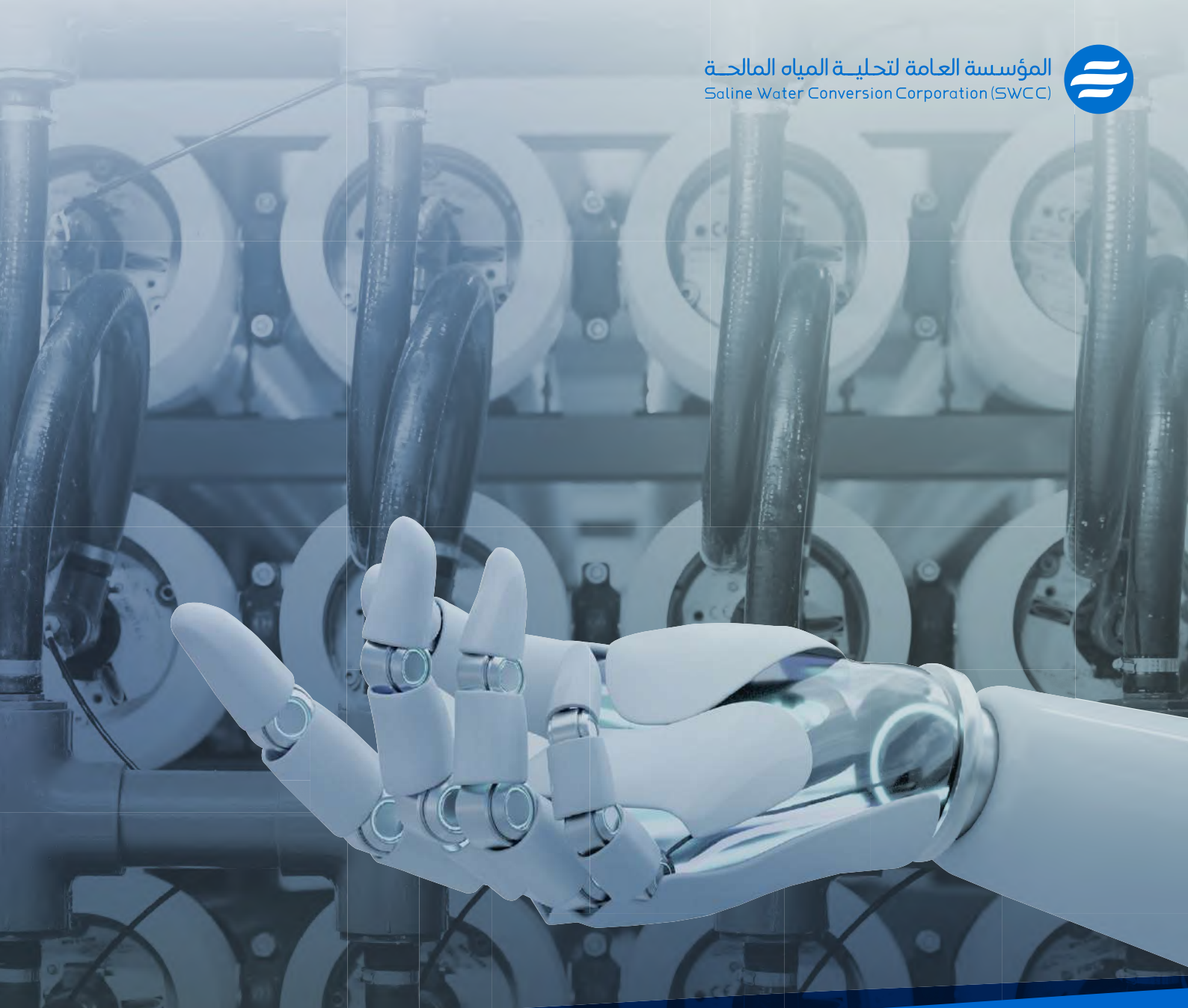


A white, articulated robotic hand is shown in the foreground, reaching out with its index finger pointing towards the left. The hand is positioned in front of a background of industrial desalination equipment, which includes several large, circular, metallic components and pipes. The entire image has a blue tint.

