A Generic Guideline for Water Metering in the South African Dairy and Agri-Processing Industries

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1 Introduction

Process resource efficiency is, with increasing resource prices and resource scarcity, becoming crucial for keeping operational costs down in the dairy industry. In most of the world, electricity prices motivate for monitoring and savings investments and in some regions, high water tariffs or water scarcity can be drivers for monitoring and water conservation investments. In the last decade, the industry has also become increasingly aware of such opportunities and developed technology that can ensure savings and reuse and/or recycling of water. The economies of savings and recycling is increasing the demand for accurate measuring and monitoring of the processes and flows in the production.

Metering, measuring and monitoring of resource flows and process parameters have shown to be a very effective way to optimize production and save on energy, water, additives and detergents. In depth understanding of consumption and flows are crucial to make the right resource saving investments.

1.1 Background

South Africa has a huge and important segment of wet industries – especially in the agri processing industry. The production is in most aspects matching global standards but due to historically low utility prices for both electricity and water, few industries have been motivated to implement metering and measuring equipment or invest in water and energy saving technology. The National Cleaner Production Centre-SA (Industrial Water Efficiency Project) and Department of Water and Sanitation (Compliance Monitoring and Enforcement) has in their industrial assessments and regulatory industrial site visits identified a huge lack of metering and measuring and attention to even very basic consumption and flows, especially related to water. Additionally, several studies have shown that simple metering and monitoring of water inflow can help industries develop water balances, identify leaks and inefficient water processes that can be fixed in the short term and ensure significant savings on the water consumption and related costs.

The Danish Water Sector Programme under the Danish Ministry of Foreign Affairs (MFA), with support from the supervising partners including: International Finance Corporation (IFC) , National Cleaner Production Centre South Africa (NCPC-SA), the Water Research Commission (WRC) in South Africa, the Department of Water and Sanitation (DWS), the Danish EPA and the Danish Embassy, are happy to provide the current guideline focusing on implementing metering and monitoring projects in South Africa focusing on water consumption in the dairy processing industry. This will enable the development of cleaning processes and reduce waste losses, which will benefit the circular economy, the green transition, and the reduction of greenhouse gas emissions.

The guideline is the outcome of the following activities carried out in four dairy processing plants that may be considered representative of the dairy processing industry in South Africa:

1. <u>Assessment and analysis</u>: Determination of metering and monitoring needs
2. <u>Implementation</u>: Installation of water meters and data analysis system
3. <u>Monitoring and improvements</u>: Monitoring of significant water using processes and proposal of opportunities for improved water efficiency.

The four dairy plants that have participated in the project will be kept anonymous and where applicable be referred to as Dairy 1, Dairy 2, Dairy 3 and Dairy 4.

1.2 Who should use the guideline?

This process-focused guideline is designed to cater to a diverse audience, encompassing various stakeholders involved in water efficiency, sustainability, and resource management. While the guideline originates from demonstration activities in the dairy processing industry, its applicability extends beyond this sector. Here's who can benefit from this guideline:

1. Dairy Processing Industry: Dairy processing plants of all sizes, from small-scale operations to large manufacturing facilities, can use this guideline to continuously improve their water use efficiency. It offers a structured approach to enhance sustainability and reduce operational costs.
2. Dairy and Agri-Food Industries: Beyond dairy processing, this guideline is equally relevant to other agri-food industries that rely on water resources in their operations. It provides valuable insights and best practices for optimizing water usage, regardless of the specific agri-food sector.
3. Consultants and Experts: Professionals and consultants specializing in water efficiency, cost optimization, sustainability, and environmental management can use this guideline as a resource when advising dairy and agri-food industries. It serves as a comprehensive reference for guiding their clients toward more efficient and responsible water management practices.
4. Regulatory Authorities: Regulatory bodies and government agencies, such as DWS, responsible for water resource management and environmental compliance can use this guideline as a reference to assess and enhance industry compliance with water efficiency standards and regulations.
5. Sustainability Initiatives: Organizations and initiatives, such as the National Cleaner Production Centre South Africa (NCPC-SA), can leverage this guideline as part of their industrial support programs. It offers a structured framework to promote sustainable practices within the dairy and agri-food sectors.
6. Academia and Research: Academic institutions and researchers focused on sustainability, resource management, and agri-industrial processes can utilize this guideline as a basis for further study and analysis. It provides practical insights into real-world water efficiency challenges and solutions.
7. Environmental and Sustainability Associations: Industry associations and environmental groups concerned with sustainable practices in the dairy and agri-food sectors can use this guideline to support their members in adopting more responsible water management practices.

By extending the reach of this guideline to a wider audience, we aim to promote a holistic approach to water efficiency and sustainability, fostering collaboration among stakeholders to address the challenges of water resource management in the dairy and agri-food industries. Together, we can work towards a more sustainable and resilient future for these vital sectors.

1.3 Integration with Management Systems

Water efficiency and sustainable resource management are integral components of modern management systems. While there is no specific ISO standard dedicated solely to water efficiency management, this guideline aligns closely with existing ISO standards, including ISO 9001 (Quality Management), ISO 14001 (Environmental Management), and ISO 50001 (Energy Management).

- **ISO 9001 (Quality Management):** ISO 9001 emphasizes the importance of meeting customer requirements and delivering consistent quality. Water efficiency plays a role in ensuring quality, as water is often a critical component in many industrial processes. By integrating the principles of this guideline into ISO 9001-compliant quality management systems, organizations can enhance their commitment to customer satisfaction and product quality.

- **ISO 14001 (Environmental Management):** ISO 14001 focuses on environmental sustainability and responsible resource management. Water is a vital natural resource, and its efficient use aligns perfectly with ISO 14001's objectives. Organizations seeking ISO 14001 certification can incorporate the practices outlined in this guideline to address water-related environmental aspects and reduce their ecological footprint.
- **ISO 50001 (Energy Management):** ISO 50001 provides a framework for managing energy resources efficiently. While its primary focus is on energy, many aspects of ISO 50001, such as data collection, monitoring, target setting, and continuous improvement, can be adapted for water efficiency management. The systematic approach outlined in ISO 50001 can serve as a model for implementing water-saving measures and ensuring ongoing optimization.

By drawing from these internationally recognized management system standards, organizations can effectively integrate water efficiency into their broader sustainability and quality management initiatives. This not only promotes responsible resource management but also enhances compliance, efficiency, and the organization's commitment to meeting its environmental and social responsibilities. The adoption of water efficiency practices as outlined in this guideline complements and strengthens an organization's overall management system, supporting its journey toward sustainability and resilience.

2 Individual Steps in Establishing an Effective Water Metering Programme

In the pursuit of water efficiency and sustainable resource management, the ISO 50001 standard provides a robust framework encapsulated within the PLAN-DO-CHECK-ACT (PDCA) cycle. While ISO 50001 primarily addresses energy management, its PDCA concept is highly adaptable to water efficiency initiatives. However, for a truly comprehensive approach that ensures continuous improvement in water efficiency, it is essential to extend our focus beyond the traditional "CHECK" phase.

This 10-step guideline has been meticulously crafted to align with the PDCA cycle, encompassing the entire spectrum of PLAN-DO-CHECK-ACT principles, and further expanding the scope to secure continuous improvement in water efficiency within the dairy processing industry. Let's explore how each step corresponds to the PDCA cycle:

- **PLAN (Steps 1-4):** In this phase, the emphasis is on planning and preparation. The "Set-up a Water-Efficiency Team" (Step 1) serves as the foundation, bringing together key stakeholders to chart the course for water efficiency initiatives. The subsequent step, "Collect Basic Production, Water, and Energy Data" (Step 2), corresponds to planning and setting objectives. Establishing benchmarks for water-intensive processes (Step 3) and developing a measurement and monitoring plan (Step 4) align with the goal-setting aspect of the PLAN phase.
- **DO (Steps 5-8):** Moving into the DO phase, we shift our focus to implementation. Installing meters and implementing data management systems (Step 5) reflects the execution of planned activities. Steps 6 and 7 involve putting those systems into operation, which is at the core of the DO phase. Finally, identifying saving potential and monitoring savings after process changes (Step 8) represents the critical aspect of "doing" in response to data collected.
- **CHECK (Steps 5-8):** Traditionally, metering and monitoring are associated with the CHECK phase in ISO 50001, focusing on data analysis, performance assessment, and verification. Steps 5-8 of this guideline align with this phase, emphasizing the importance of evaluating the effectiveness of water efficiency measures and ensuring that they meet established benchmarks.
- **ACT (Steps 9+10):** However, to truly secure continuous improvement in water efficiency, we expand our perspective beyond the CHECK phase' typical boundaries. Steps 9 and 10, "Identify Saving Potential and Monitor the Savings After Process Changes" and "Next Steps and Continuous Improvements," respectively, represent the ACT phase in our extended approach. They encapsulate the spirit of acting on the insights gained from data, fostering a culture of ongoing innovation, and driving improvements over the long term.

By following this comprehensive 10-step approach, organizations in the dairy and agrifood processing industries can integrate ISO 50001 principles into their water efficiency efforts. This approach encompasses every phase of the PDCA cycle, ensuring that water conservation remains a continuous and evolving commitment. Together, we embark on a journey toward sustainable water management, environmental responsibility, and operational excellence.

