnel. It may also be a very iterative process as more knowledge is created and improvement measures are implemented.

**Example:**

An example of such a process is shown in figure 17:

![Diagram of a production process with high water usage](image)

**Figure 17.** Example of a production process with high water usage. In the figure the light blue arrows are representing water flows with more or less contamination of process fluids, while the dark arrows represent flows with high amount of process chemicals.

This is a generic production process with a process bath and two rinse steps. The rinse water has one recycling loop and the process bath is recovered through another loop, where valuable chemicals are recovered while by products and contaminants are removed. Some water is lost through evaporation and needs to be replaced by a water feed with low conductivity.

In the figure the light blue arrows are representing water flows with more or less contamination of process fluids, while the dark arrows represent flows with high amount of process chemicals.

On this level several parameters should be monitored and used for process control. Mostly measured to stay in the right process window on chemical balance, rinse water requirement, control of contaminants as well as other parameters important for the process, e.g. temperature, pH, spray nozzle pressure etc. In a complex process a digital modelling may be required.

Also the different recycling equipment’s are controlled by a variety of measured parameters; pressure, internal flow, concentration gradients, operating temperature etc.

As some chemicals in this example is recovered and feed-back to the process, it is very important to safeguard that it has the correct mixture of chemicals for the process. It may be necessary to design a touch up chemical mixture to match the composition in the recovered chemicals. Also risk for accumulation of unwanted elements in process bath and rinse baths has to be monitored.
4.5.5 Design of KPIs on operational site

In this table a summary of what information is requested from which stakeholder at a production site. This can serve as a basis for determining and formulating KPIs to be used by relevant stakeholders in the organisation.

Table 1. Industrial water management KPI perspectives for different stakeholders

<table>
<thead>
<tr>
<th>Topic</th>
<th>Stakeholder:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant operator / technician (Water)</td>
</tr>
<tr>
<td></td>
<td>Plant Management (Water)</td>
</tr>
<tr>
<td></td>
<td>Plant Management (Production)</td>
</tr>
<tr>
<td></td>
<td>Company/Site Management (Water &amp; Production)</td>
</tr>
<tr>
<td></td>
<td>External stakeholders</td>
</tr>
<tr>
<td>Fresh water</td>
<td></td>
</tr>
<tr>
<td>Fluctuation in demand</td>
<td>Fresh water demand p.a.</td>
</tr>
<tr>
<td></td>
<td>Fresh water demand vs. availability</td>
</tr>
<tr>
<td></td>
<td>Fresh water / unit of product n.b. with awareness of the relationship</td>
</tr>
<tr>
<td></td>
<td>water usage = f(production + baseline)</td>
</tr>
<tr>
<td></td>
<td>Fresh water demand compared to benchmark value</td>
</tr>
<tr>
<td></td>
<td>Fresh water management for the region, scarcity</td>
</tr>
<tr>
<td>Fluctuations in incoming water</td>
<td>Fresh water saving</td>
</tr>
<tr>
<td>quality</td>
<td>Fresh water quality parameters</td>
</tr>
<tr>
<td></td>
<td>Cost savings in Fresh water supply CAPEX / OPEX</td>
</tr>
<tr>
<td></td>
<td>Fresh water demand per compartment (groundwater, surface water, tab)</td>
</tr>
<tr>
<td>Ratio own vs. 3rd party supply</td>
<td></td>
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<tr>
<td>Pretreatment effort</td>
<td>CAPEX / OPEX for pretreatment</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Share accounted to production</td>
</tr>
<tr>
<td></td>
<td>CAPEX / OPEX site fresh water infrastructure</td>
</tr>
</tbody>
</table>
### Wastewater

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluctuation in quantity and quality</td>
<td>Total wastewater generation p.a.</td>
<td>Recipient environmental quality</td>
</tr>
<tr>
<td>Complexity of ww treatment</td>
<td>WW treatment CAPEX / OPEX</td>
<td>Care for downstream users or water protected areas</td>
</tr>
<tr>
<td>Complexity of wwt technology operation</td>
<td></td>
<td>Effects on municipal waste water treatment</td>
</tr>
<tr>
<td>WW Reuse - cost ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear water quality</td>
<td></td>
<td>Compliance with regulation</td>
</tr>
<tr>
<td>Share accounted to production</td>
<td></td>
<td>CAPEX / OPEX site wastewater infrastructure</td>
</tr>
</tbody>
</table>

### Energy

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy for process (e.g. temperature control)</td>
<td>Energy cost for freshwater pretreatment</td>
<td>Energy demand in water management</td>
</tr>
<tr>
<td></td>
<td>Energy cost for wastewater treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy cost saving fw /ww</td>
<td>Cost savings in energy use CAPEX / OPEX</td>
</tr>
</tbody>
</table>

### Maintenance in water management

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance effort (work)</td>
<td>Maintenance cost</td>
<td>Impact on plant productivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Municipal water and sewage infrastructure</td>
</tr>
<tr>
<td>Maintenance chemicals (safety)</td>
<td>Maintenance frequency</td>
<td></td>
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<tr>
<td>-------------------------------</td>
<td>------------------------</td>
<td>---</td>
</tr>
<tr>
<td>Response time for unplanned defects</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Strategic aspects**

<table>
<thead>
<tr>
<th></th>
<th>Waterborne risk of production interruption</th>
<th>Resilience against waterborne risks of production interruption; Financial value of increased resilience</th>
<th>Water risks for neighbours, environment and society</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Waterborne risk on product quality</td>
<td>Risks for changes in regulation</td>
<td>Need for setting new or further regulations</td>
</tr>
<tr>
<td></td>
<td>Response time for failures (ww loss)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Plans for further work in WP1

This document describes the draft framework for formulating performance indicators related to a water management system, e.g. the system currently developed in INSPIREWATER. During the project this framework will be developed further by testing and possibly implementing the water management and relevant indicators at our industrial project partners. More specifically, the work is planned to include:

- Adaptation of the current Water Management system and indicators used to better reflect the different needs through discussions with Clariant, Sandvik and ArcelorMittal on design of WMS and indicators, based on this framework. This design should reflect their existing systems, their pre-requisites and their needs in their present set up of water processes as well as the proposed new solutions developed in the INSPIREWATER project.
- Refinement of the system including work with performance indicators at different levels
- Implementation and testing of the developed framework for WMS and indicators
- Further collection of external input during the project phase
- Optimisation of the WMS and indicators by taking the results from other WPs into account
- Possible further exploitation of the water management system work in INSPIREWATER
- Presentation of the revised and further developed general framework as well as solutions for each partners in a final report.
6. References


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