Smart Desalination

Hydrating the future using AI

WHITE PAPER



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Foreword

This white paper is intended for readers who are curious about desalination and Artificial Intelligence (AI) and the interconnected future of both fields. The overall aim is to highlight the importance of digital innovation and AI in the desalination Industry.

Executive Summary

Since the dawn of time, water has always been at the center of humanity's existence. However, water is a scarce resource due to shortage, access failure, and increased human consumption. With the ongoing water shortage, desalination could contribute to achieving water security, especially in water-stressed countries.

As the world is witnessing the Fourth Industrial Revolution, technology is becoming increasingly connected, and we are now observing a convergence of the digital and physical world. Emerging technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT) are shaping multiple industries, including desalination, allowing them to increase productivity and reduce energy costs.

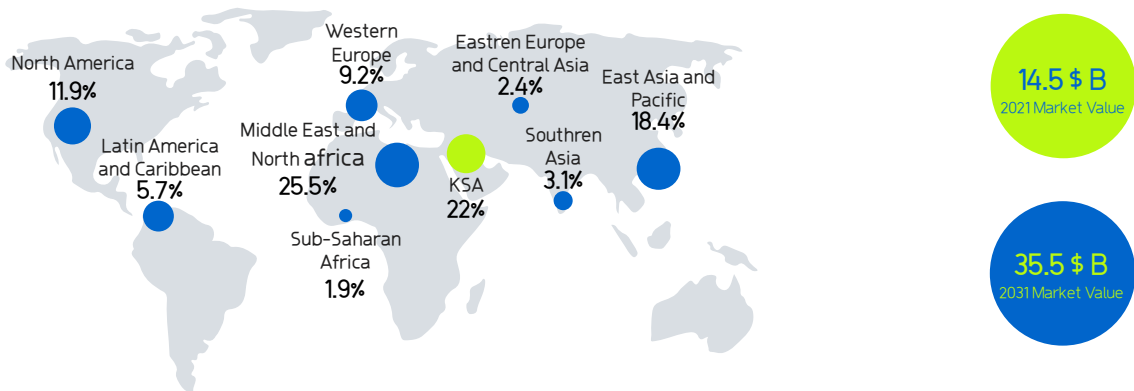
Reaching a full scale smart desalination plant, “The smart desalination journey” as we call it, counts on unlocking the value of data. AI systems have the ability to analyze, predict, and improve based on data, which is an essential pillar to drive the digital transformation of desalination plants.

This white paper presents some practical Artificial Intelligence applications for the desalination industry, which the Saline Water Conversion Corporation (SWCC) is adopting. These applications enhance SWCC plant's operational performance by optimizing timing of asset maintenance, reducing chemical and energy consumption related costs, while also aiming for better sustainability, improved employee engagement, and efficient productivity.

Introduction

Humans depend on water to perform most of their activities. Moreover, water is essential in nearly all industries. The growing demand for freshwater due to the constant population growth around the globe poses a serious threat as the world faces a water scarcity crisis, especially in water stressed regions, such as the Middle East, which finds itself at the center of this issue. Consequently, many nations have considered water desalination as a vital freshwater supply. Desalination is the process that separates dissolved salt from seawater to produce freshwater for human use. The global water desalination market was valued at US\$ 14.5 billion in 2021 and is projected to reach a market value of US\$ 35.5 billion by 2031. In fact, desalinated seawater is the main water resource in Saudi Arabia. Saudi Arabia produces more than 7.6 million cubic meters (MCM) of desalinated water per day, representing 22% of the total desalinated water worldwide to quench the urban need of 9.6 MCM/day while the rest is supplied through ground water sources.

Desalination capacity by regions

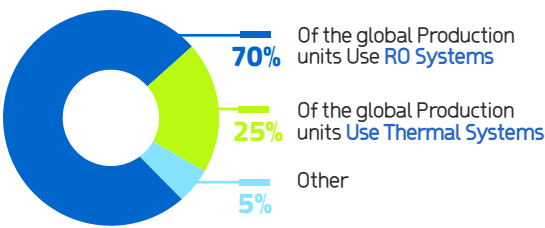


Even though desalination plants nowadays use computerized control systems to control the operations of the plant, the industry continues to face several challenges mostly related to production disruption and worker safety.