In Figure 1it is illustrated how the 10-step procedure fits with the PDCA principles adapted from ISO50001.

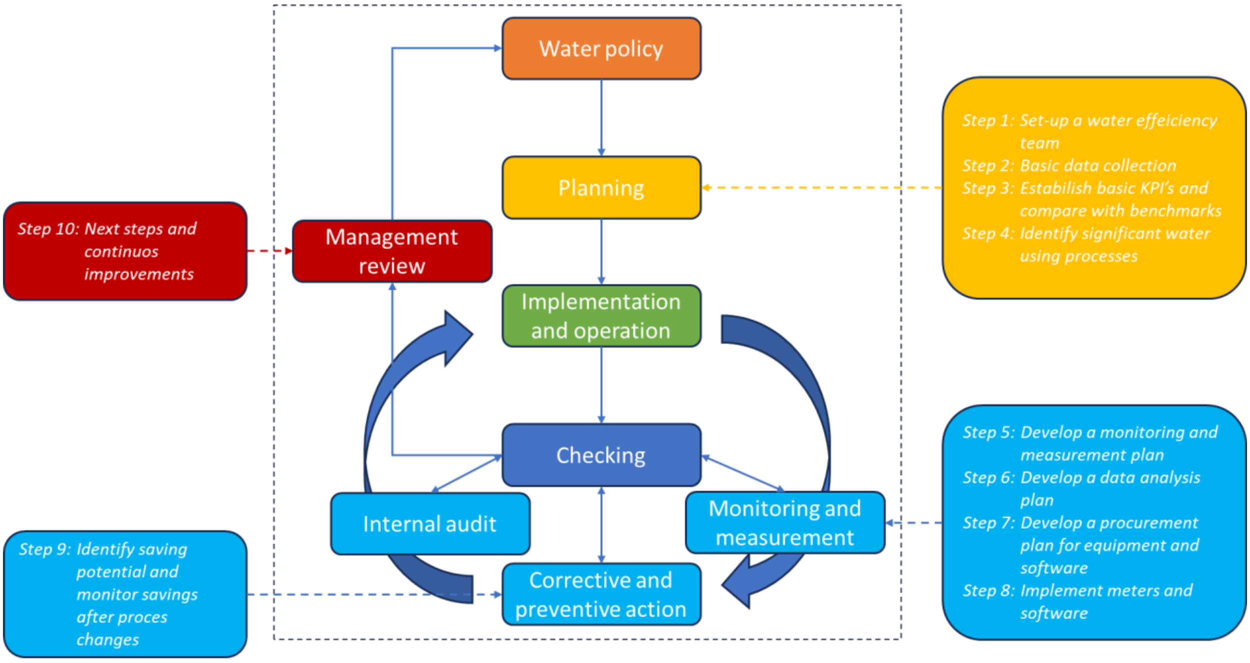


Figure 1: Illustration of how the 10-step procedure in the current guideline fits with the PLAN-DO-CHECK-ACT principles within the dotted box (adapted from ISO 50001).

It is however important to note, that the current guideline is not a full guideline in establishing a Water Efficiency Management System – but the proposed steps to have an effective metering system and secure continuous improvements in water use efficiency.

2.1 Step 1: Set-up a water efficiency team

Water efficiency requires a collaborative effort across different departments and teams within a dairy processing plant. Establishing a dedicated water efficiency team can help ensure that water-saving measures are effectively implemented, monitored, and maintained. With the right team in place, dairy processing plants can maximize the benefits of sub-metering and other water-saving measures, leading to cost savings, improved environmental performance, and a more sustainable operation.

A dedicated team consisting of relevant staff across the organisation should be set-up covering different departments of the organisation e.g.:

- Management representative (Chairman)
- Quality
- Environment
- Utilities and/or Engineering
- Production departments
- Eventually external consultant(s)

Management should secure sufficient resources to be available to the water efficiency team. A Water Efficiency Manager may be appointed to lead the activities of the team on a day-to-day basis.

At each of the 4 dairy processing plants at which the demonstration projects were conducted, a project champion was appointed to lead on-site work associated with the project. At 3 of the facilities the project champion was a representative from Production, and at one of the facilities a Quality Specialist led the project. Each site also had a Project Sponsor from senior management. All of the sites included a representative from Engineering. This is essential as the meters need to be installed in pipelines and connected to data concentrators to enable online data access.

2.1.1 Management responsibility and leadership

The importance of management leadership in achieving successful outcomes in water efficiency activities cannot be overstated. Management leadership sets the tone, direction, and commitment level for water efficiency initiatives within a dairy processing plant. Here's an elaboration on why management leadership is crucial:

1. <u>Establishing Priorities:</u> Management leadership is responsible for setting organizational priorities. When leaders prioritize water efficiency, it signals to employees that this is a fundamental aspect of the business strategy. It ensures that water conservation is not an afterthought but an integral part of daily operations.
2. <u>Resource Allocation:</u> Effective water efficiency initiatives often require investments in technology, equipment, training, and ongoing maintenance. Management leadership is essential for allocating the necessary resources to support these initiatives, ensuring that they are adequately funded and staffed.
3. <u>Cultural Shift:</u> Water efficiency initiatives often involve changes in processes, behaviors, and attitudes. Management leaders are instrumental in driving a cultural shift within the organization, emphasizing the importance of water conservation and encouraging employee engagement in sustainability efforts.
4. <u>Goal Setting:</u> Management leaders play a critical role in setting clear and measurable water efficiency goals for the organization. These goals provide a framework for action and help align the efforts of all employees toward a common objective.
5. <u>Accountability:</u> Leaders hold teams and individuals accountable for meeting water efficiency targets. Accountability ensures that progress is monitored, and deviations from the plan are addressed promptly.
6. <u>Investor and Stakeholder Relations:</u> Many investors, customers, and stakeholders place a high value on sustainability and responsible resource management. Management leadership in water efficiency initiatives can enhance the organization's reputation, strengthen stakeholder relations, and attract environmentally conscious investors.
7. <u>Regulatory Compliance:</u> Management leaders are responsible for ensuring that the organization complies with water efficiency regulations and standards. They should stay informed about evolving regulations and take proactive measures to meet or exceed them.
8. <u>Innovation and Continuous Improvement:</u> Management leaders foster an environment of innovation and continuous improvement. They encourage employees to seek innovative solutions for water conservation and support the implementation of new technologies and best practices.
9. <u>Communication and Transparency:</u> Effective communication from management leaders about the importance of water efficiency, progress made, and successes achieved can motivate employees and create a sense of shared purpose. Transparency builds trust with stakeholders and demonstrates a commitment to sustainability.
10. <u>Long-Term Vision:</u> Management leaders should have a long-term vision for water efficiency that extends beyond immediate financial gains. They recognize that sustainable water management is essential for the organization's long-term viability and resilience.

In summary, management leadership is the driving force behind successful water efficiency activities in dairy processing plants. Their commitment, vision, and support create an environment where water conservation becomes a core value, leading to positive environmental, financial, and operational outcomes.

2.2 Step 2: Collect basic production, water and energy data and existing metering praxis

To identify opportunities for water efficiency improvements and evaluate the effectiveness of sub-metering, it is important to collect basic production, water, and energy data. This data provides a baseline for identifying areas of water wastage and inefficiency and can be used to measure the effectiveness of water-saving measures over time. Additionally, it is important to understand the existing metering praxis of the dairy processing plant.

The data collection should be done at the overall factory level and cover all aspects of water use within the plant, including water use in processing, in-place cleaning, utilities, and other operations. Water-related energy consumption should ideally also be measured, as water and energy use are closely linked. For example, where hot water is used, the energy component of that water is typically significant from a cost and emissions perspective. Where water is used in combination with chemicals, for example to make up a sanitizer solution used for cleaning of floors and surfaces, chemical concentrations and costs should be determined. Data should be collected over a sufficiently long period, to ensure that it is representative. Typically, a baseline period of 1-3 months should be sufficient – but in plants with large seasonal variations a longer period may be required.

In addition to collecting basic data, it is important to understand the existing metering praxis of the dairy processing plant. This includes identifying existing primary (main) water meters, sub-meters and auxiliary measuring devices and understanding their accuracy and reliability. Understanding the existing metering praxis can help to identify potential gaps or issues with the current monitoring system that may need to be addressed.

By collecting basic production, water, and energy data and understanding the existing metering praxis, dairy and agri-processing plants can identify areas of high water and energy consumption, establish a baseline for future water-saving measures, and address any issues with the existing metering praxis. This information will be useful in identifying opportunities for improvement and setting targets for future water efficiency measures.

When the demonstration projects in the 4 dairy processing facilities were launched, each facility was sent a questionnaire which was used to gather basic information on historical water use. This was followed by much more intensive data gathering through plant visits. An example of the questionnaire that was provided for Dairy 2, a facility that produces a range of artisanal cheeses, is provided in Table 1 below.

Table 1: Example of a questionnaire for Dairy 2 on basic water and energy consumption and production data.