With the increased availability of the plant's production data, a call for thoughtful consideration of AI is needed. AI systems work by ingesting and analyzing the data for correlations and patterns, and using these patterns to make future predictions.

AI focuses on three cognitive skills: learning, reasoning, and self-correcting.

AI can help the desalination industry increase the efficiency of its water production, improve the safety of its employees and reduce its environmental impact.



THERMAL

It uses high energy and heat to evaporate and condense water to purify it.

RO (REVERSE OSMOSIS)

It uses high pressure (100–800 psi) to force water through a semi-permeable membrane that filters out dissolved ions, molecules, and solids.



DESALINATION THE INDUSTRIAL REVOLUTION

The scientific advancements during the Industrial Revolutions brought significant transformations in desalination. The process of water desalination, once done in a very primitive way, has now become a key player in providing water at remarkable volumes to countries that lack fresh water supply.

Industry 1.0

In **1784**, the first industrial revolution was marked by the employment of water and steam power so that the processes of manufacturing products were mechanized for the first time and thus mass production was born.

Desalination through distillation and filtration have been used for thousands of years. However, around the first industrial revolution, sophisticated desalination mechanisms only existed as laboratory phenomena.

Industry 2.0

In **1870**, the second industrial revolution was distinguished by the use of electrical power, gas and oil, to enable mass production even further.

During the second industrial revolution, thermal desalination methods spread. For instance, in **1928**, Saudi Arabia started the construction of the first MSF plant in Al-wajh and Duba with a capacity of 227.1 m³/d.

Industry 3.0

In **1969**, the third revolution introduced nuclear energy, electronics, and information technology to automate production. It denotes the digital revolution stage that turned analog electronic and mechanical machines into today's digital technology.

The reverse osmosis industry started during the third industrial revolution, and the world's first commercial RO plant was established. Its new initiative grabbed the attention of engineers and governments from all over the world.

Industry 4.0

Nowadays, we are going through the fourth industrial revolution, known as "Industry 4.0". It has been contributing to technological breakthroughs in many critical fields, such as AI, the IoT and robotics and which are without a doubt shaping the future across every industry.

Now, desalination plants can adopt IR 4.0 technologies such as AI, IoT, Robotics and digital twins to achieve radical improvements in productivity and automation.

Timeline

Digital Economy in the Middle East

There has never been a more critical time for businesses to accelerate the adoption of digitalization and innovation especially after the outbreak of the COVID-19 pandemic, which affected billions of people and disrupted businesses worldwide. As businesses recover from Covid-related disruption and head to the new norm, a major change characterized by a steep rise and a strong demand for a digital workforce and workplace is occurring. In order to gain a competitive edge and deal with an increasingly technology-enabled global economy, organizations around the globe are digitally transforming.

How the digital maturity is reflected by regions?

Region	Advancers/Leaders
US/Canada	49%
Europe	41%
Middle East	50%
Asia	48%

Note: The ESI ThoughtLab survey covered UAE, KSA and Oman for this report, with over 190 businesses and decision makers polled.

In a survey about digital maturity conducted before the pandemic, countries in the middle east where 70% of the world's desalination plants are located, responded relatively more positively than their US, European and Asian counterparts.

This shows that despite its relatively small population, the Middle East is betting heavily on digitalization. Digital transformation programs are helping companies in the Middle East empower employees, engage customers, optimize operations and enhance services.

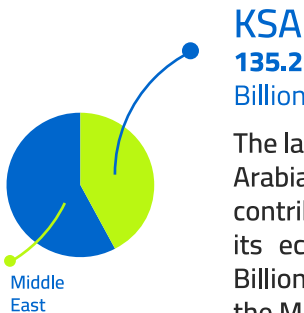
Digital systems such as Programmable Logic Controllers (PLCs), Distributed Control Systems (DCS) and Supervisory control and Data Acquisition (SCADA) are used across a variety of industries, including desalination, to control industrial processes by running machines and motors.

This digital landscape is currently under transformation using AI as the technology overcomes human constraints in information processing allowing humans to make faster and more accurate decisions.

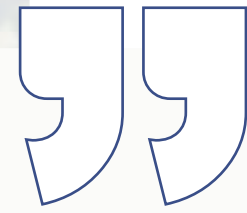
AI By 2030

\$15.7
Trillion

In 2030, AI is estimated to contribute up to \$15.7 trillion to the global economy.



The largest share will be in Saudi Arabia where AI is expected to contribute over \$135.2 Billion to its economy out of the \$320 Billion projected contribution to the Middle East economy.



“We are living in time of scientific innovation unprecedented technology, and unlimited growth prospects.

These new technologies such as Artificial Intelligence and the Internet of Things, if used optimally, can spare the world from many disadvantages and can bring to the world enormous benefits.”

HRH Crown Prince

Mohammed Bin Salman

A key factor in driving digital innovation is government support. As the Middle East region is moving away from its traditional heavy reliance on oil revenues and towards revenue diversification, Saudi Arabia Vision 2030 is set to create a more diverse and sustainable economy.

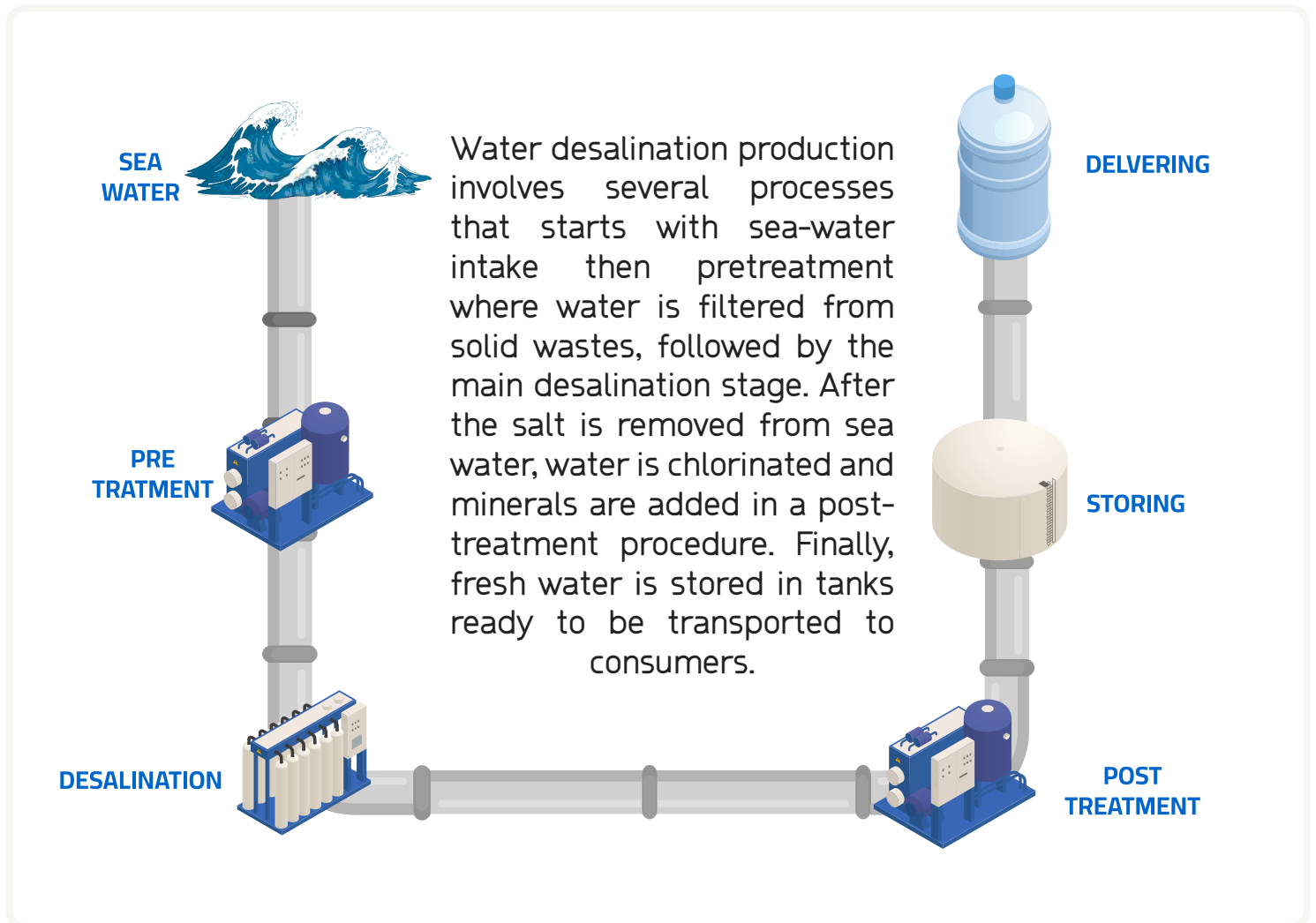
With an ambitious goal to make the country a pioneering and successful global model of excellence on all fronts, in 2019, the Kingdom of Saudi Arabia launched the Saudi Data and Artificial Intelligence Authority (SDAIA).