Questionnaire on Energy and Water Metering and Monitoring

COMPANY DETAILS		
Company		Dairy 2
Location		
Province		
Year established		
Name		
Contact Number		
Email Address		
PRODUCTION		
Capacity	litre milk/day	16,646
Operating days/year	days/year	208
Products		
Product #1 - Haloumi	tonnes/day	1.5
Product #2 - Feta Homogenised	tonnes/day	0.4
Product #3 - Feta	tonnes/day	0.2
Product #4 - Parmesan	tonnes/day	0.1
Product #5 - Ricotta	tonnes/day	0.2
Product #6 - Other (Mascarpone, Mozzerella etc.)	tonnes/day	0.3
ENERGY		
Annual electricity consumption	kWh	1,220,423
No. of electricity sub-meters or loggers	#	1
Type of meters (SMART, analogue, etc.)		SMART
Data storage		Yes
Data analysis		Yes
Rate your energy management systems		3 - Average
Rate your energy data management systems		3 - Average
WATER		
Annual water consumption	kl	18,510
No. of water meters	#	3
Type of meters (SMART, analogue, etc.)		Analogue
Data storage		No
Data analysis		No
Rate your water management systems		2 - Poor
Rate your water data management systems		2 - Poor

2.3 Step 3: Establish overall key performance indicators and compare with benchmarks

Comparing a dairy processing plant's water use with relevant benchmarks and KPIs is an important step in understanding its water efficiency performance. KPIs such as water use per tonne of milk delivered or per tonne of cheese produced can provide a useful benchmark for comparing a plant's water efficiency performance with industry standards.

By comparing its water use with these benchmarks, a dairy processing plant can identify areas where it is underperforming and take steps to improve its water efficiency. For example, if a plant's water use per tonne of milk delivered is higher than the industry benchmark, it may indicate that there are opportunities to reduce water use in processing, cleaning, or other operations.

In addition to benchmarking against industry standards, comparing water use over time can help identify trends and areas for improvement. By establishing a baseline of water use and monitoring changes over time, dairy processing plants can evaluate the effectiveness of water-saving measures and adjust their operations accordingly.

Comparing water use with relevant benchmarks is an important step in understanding a dairy processing plant's water efficiency performance. By doing so, the plant can identify areas for improvement and take steps to reduce water use and improve its environmental performance.

Table 2: Water consumption benchmarks in European dairies (years 2012-2014) /2/.

Product	Water consumption (m^3/tonne of raw materials)
Market milk	0.33–12.61
Cheese	0.24–4.90
Powder (e.g. milk, whey)	0.50–4.27
Fermented milk	1.91–17.23

Table 3: Benchmarks of environmental performance levels for specific wastewater discharge /2/

Main product (at least 80 % of the production)	Specific wastewater discharge (yearly average) (liter/liter)
Market milk	0.3–3.0
Cheese	0.75-2.5
Powder	1.2–2.7

Table 4: Benchmark data on consumption of water (liter/liter of processed milk) from some Scandinavian dairies /3/.

Product range	Sweden	Denmark	Finland	Norway
Market milk + cultured products	0.96-2.8	0.60-0.97	1.2-2.9	4.1
Cheese, whey	2.0-2.5	1.2-1.7	2.0-3.1	2.5-3.8
Powder, cheese and/or liquid products	1.7-4.0	0.69-1.9	1.4-4.6	4.6-6.3

However, it is important to remember that most benchmarks will cover a very wide range – so even though a dairy plant is within this range, there may still be significant opportunities to improve. Conversely, a small plant with a diverse product mix may operate on the upper end of the range yet may be operating very efficiently. The variety of dairy processing plants participating in the project can be seen from Table 5 ranging from a small niche manufacturer to one of the largest plants in South Africa.

Table 5: Introduction to the four South Africa based dairy plants participating in the project.

Dairy plant	Milk processing capacity (L/day)	Main products	Comments
Dairy 1	990,000	UHT and Extra shelf-life milk, yoghurt, cheese, powdered products, butter, cream	Has metering system in place, but all meters are read manually, and the focus is primarily on supply, CIP and utilities.
Dairy 2	40,000	Niche cheese manufacturer producing various speciality cheeses, principally haloumi	Very limited metering systems in place on the supply side –all manually read
Dairy 3	90,000	Fresh milk, sour milk, yoghurt, cheese, cream and fruit juice blends	Some very limited metering system in place on the supply side –all manually read
Dairy 4	210,000	Cheese and butter	Some online metering already in place, but focused more on water security than on efficiency

2.4 Step 4: Identify Significant Water Users and establish process benchmarks

Overall dairy water use benchmarks may give an indication that a dairy has water saving potential. However, to identify opportunities for improving water efficiency, it is important to identify and understand the significant water users (SWU's) within a dairy processing plant. SWU's are water users that either use large quantities of water, offer significant opportunity for improvement, or both. The concept of SWU's steams from the ISO50001 energy management systems standard, which may also be used to manage water. By identifying these processes, it is possible to establish process benchmarks for water use that can be used to monitor and improve efficiency.

The main water-using processes in a dairy processing plant typically include milk processing, cleaning and sanitizing of equipment, surfaces and floors, utility operations such as steam generation, cooling and refrigeration. These processes often represent the largest water use in a plant and offer the greatest opportunities for water savings.

A walk-through of the dairy - supported by available process and water use data is likely to be able to identify the main water using processes. If sufficient data is available, it may also be possible to rank the water users according to size. Observations and qualitative assessments also highlight processes in which savings could easily be realised.

Once the main water-using processes have been identified, it is important to establish process benchmarks for water use. This involves setting targets for water use per unit of product or per process step, based on

Significant Water Users

The following items were identified as possible areas for improved water efficiency:

Dairy 1

- Water treatment is sub-optimised, leading to excessive backwashing and rinsing
- Excessive flashing of steam (high-pressure condensate)
- Unnecessary operation of RO plant, with excessive retentate loss
- Once-through use of water for cooling during caustic flake dissolution
- Various maintenance problems leading to water losses
- Excessive boiler blowdown
- Passing valves in boiler house –blowdown and pressure relief valves
- Poor control of manual environmental cleaning –work practices and equipment
- Condensate contamination preventing full recovery of condensates (roughly 45% recovered)
- Overflows of water storage tanks

Dairy 2

- No condensate recovery from vats
- Live steam used for heating leads to steam losses, increased blowdown
- Opportunities to improve environmental cleaning
- Overflows from block former washing machine
- Clean water used for cooling vats discharged to drain
- Steam pressure to vats too high, leading to excessive flows (no steam traps used)
- Overfilling of chilled water troughs leading to overflows with the addition of cheese
- CIP plant not equipped with recovered water tank
- Operators changing CIP settings leading to excessive flush volumes
- Manual flushes leading to excessive volumes to drain
- Water not recovered from separator and homogenizer

Dairy 3

- No condensate recovery in place
- Excessive quantities of water to drain from homogenizer and separators
- Two of the 3 CIP plants do not have recovered water tanks
- Vacuum pumps discharging water that should be recovered –increases make-up requirements
- Inefficient environmental cleaning practices
- Manual cleaning of vessels prior to CIP suboptimal
- Vessels leaking from lids during water addition
- Various miscellaneous leaks
- Water of higher than required quality used in some applications

Dairy 4

- Overflows on water storage tanks due to manual control of operations
- Various leaks of water and steam –maintenance capacity is a challenge
- Water used for heating in a once-through fashion
- Large bore hoses used for environmental cleaning –some equipped with trigger nozzles
- Excessive venting of steam –poor pressure control
- Excessive steam usage for deaeration at hotwell leading to unnecessary evaporation
- Leaking boiler blowdown valve
- Condensate not recovered from vats or CIP plants
- Poor temperature control on CIP plants leading to excessive evaporation
- Excessive water use at vacuum pumps
- Crate washing operation sub-optimal

industry standards or best practices. These benchmarks can be used to monitor and evaluate the effectiveness of water-saving measures over time and to identify areas for improvement.

Establishing process benchmarks requires a detailed understanding of each process and its associated water use. This information can be obtained through site visits, consultations with process experts, and by reviewing water use data collected in Step 2.

By identifying significant water users and establishing process benchmarks, dairy processing plants can focus their water efficiency efforts on the processes that offer the greatest opportunities for savings. This approach can help prioritize actions and maximize the impact of water-saving measures.

Significant water users identified in the four dairy plants over the course of this project are:

- A significant amount of water is used for CIP (cleaning in place) – cleaning of vessels and pipelines and also washing of reusable moulds/block formers.
- Manual cleaning is a significant user – washing and sanitising of floors, walls and external equipment surfaces.
- Water is also used for utilities, mainly boiler make-up for steam systems, but also vacuum pumps, cooling water, mechanical seals on pumps and homogeniser piston oil cooling – some of this usage is once through without recovery
- Most of the water use in dairy processing tends to be non-consumptive, presenting opportunities for treatment and recycling – none of the facilities segregate effluent, making end-of pipe solutions complex and expensive.

The initial analysis in the four dairy plants identified several areas for optimization as listed in above text box to exemplify the details covered in the initial analysis.

As the next steps may involve decisions with respect to investments in meters, installation costs and data analysis systems, it is feasible to assess the economic value of potential savings. However, decisions on metering involve more than simply the savings associated with reduced usage, there are also aspects such as water security, reduction of costs of water treatment etc. may be included in the assessment.

2.5 Step 5: Develop a measurement and monitoring plan for the dairy

To effectively monitor and manage water use in a dairy processing plant, it is important to develop a measurement and monitoring plan. This plan should identify the key water-using processes and equipment (significant water users), establish performance targets, and specify the metering equipment required to measure water use accurately.

Choosing the right metering equipment is an essential part of developing a measurement and monitoring plan. The metering equipment should be capable of accurately measuring water use for each process or piece of equipment, and should be easy to install, maintain and read.

In the next sub-section, the key factors to consider when choosing the right metering equipment for a dairy processing plant is discussed. By selecting appropriate metering equipment and developing a comprehensive measurement and monitoring plan, it is possible to accurately track water use and identify opportunities for improvement.

2.5.1 Choosing the right metering equipment

Which type of metering equipment should be selected? There are different types of metering and sub-metering equipment available – for the demonstration project ultrasonic meters were selected as these meters have shown great performance in the Danish dairy industry. However, other types of meters are

Ultrasonic meters applied in current project

Kamstrup is a Danish company that specializes in producing ultrasonic smart water meters. Their water meters are known for their high accuracy, durability, and advanced features, and are used by water utilities and water users around the world.

Here are some key features of Kamstrup's ultrasonic smart water meters:

1. High accuracy: Kamstrup's ultrasonic smart water meters are highly accurate. They can detect even small changes in water flow and provide precise readings.
2. Non-intrusive design: Kamstrup's water meters use ultrasonic technology to measure water flow, which means that they do not have any moving parts or internal components that can wear out over time. This makes them more durable and less likely to require maintenance or repairs. Their design also makes them less likely to harbour bacteria and yeasts.
3. Wireless connectivity: Kamstrup's ultrasonic smart water meters can be connected to a wireless network, which allows water usage data to be collected and analyzed in near real-time. This can help water users to detect leaks and other issues quickly, reducing water waste and saving money.
4. Remote monitoring: Kamstrup's ultrasonic smart water meters can be remotely monitored using their cloud-based software platform or to any platforms capable of receiving data from Kamstrup. This allows the plants to access data from the meters and analyze it in near real-time, helping to improve water management and reduce costs.
5. Long battery life: Kamstrup's ultrasonic smart water meters are designed to have a long battery life, with some models lasting up to 16 years. This helps to reduce meter replacement costs and ensures that the meters are always operational.
6. Cable free installation: As meters from Kamstrup are equipped with long lasting batteries and wireless data communication, no cabling is required to do the installation.
7. Total cost of ownership: The simple installation and long-lasting battery life may result in a low total cost of ownership over the lifetime of the meters.

Overall, Kamstrup's ultrasonic smart water meters offer several advanced features and benefits that can help water users to improve their water management practices and reduce costs. However, while Kamstrup's ultrasonic smart water meters have many benefits, there are some potential drawbacks to consider as well:

- Initial cost: Kamstrup's ultrasonic smart water meters can be more expensive than traditional mechanical water meters, which can be a barrier to adoption for some dairy plants.
- Compatibility issues: Kamstrup's ultrasonic smart water meters may not be compatible with all existing water infrastructure or data management systems, which can create additional costs and challenges.
- Cleaning: The Kamstrup meters are not compatible with cleaning chemicals and therefore can only be used on freshwater lines – they should not be used in pipes requiring Cleaning-in-Place (CIP).

https://www.kamstrup.com/en-en/submetering-solutions/industry-management available and the primary factors to consider when selecting metering and sub-metering equipment are the size and complexity of the plant, the type of water used, the accuracy and frequency required required, and the budget available.

Additional factors to consider are:

1. Compatibility with Existing Infrastructure: The metering and sub-metering equipment should be compatible with the plant's existing infrastructure both in terms of data integration, software compatibility, and communication protocols.
2. Installation Requirements: There will be different installation requirements for different types of metering and sub-metering equipment, such as the need for power or data connections, the location of the equipment, and any calibration or testing requirements.
3. Maintenance and Support: It is important to consider maintenance and support requirements when selecting metering and sub-metering equipment e.g. availability of spare parts, the need for regular calibration or servicing, and the availability of technical support. Kamstrup, the meter supplier in the current project, has local presence and support in South Africa.
4. Hygiene: In the food and agri-processing industries, meters may need to be hygienic in terms of their design, thereby minimizing the risks of microbial contamination in downstream processes. A meter with complicated internals could harbour microorganisms, becoming a locus of infection.

2.5.2 Example of a measurement and monitoring plan for a dairy

In Table 6 an example of the developed metering plan for Dairy 2 is provided. This is only an example and the format of a metering plan can be customised to suit user requirements.

The plan covers the following information based on an evaluation of the main water consuming processed in the plant:

1. Meter No.: A unique ID for the meter in question
2. Description: A description of the water use that is represented by the specified metering point
3. Line size: Size of the pipe – this information and the expected flow rate are important for procurement of the correctly sized meter
4. Water type: Whether the water is from municipal supply, own borehole, blend of the above, recycled water etc.
5. Hot or cold? Important information in the procurement plan. For example, Kamstrup offers meters for hot applications that measure both flow and temperature
6. Comments: Any information considered relevant that is not captured elsewhere
7. Meter type: Is it a main/primary water meter, a sub-meter, a sub of a sub-meter or a virtual meter? Virtual meters could, for example, be a display of the sum of the flows and/or volumes from two or more physical meters.
8. KPI: Which Key Performance Indicator should be monitored to evaluate improvements in water efficiency for the specific point being metered? This KPI would typically use the metered values and data from other sources for its calculation.
9. Frequency: At which frequency should the KPI be calculated?
10. Responsible: Who in the Water Efficiency Team will bear the primary responsibility for meeting the targets for this KPI?

Table 6: Metering plan developed for Dairy 2.

METER NO.	DESCRIPTION	LINE SIZE	WATER TYPE	HOT OR COLD?	COMMENTS	METER TYPE	KPI	FREQUENCY	RESPONSIBLE
1	Main municipal supply	50mm	Municipal	COLD	This is the main supply. It splits from here to the clean area, the JoJo tanks at the effluent plant and to the 45kL water storage tank.	Main meter	Cubic meters of municipal water supplied per day	Daily	Production Manager
2	Small Borehole Supply	32mm	Borehole	COLD	This water is blended with municipal water and water from the 45kL storage tank. The 45kL storage tank contains a mixture of municipal water and water from the new borehole.	Main meter	Cubic meters of small borehole water supplied per day	Daily	Production Manager
3	Large Borehole Supply	25mm	Borehole	COLD	This is a new borehole that is deeper and larger than the existing one. This water is mixed with municipal water in the 45kL storage tank, and this blend of water is then sent to be blended with water from the small	Main meter	Cubic meters of large borehole water supplied per day	Daily	Production Manager
4	Total Water Supply	N/A	Municipal and Borehole	COLD	This is not a physical meter but a virtual one which adds the volume and flow of municipal and borehole water together to get the total water supplied to the site.	Virtual meter	Cubic meters of water Cubic meters of water used Cubic meters of water used	Daily Daily Daily	Production Manager Production Manager Production Manager
5	Municipal supply to High-care, Packaging, Logistics, Admin and Chilled Water	40mm	Municipal	COLD	This water is supplied to JoJo tanks on the upper level of the cheese plant building.	Sub-meter to main meter 1	Cubic meters of water to packaging, logistics and admin per day	Daily	Production Manager
6	Municipal supply to small borehole water blending plant	25mm	Municipal	COLD	This meter was the meter originally used for washing with a hose in the plant	Sub-meter to main meter 1	Cubic meters of municipal water to water blending per	Daily	Engineering Manager
7	Municipal Supply to handwash and large borehole water blending plant	40mm	Municipal	COLD	This is mains water supplied to the 45kL storage tank and the handwash tank. It is blended with borehole water and then transferred to the blending area at the effluent plant.	Sub-meter to main meter 1	Cubic meters of water supplied to cheese processing per day	Daily	Production Manager
8	Blended Supply to Cheese Processing	65mm	Blend of municipal and borehole	COLD	This is a blend of municipal and borehole water that includes water from the small and large borehole.	Sub-meter to virtual meter 4	Cubic meters of water supplied to cheese	Daily	Production Manager
9	Boiler feedwater	32mm	Blend of municipal and borehole water plus recovered condensate	HOT	Feedwater measurement will be taken as a proxy for steam. No meter currently in place. Should be installed on the low-pressure side to minimise stress placed on meter.	This is neither a main meter or a sub-meter. It	Tons of feedwater per ton of milk received	Daily	Production Manager
10	Boiler make-up water	25mm	Blend of municipal and borehole	COLD	Manual meter in place but cannot be converted to produce a pulse output.	Sub-meter to sub-meter 8	Tons of make-up water per ton of feedwater	Daily	Engineering Manager
11	CIP plant make-up water (chemicals and rinse)	40mm	Blend of municipal and borehole	COLD	Manual meter in place but cannot be converted to produce a pulse output.	Sub-meter to sub-meter 8	Litres of water per CIP completed	Daily	Production Manager
12	Process water supply to balance tank (upstream of branch to pasteurisation water)	40mm	Blend of municipal and borehole	COLD	No meter in place	Sub-meter to sub-meter 8	Litres of balance tank water per litre of milk processed	Daily	Production Manager
13	Water supply to block form washer (compartments and pre-rinsing hose)	25mm	Blend of municipal and borehole	COLD	No meter in place	Sub-meter to sub-meter 8	Litres of water per block form washed	Daily	Production Manager
14	Ambient water supply to the stretching machine	25mm	Blend of municipal and borehole	COLD	No meter in place	Sub-meter to sub-meter 16	Litres of water per day Litres of water per ton of	Daily Weekly	Production Manager Production Manager
15	Chilled water supply to the vats and the Mozzarella area	25mm	Blend of municipal and borehole	COLD	No meter in place	Sub-meter to sub-meter 5	Litres of chilled water per day	Daily	Production Manager
16	Ambient water supply to the cheesemaking area	40mm	Blend of municipal and borehole	COLD	No meter in place	Sub-meter to sub-meter 8	Litres of ambient water to Litres of ambient water per kg	Daily Daily	Production Manager Production Manager

It is important to note that the measurement and monitoring plan includes some aspects of data analysis. The data analysis plan in the next sub-section is described separately to the measurement and monitoring plan, but in practice, these two steps are done in parallel. It is only through an integrated consideration of both what will be metered and how the resultant data will be used that a final measurement and monitoring plan can be developed.