SDAIA aims to drive the data and AI agenda to position the country as a data-driven leader. Additionally, the kingdom aims to attract investments worth \$20bn and train up to 20,000 data and AI specialists by 2030.

The Kingdom has developed several innovations that contributed to preserving the environment and the sustainability of the desalinated water production, through which it aims to reduce carbon emissions and increase desalinated water production in alignment with Vision 2030.

Challenges The Desalination Industry Faces

Like most manufacturing plants worldwide, desalination plants face multiple challenges that hinder the fluidity of the processes and could pose a threat to its longevity. From increased energy costs and emission rates to machine failures and reduced employee productivity, some of these challenges will be discussed.



All these processes generate a huge number of interconnected decision parameters/variables throughout the water flow. Analyzing this complex data is often overwhelming, inhibiting the ability of the plant managers and engineers to find adequate solutions in a timely manner.

Machine Learning (ML) which is a subset of AI can analyze these vast production datasets to predict and adapt to certain scenarios and thus convert challenges into opportunities.

Challenges The Desalination Industry Faces

Machine Failures



One of the major challenges that desalination plants face is the lack of visibility on the status of the equipment (turbine, valve, pipes, membranes, etc.) which leads to suboptimal timing for maintenance, increased costs and unnecessary downtime or outage. In fact, it is estimated that almost every plant loses at least 5% of its overall productivity, with others experiencing as much as a 20% loss, due to downtime.

Downtime is the period of time when a machine is not in production. The total amount of downtime a plant experiences includes any stops during production that cause a loss of revenue for the organization. Legacy infrastructure is the main perpetrator because of its need of frequent maintenance and its issues can cause outages.

Although RO membrane cleaning is standard, it takes the plant offline and causes liquid waste to be discarded. Different materials could gradually accumulate on membranes during operation, organic material such as algae bloom and jellyfish, inorganic solutes, and biofilms contaminating the feed water. The overall effect is a shortage of permeability, which is offset by increasing pressure to maintain water production. Additionally, this counts to the power consumption and water cost over the plant's lifetime.

Employee Productivity and Safety



People are vital resources for desalination plants. Enabling humans to be as productive as possible is a key concern for organizations. In general, human beings are prone to make mistakes, slips, or lapses that often occur when assigned routine tasks that are very typical and require little thought. For example, taking water quality readings from water treatment equipment is a repetitive task that needs to be done periodically by other staff and often leads to many data entry errors.

An important factor causing employee productivity reduction is the absence of immersive training. To illustrate, training employees who work with hazardous equipment and risky processes can not always be manageable. Thus, improving the training quality and employees' productivity while ensuring their safety is a challenge in desalination plants.

Environmental Impact



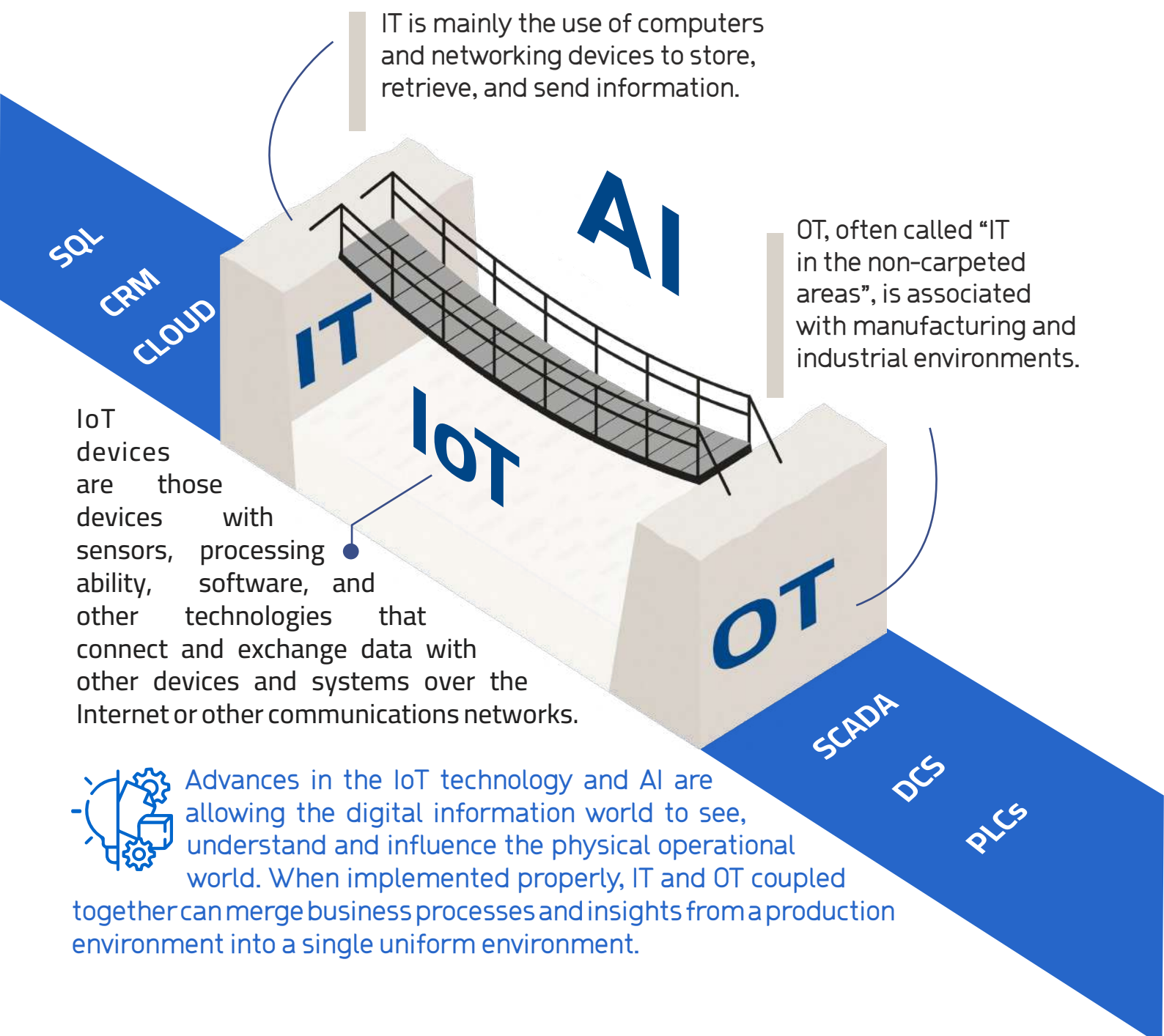
Water production, allocation, and utilization phases yield high energy consumption. Desalination alone is accountable for 0.4% of the global electricity consumption. Although RO is the most energy-efficient commercial seawater desalination technology, it still requires high amounts of energy.

Alongside high-energy consumption, increased CO₂ emissions is a key challenge of desalination. Some studies show that the US water production sector is responsible for 5% of all carbon emissions. The estimated carbon footprint of RO desalination has been measured from 0.4 to 6.7 kg CO₂ eq/m³. That is, desalinating 1000 cubic meters of seawater could potentially release as much as 6.7 tons of CO₂.