2.6 Step 6: Develop a data analysis plan

The data analysis plan is developed in conjunction with the measurement and monitoring plan. This plan should identify the key performance indicators (KPIs) to track, establish how data will be collected for the calculation of these KPI's, the frequency with which data will be collected and how the data and KPI's will be presented to water users.

To develop an effective data analysis plan, it is important to consider the purpose of the plan, the type of data collected, and the tools and resources available for analysis. The plan should also consider the need for data visualization and reporting to support decision-making and communicate progress. Different reporting and presentation formats can be used for different audiences – for example, water use data required by senior management may differ from that required by those on the shop floor.

In the next sub-section, we will discuss the importance of selecting a data management system supplier. Data management system suppliers are service providers that access the raw data, store it a database, process the data and then display the raw data and KPI's calculated from the raw data using a visual online interface. The system used should be capable of collecting, storing, and analyzing data efficiently and accurately. By selecting the right data management system supplier, it is possible to streamline data collection and analysis, and to support effective decision-making to improve water efficiency.

When selecting a water data management system supplier for a dairy or agri-processing plant, there are several factors to consider. Here are a few:

1. <u>Compatibility</u>: The data management system should be compatible with the selected metering equipment and should be capable of collecting data from a variety of sources, not only the water meters themselves. For example, some KPI's will use data involving production volumes, process data such as temperature and pressure and fuel consumption for steam generation equipment. While all of these inputs may be measured electronically, it is not a given that the data they produce is transferable into the data management system.
2. <u>Accuracy</u>: The system should be capable of accurately collecting and storing data, with minimal risk of data loss, corruption
3. <u>Scalability</u>: The system should be scalable and able to handle large amounts of data as the plant grows and expands. This could also be important in cases where a higher frequency of data collection may become necessary or required at some point in the future
4. <u>Integration</u>: The system should be able to integrate with other plant systems, such as process control systems and energy management systems, to provide a comprehensive view of plant performance. This refers specifically to the ability of the system to collect data from these other systems.
5. <u>User-friendly</u>: The system should be easy to use, with a clear and intuitive user interface that allows users to quickly and easily access the data they need.
6. <u>Customisability</u>: The system should be readily customisable to allow for the inclusion of plant-specific KPI's

Data management applied in current project

Water Metering data from the Kamstrup Water Meters is transferred to "the energy shop" online platform on an hourly basis.

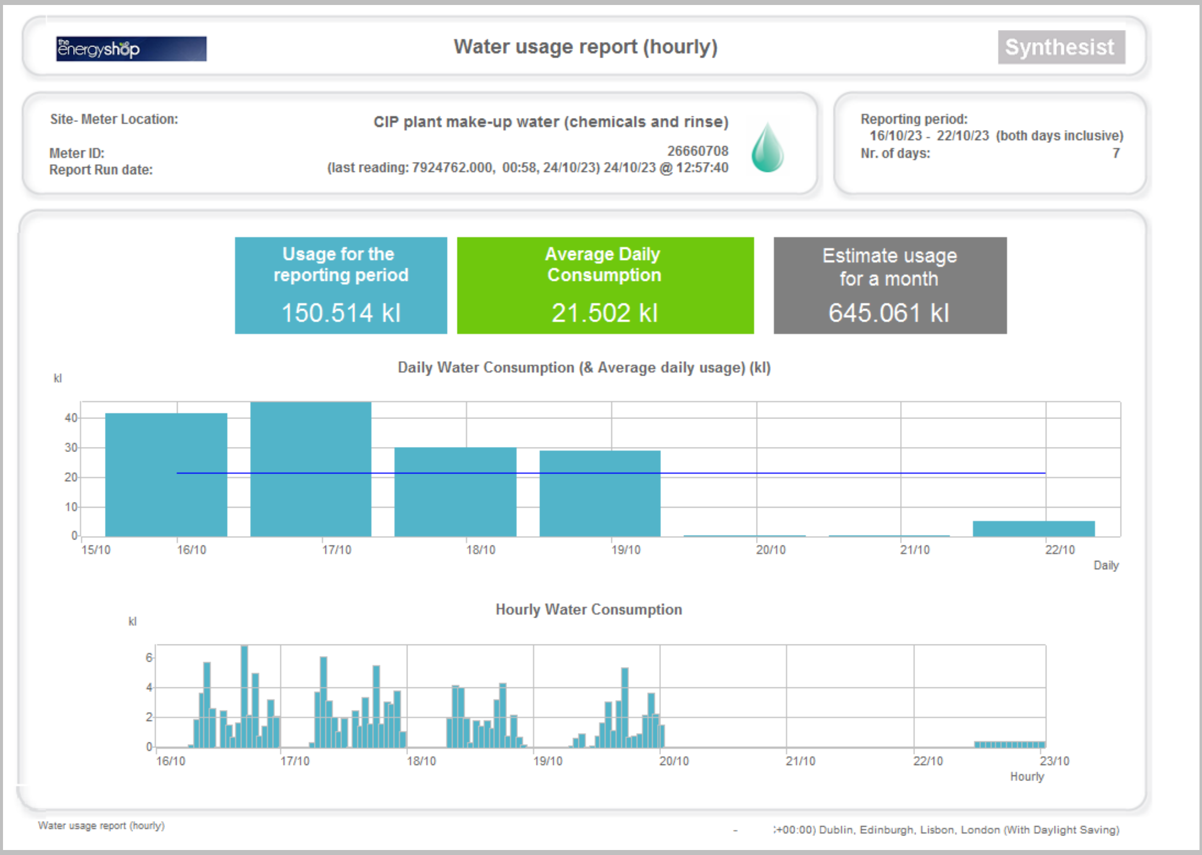
The online functions of the platform include:

- Profile graphing
- Tariff reports
- EPC (Energy Performance Certificates)
- Carbon Reporting
- Bespoke Reporting such as energy balancing, energy conversion (delta Temp -> kWh), Temperature variance, baseloads, League reports (tabulation of sites in order of efficiency), Power Factor evaluation, PV/Solar system estimation
- Alerts and exceptions such as exceeding variances on consumption

Manual data such as daily production specific data (milk weigh in, no. of CIPs etc.) is transferred to the system by weekly manual upload of a csv-file for calculation of relevant KPI's (water consumption per amount of milk processed (L/L), water consumption per CIP (L/CIP) etc.

The energy shop also provides training courses via our online platform and IEPA accreditation; consulting on metering solutions and alternate energy proposals.

www.theenergyshop.co.za



7. Security: The system should have robust security measures in place to protect data from unauthorized access or tampering. Secure backup and effective cybersecurity are essential.
8. Reliability: In the South African context, an uninterruptible power supply and backup power are non-negotiable for the servers used to host the data.

9. Costing: The cost of the system should be within the plant's budget, and the supplier should be able to provide a clear breakdown of all associated costs, such as installation, maintenance, and ongoing support.
10. Support: The supplier should provide reliable customer support and technical assistance, including training and ongoing maintenance. The Energy Shop, the supplier of the data management system applied in the current project, is a local company based in Johannesburg.

It may not be possible to meet all these objectives and different dairy and agri-processing plants may have different criteria when weighing which factors to give highest priority. However, by considering these factors when selecting a data management system supplier, dairy and agri-processing plants can ensure that they are using a system that meets their needs and supports their goals for improved water efficiency.

2.7 Step 7: Develop a procurement plan for meters and data management system

To successfully implement a water efficiency program in a dairy processing plant, it's crucial to develop a well-structured procurement plan for acquiring the necessary meters and data management systems. This plan is essential for ensuring that the chosen equipment aligns with the plant's goals, budget, and specific requirements.

In this section, we will outline the key considerations and steps involved in developing an effective procurement plan. By carefully planning the acquisition of meters and data management systems, dairy processing facilities can streamline the procurement process, make informed decisions, and ultimately enhance their capacity to monitor and manage water usage efficiently.

Developing an effective procurement plan for meters and data management systems in the context of improving water efficiency in a dairy processing plant involves several key steps. Here's an elaboration on these steps:

1. Define Project Objectives and Requirements: Start by clearly defining the objectives of your water efficiency project. What specific goals are you trying to achieve with the meters and data management systems? For example, you may aim to reduce water consumption by a certain percentage.

   Identify the specific requirements for meters and data management systems based on the plant's size, complexity, and the processes involved. Consider factors such as the number of meters needed, data accuracy requirements, integration with existing systems and how you would like the final data to be accessed and presented.

2. Conduct a Needs Assessment: Perform a comprehensive needs assessment to determine the exact types and quantities of meters required. This assessment should consider the different water uses within the plant, including processing, cleaning, and other operations.

   Identify the critical data points that need to be monitored to achieve your water efficiency goals. This could include flow rates, temperature, pressure, and other relevant metrics.

3. Budget Planning: Determine the budget available for procuring meters and data management systems. Include not only the cost of purchasing the equipment but also expenses related to installation, maintenance, ongoing support and data subscriptions.

   Prioritize your spending based on the critical areas where meters will provide the most significant impact on water efficiency.

4. Supplier Selection: Research and identify reputable suppliers or manufacturers of meters and data management systems. Consider factors such as their track record, reliability, product quality, and customer support.

   Obtain quotes or proposals from multiple suppliers to compare costs and features. Ensure that the selected supplier can meet your specific requirements. Ensure that the meter supplier and data management system supplier talk to each other and confirm compatibility prior to making a commitment to either of them.

5. Technical Evaluation: Conduct a technical evaluation of the proposed meters and data management systems. Assess their compatibility with existing infrastructure, accuracy, ease of installation, and data communication capabilities.

   Verify that the selected equipment complies with relevant industry standards and regulations.

6. Procurement Strategy: Develop a procurement strategy that outlines the procurement process, including timelines, milestones, and responsibilities. Define the steps for purchasing, installing, and commissioning the equipment.

   Consider whether a phased procurement approach is necessary, especially for larger projects, to minimize disruption to plant operations.

7. Contract Negotiation: Negotiate contracts with chosen suppliers that clearly specify pricing, warranty terms, delivery schedules, and support services. Ensure that all contractual obligations are well-documented.

   Include provisions for ongoing maintenance and support to keep the meters and data management systems functioning optimally.

By following these steps, dairy processing plants can develop a well-structured procurement plan that ensures the successful acquisition and utilization of meters and data management systems to enhance water efficiency.

2.8 Step 8: Install meters and implement data management system

After developing a procurement plan and selecting the appropriate meters and data management systems, the next crucial phase is installation and implementation. This step ensures that the chosen equipment is properly integrated into the dairy processing plant's infrastructure, allowing for accurate data collection and effective management of water resources.

Steps for Installation and Implementation will be:

1. Site Preparation: Before installation, assess the physical location and conditions where meters and data collection systems will be placed. Ensure that the chosen locations allow for accurate measurement, ease of maintenance and limited risks of damage due to plant operations such as cleaning. Physically mark each installation point to eliminate all confusion regarding where meters will be installed and the meter sizes to be installed.

   Prepare the installation sites by providing adequate support structures, such as mounting brackets or pipes, to secure the meters securely in place.

2. Meter Installation: Follow the manufacturer's guidelines and recommendations for meter installation. This includes proper alignment and orientation, distances from bends, proximity to data collectors, process conditions in the pipeline and operating environment.

   Verify that all meters are functioning correctly and accurately by conducting initial tests and inspections.

3. Data Management System Integration: Install the data management system and any associated software that will be used to collect, store, and analyze the data from the meters.

   Ensure that the data management system is compatible with the selected meters and can effectively communicate with them.

4. Sensor Calibration: If relevant, calibrate all sensors and meters to ensure their accuracy. Calibration should be performed according to a predefined schedule to maintain data precision over time.

   Record calibration details and maintain a calibration log for future reference and compliance reporting.

5. Data Validation and Testing: Conduct thorough testing of the entire system to validate data accuracy and the seamless functioning of the data management system. In the case of meters that will be used for online monitoring, confirm that the readings in the field correspond to the readings in the online system.

   Verify that data is being collected and processed correctly, and that any alarms or alerts are set up in the data management system to notify staff of anomalies.

6. Staff Training: Train relevant staff members, including operators and maintenance personnel, on how to use the meters and the data management system effectively.

   Ensure that staff understand how to troubleshoot common issues and perform routine maintenance tasks.

7. Documentation and Record Keeping: Maintain detailed records of the installation process, including equipment manuals, calibration records, and any modifications made during installation.

   Create an inventory of all installed meters and their locations within the plant.

8. System Commissioning: Commission the entire system by putting it into operation and collecting real-time data. Monitor the system closely during this phase to identify and resolve any issues that may arise.
9. Performance Verification: Verify that the meters and data management system are functioning as expected and that data collection is accurate. Compare actual performance with expected benchmarks.
10. Continuous Monitoring and Maintenance: Implement a schedule for regular maintenance and calibration of meters and data management equipment.

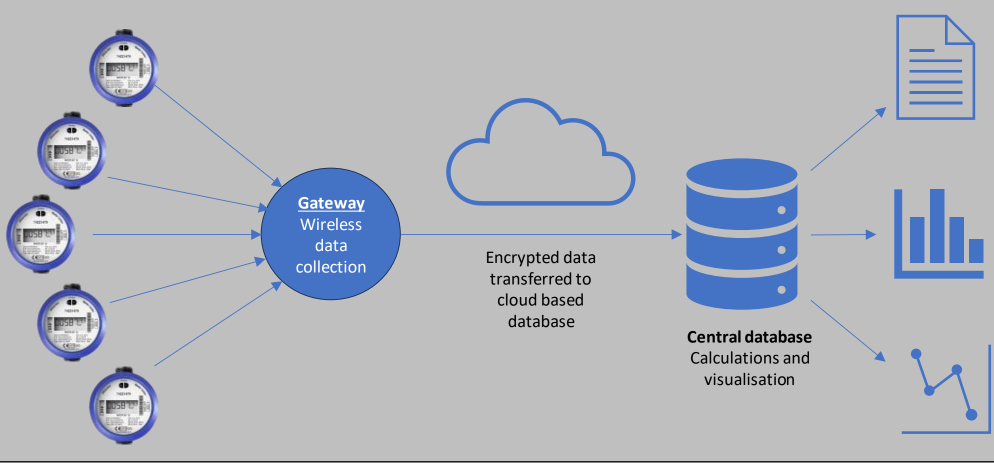
    Continuously monitor the data collected by the system to identify trends, anomalies, and opportunities for improving water efficiency.

By following these steps during the installation and implementation phase, dairy processing plants can ensure that their meters and data management systems are properly integrated and functioning effectively to support water efficiency efforts.

Examples of water meters installed in the cheese department of Dairy 1

Examples of water meters installed in Dairy 2

Metering and data infrastructure applied in current project



2.8.1 Examples of reports and relevant data on water use in demonstration dairies

For each water meter it is possible to access water consumption data on an hourly basis. A standard consumption report can be drawn from the data management system from each meter – the report will provide daily as well as hourly data and projections on the monthly consumption. An example report is provided in Figure 2 and data can be extracted as a text-file as well for separate processing.

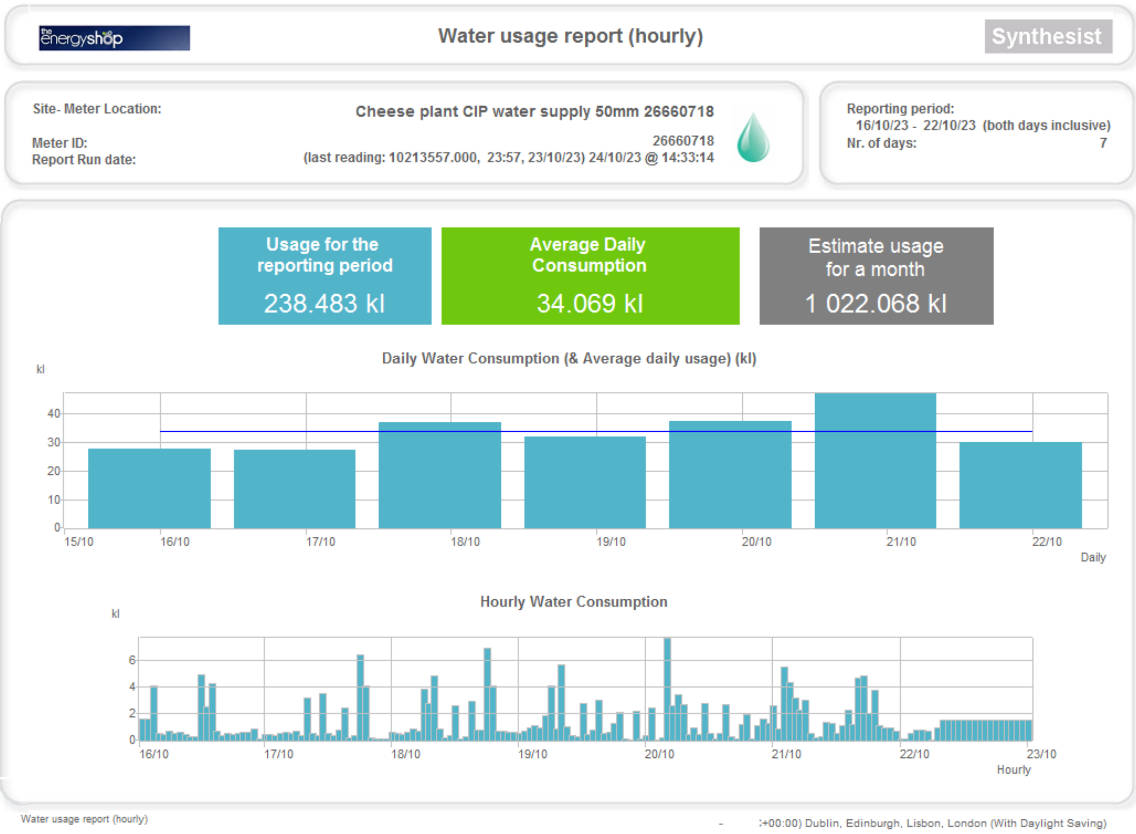


Figure 2: Example report of water consumption (daily/hourly) over 1 week in CIP plant of Dairy 3.

The data management system also offers the possibility to manually enter offline data to calculate e.g. production specific KPI's. These data are entered daily – examples of data are:

- Total milk weigh-in (KPI: water consumption per L of milk delivered – L/L)
- No of CIPs (KPI: water consumption per CIP – L/CIP)
- No of cheese blocks washed (KPI: water consumption per block washed – L/block)

A sample report of a daily KPI's from Dairy 2 over one week of production is provided in Figure 3.

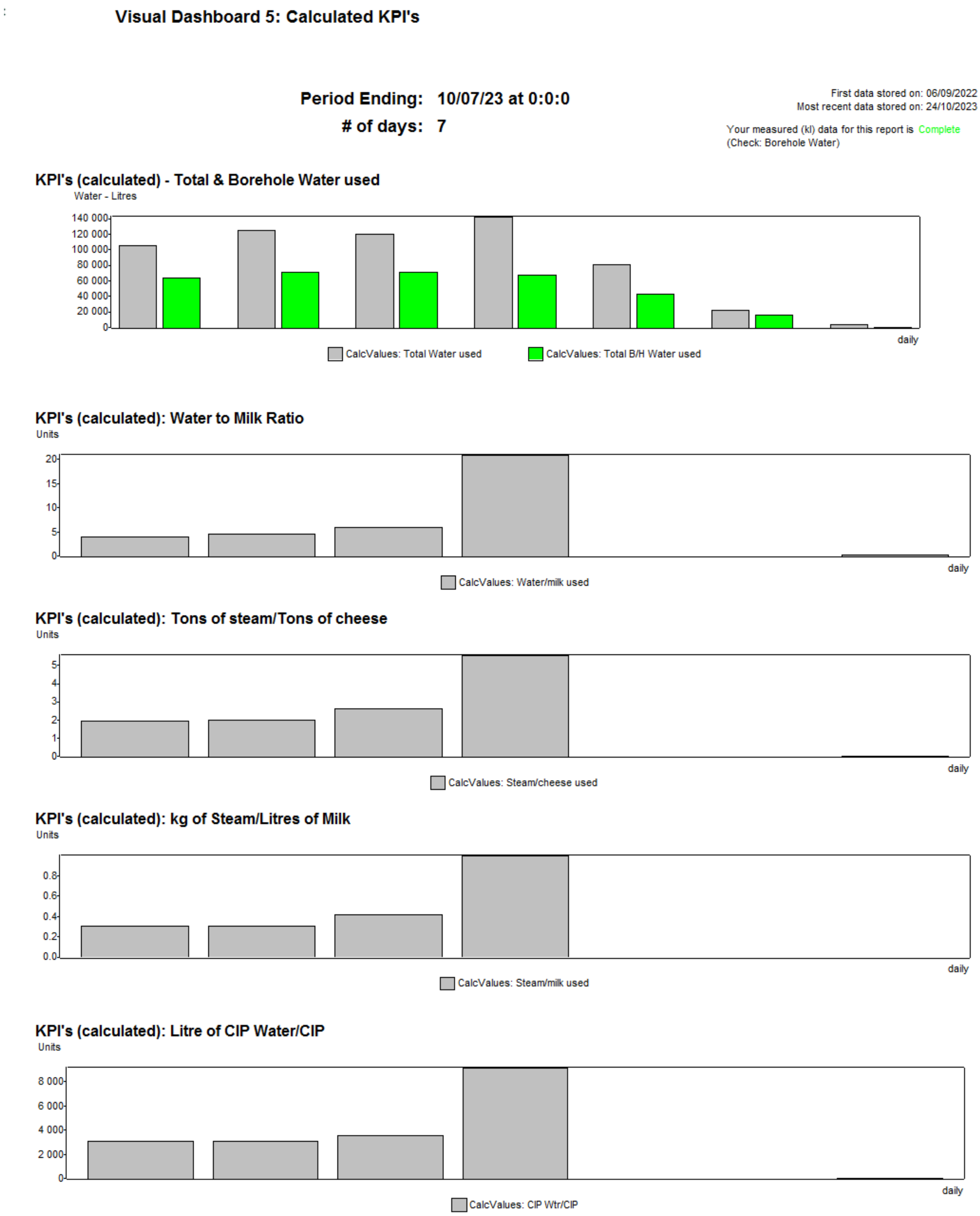


Figure 3: Example report of selected production specific KPI's from Dairy 2 (X-axis: Monday – Friday).

The example above shows an unusual high water to milk ratio on Thursday in the respective week. Further analysis shows that both the specific steam consumption and the specific water consumption per CIP were unusually high for that day. This allows the dairy plant to investigate what may be the root cause for this unusual consumption pattern.

2.9 Step 9: Identify saving potential and monitor the savings after process changes

After meters and data management systems are successfully installed and operational, the focus shifts to identifying saving potential and implementing process changes to improve water efficiency. This step involves ongoing monitoring and analysis to pinpoint areas where water savings can be achieved, followed by the implementation of process and/or equipment changes. It is crucial to monitor and measure the impact of these changes to ensure they align with water efficiency goals.

Case study: Water and Energy Recovery Project at Dairy 2

Water metering allows water users to quantify water usage and wastage, and then to use this data to develop water efficiency projects. At Dairy 2, metering of water to the cheesemaking area revealed a water recovery opportunity of close to 20 m^3/day. Most of this water is being used for cooling cheese vats, and the water is passed through the vat jackets and then directed to drain. The vat jackets are also used for heating product with steam, and the condensate is also lost to drain.

The dairy decided that since the water and condensate were very clean water streams which did not make contact with any surfaces except the vat jacket internals, this water could be recovered. Metering of the CIP plant make-up showed that the CIP requirement was more than double that of the vat jackets, and this was selected as a suitable sink.

In addition to this opportunity, the dairy also was in the process of installing a new hotwell for the steam system and was interested in recovering waste heat from the flash steam being generated through condensate recovery. The recovered water was identified as an ideal heat sink, given that water supplied to the CIP plant is heated with steam in the CIP vessels. Supplying hot recovered water would therefore not only save water, but also energy. Energy would be recovered directly through recovered condensate, by heat absorption into the cooling water passed through the vat jackets and from latent heat recovered from flash steam. The flash steam will be condensed in a vent condenser, which would divert the condensed vapor back into the hot well, thereby also recovered a small amount of water.

An integrated water and energy recovery project was conceived and is scheduled for implementation in the next few months. As per October 2023, the new hot well and water recovery vessels have already been procured and construction is underway.

Water and energy recovery from cooling of cheese vats being analysed.

Steps for Identifying Saving Potential and Monitoring Savings will be:

1. Data Analysis and Benchmarking: Utilize the data collected by the meters and data management systems to perform a comprehensive analysis of water usage patterns within the dairy processing plant.

   Compare current water use data with established benchmarks and historical data to identify areas where water consumption is higher than expected or where improvements can be made.

2. Identify Water-Intensive Processes: Identify and prioritize water-intensive processes within the plant, such as pasteurization, cleaning, or cooling, which may offer the most significant potential for water savings.

   Focus on areas where process changes can lead to substantial reductions in water consumption.

3. Engineering Assessment: Conduct an engineering assessment of the identified processes to evaluate their efficiency. This may involve assessing equipment condition, reviewing process flows, and identifying opportunities for optimization.

   Engage with process engineers and specialists to identify potential improvements.

4. Implement Process Changes: Based on the assessment, develop and implement process changes aimed at reducing water consumption. This may involve adjustments to process parameters, equipment upgrades, or the adoption of water-efficient technologies.

   Ensure that any changes are well-documented and communicated to relevant staff.

5. Performance Monitoring: Continuously monitor the performance of the modified processes. Collect data to assess the impact of the changes on water usage and operational efficiency.

   Compare post-change data with baseline data to quantify water savings and efficiency improvements.

6. Data Visualization and Reporting: Implement data visualization tools and reporting mechanisms to provide real-time insights into water usage and efficiency.

   Generate regular reports to communicate progress and savings achieved to relevant stakeholders.

7. Feedback Loop and Optimization: Establish a feedback loop to gather input from plant personnel and process operators regarding the effectiveness of the implemented changes.

   Use feedback to further optimize processes and fine-tune adjustments to maximize water savings.

8. Documentation and Record Keeping: Maintain detailed records of all process changes, including the rationale behind each change, dates of implementation, and associated water savings.

   Keep records of any challenges faced during the implementation and how they were resolved.

9. Periodic Audits and Reviews: Conduct periodic follow-up on the status of the water management on-site including audits and reviews of water efficiency initiatives and process changes to ensure that they continue to align with goals.

   Adjust strategies and approaches as needed based on ongoing performance assessments.

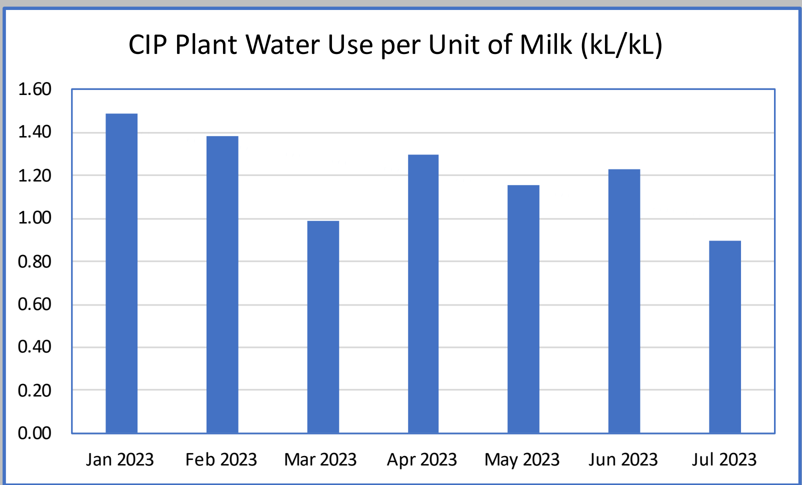
Case study: CIP Plant Optimisation Project, Dairy 2

Dairy 2 installed a water meter on the water supply to the factory's CIP plant. While some opportunities were known to the dairy before the installation of this meter, such as the need for a recovered water tank, installing the meter allowed the dairy to track the benefits of optimisation projects. These projects included:

- Reductions in rinse volumes at the start and end of each individual CIP step to ensure that volumes were not excessive
- Elimination of unnecessary CIP steps – for example, the dairy was conducting cleaning with both acid and caustic soda for every CIP, and this is overly excessive
- Optimisation of CIP frequencies, and replacement of some extensive CIP cycles with shorter versions for periodic use
- Elimination of fluid losses during CIP through plant modifications

CIP plant of Dairy 2.

Over time, reductions in CIP plant water consumption were achieved, saving both water and energy. Below is a chart outlining improvements achieved so far. Further optimisation is planned in the coming months, and investment in a recovered water tank is expected in the new year. The changes were made with due consideration for microbiological testing and analysis.



Relative water consumption for CIP to milk weigh in Dairy 2 during the course of the project.

10. Continuous Improvement Culture: Foster a culture of continuous improvement by involving all relevant staff members in the process. Encourage them to suggest ideas for further water efficiency enhancements.

11. Provide training and awareness programs to keep staff engaged and informed about water-saving initiatives.

By following these steps, dairy processing plants can systematically identify saving potential, implement process changes to improve water efficiency, and closely monitor the savings achieved over time. This approach helps maintain a sustainable and efficient water management strategy within the facility.

2.10 Step 10: Next steps and continuous improvements

The journey toward improved water efficiency in dairy processing is an ongoing commitment to sustainability. After implementing initial process changes and achieving water savings, it's crucial to plan for continuous improvements and consider what comes next in your water management strategy. Step 10 focuses on the long-term sustainability of water-efficient practices and the continual pursuit of greater efficiency.

Steps for Next Steps and Continuous Improvements will be:

1. Performance Evaluation: Routinely track overall site performance, preferably using statistical baselines to validate the performance improvement. Regularly assess the performance of water-saving initiatives and process changes. Use data analysis and benchmarking to gauge the effectiveness of implemented measures.

   Identify areas where further improvements or optimizations are possible.

2. Stakeholder Engagement: Engage with relevant internal and external stakeholders, including plant operators, engineers, management, water supply authorities and regulators to gather feedback on the effectiveness of water efficiency measures and to solicit new ideas for improvement.

   Encourage a collaborative approach to problem-solving and innovation.

3. Technology and Innovation: Stay updated on advancements in water-saving technologies and sustainable practices within the dairy processing industry. Engage with industry bodies, technology suppliers and OEM's.

   Explore opportunities to integrate new technologies or innovative solutions that can further enhance water efficiency.

4. Training and Education: Provide ongoing training and education for plant personnel to ensure they are equipped with the knowledge and skills necessary to support water efficiency efforts. It is important to include plant-specific training as well as training in generic principles.

   Conduct periodic workshops or seminars to promote a culture of continuous learning.

5. Data-Driven Decision Making: Continue to leverage the data collected by meters and data management systems to inform decision-making.

   Use data analytics and real-time monitoring to identify trends, anomalies, and opportunities for optimization.

6. Set New Goals: Set new water efficiency goals based on performance evaluations and evolving business objectives.

Ensure that these goals are specific, measurable, achievable, relevant, and time-bound (SMART) to provide clear direction.

7. Resource Allocation: Allocate resources, including budget and personnel, to support ongoing water efficiency initiatives.

   Prioritize projects and initiatives based on their potential impact and alignment with organizational priorities.

8. Benchmark Against Industry Best Practices: Continually benchmark your water efficiency practices against industry best practices and standards.

   Participate in industry associations and forums to stay informed about the latest trends and benchmarks.

9. Sustainability Reporting: Consider reporting on your water efficiency achievements and sustainability efforts to stakeholders, customers, and regulatory bodies.

   Transparent reporting can enhance your organization's reputation and demonstrate a commitment to sustainability.

10. Celebrate Successes and Recognize Efforts: Acknowledge and celebrate the successes and achievements in water efficiency. Recognize the efforts of individuals and teams that contribute to sustainability goals.

    Use positive reinforcement to encourage continued commitment to water-saving initiatives.

11. Feedback Loop and Adaptation: Maintain an open feedback loop with all stakeholders to continuously adapt and improve your water efficiency strategy.

    Be flexible and willing to adjust your approach based on changing circumstances and emerging opportunities.

By embracing a culture of continuous improvement and implementing these steps, dairy processing plants can ensure that their water efficiency efforts remain effective and sustainable over the long term. This approach not only conserves valuable water resources but also contributes to cost savings and environmental stewardship.

3 Summary and conclusion

As the dairy processing industry continues to grow and evolve, the responsible management of water resources has become more critical than ever. Water efficiency not only supports sustainable operations but also contributes to cost reduction and environmental conservation. This comprehensive guideline has been developed to assist dairy processing plants in identifying opportunities for improved water efficiency and implementing effective measures.

3.1 Key Take Away Points

Throughout this guideline, we have explored a systematic approach to enhancing water efficiency within dairy processing facilities. Here are the key takeaways:

1. Establish a Water-Efficiency Team: The journey toward water efficiency begins with the formation of a dedicated team responsible for planning, implementing, and overseeing water-saving initiatives.
2. Collect Basic Production, Water, and Energy Data: Accurate data collection and analysis are fundamental to understanding current water usage patterns, establishing baselines, and setting targets for improvement.
3. Identify Significant Water-Using Processes and Establish Process Benchmarks: Focus on water-intensive processes and set process benchmarks to guide your water efficiency efforts.
4. Develop a Measurement and Monitoring Plan: Choose the right metering equipment and data management systems to collect, store, and analyze data efficiently.
5. Select a Data Management System Supplier: Consider compatibility, accuracy, scalability, and cost when selecting a data management system supplier.
6. Install Meters and Implement Data Management Systems: Proper installation and integration of meters and data management systems are crucial for accurate data collection.
7. Identify Saving Potential and Monitor Savings After Process Changes: Continuously monitor performance, identify saving potential, implement process changes, and quantify the impact of these changes on water efficiency.
8. Next Steps and Continuous Improvements: Sustainability and continuous improvement are at the heart of successful water efficiency efforts. Stay vigilant, innovate, and adapt to changing circumstances. Set ever more challenging targets as performance is improved.

3.2 Embracing a Culture of Water Efficiency

Water efficiency in dairy processing is not a one-time endeavor but an ongoing commitment to responsible resource management. By following the steps outlined in this guideline and fostering a culture of water efficiency, dairy processing plants can achieve the following benefits:

- Resource Conservation: Efficient water management reduces water consumption, preserving this precious resource for future generations.
- Cost Savings: Improved water efficiency often translates into lower operational costs, making dairy processing plants more financially sustainable.
- Environmental Stewardship: Reduced water usage contributes to a smaller environmental footprint, aligning with corporate social responsibility and sustainability goals.
- Regulatory Compliance: Meeting or exceeding water efficiency standards and regulations helps maintain a positive relationship with regulatory authorities – including a license to operate under water scarce conditions

- Competitive Advantage: Demonstrating commitment to sustainability and efficient resource use can enhance an organization's reputation and competitiveness in the marketplace.

3.3 A Sustainable Future

In conclusion, the dairy processing industry has a significant role to play in promoting water efficiency and environmental responsibility. By implementing the practices and strategies outlined in this guideline, dairy processing plants can contribute to a more sustainable and resilient future while realizing tangible benefits in terms of cost savings and operational efficiency.

Remember that water efficiency is not just a checklist of tasks but a journey toward a more sustainable and responsible operation. We encourage dairy and agri-processing facilities to adapt and tailor these guidelines to their specific needs, continually seek innovative solutions, and actively engage in ongoing education and collaboration within the industry.

Together, all stakeholders shall work towards a future where water efficiency is not only a goal but a shared commitment to environmental stewardship and sustainable growth in the dairy and agri-processing sector.

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