Bridging The Gap Between IT and OT

With the right approach and mindset, the industry challenges mentioned earlier can be converted into opportunity areas but first we have to think about them in a more general way. In a broader context most of these challenges can become a gap between information technology (IT) and operational technology (OT).

Due to the lack of common software interfaces, standard data formats, and common connectivity protocols between the two technologies, organizations are struggling with the IT and OT worlds which have largely occupied separate domains.





Smart Desalination Plants

Smart desalination plants take advantage of Industry 4.0, which is characterized by interconnected IT-OT systems, such as those machines and software that can self-diagnose and alert potential malfunctions. Better machines and devices with smart sensors are being introduced by IoT, which uploads continuous streams of data to the cloud for analysis. The information is then processed using AI and machine learning, which keeps improving with more data available. By having water production units that use smart-connected equipment, data-driven decision-making, higher efficiency and productivity can be achieved.

IoT sensors gather real-world data about the water flow, such as temperature, pressure and chemical composition. It also collects the health state of machinery by monitoring temperature, vibrations and operating conditions. Different equipment such as pipes, pumps and valves can be connected via IoT to communicate everything that's happening throughout the desalination process.

While IoT is concerned with the real time gathering of production data, AI and ML on the other hand uses mathematical algorithms to get insights from the data. The high volume, velocity and variety of IoT data often requires big data analytics technologies that leverage AI to improve manufacturing efficiency and decision making.

Journey to SMART DESALINATION

By introducing the use of advanced analytics powered by AI/ML, we allow the desalination system's maturity levels to progress from basic data availability to action-oriented data. There are four levels that can be used to assess the journey through which a desalination plant can improve and evolve to a smart desalination plant.



LEVEL 1 BASIC DATA AVAILABILITY

At this level a factory or facility is not really "smart" at all. There is data available, but it is not easily accessed or analyzed.



LEVEL 2 PROACTIVE DATA ANALYSIS

At this level data can be accessed in a more structured and usable form. Usually, this data is centrally available and organized with degrees of visualization through displays and dashboards allowing for more proactive data analysis.

Descriptive analytics: Is the analysis of historical data to understand trends and evaluate metrics over time.



LEVEL 3 ACTIVE PREDICTIVE DATA

At this level operational data can be analyzed using AI/ML. The system is more automated than level two and can predict situations.

Predictive analytics: A system that predicts the possibilities of a particular event in the future.

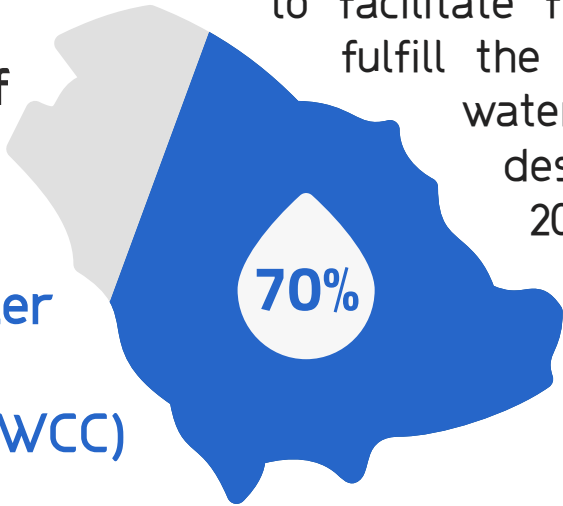


LEVEL 4 ACTION ORIENTED DATA

At this level the system determines prescriptive solutions based on the active data of level three, and takes action to alleviate an issue, improve a process, or determine best practices. This is done with minimal human intervention and can enable autonomous systems.

Prescriptive analytics: A system which has the intelligence of taking its own decisions and the ability to modify it with dynamic parameters.

In 1974
The Kingdom of
Saudi Arabia
established
the Saline Water
Conversion
Corporation (SWCC)



to facilitate freshwater production and fulfill the severe shortage of fresh water in the Kingdom through desalination solutions, As of 2021, SWCC provided **70%** of the total desalinated water in the Kingdom, making it a key player in the industry.



Throughout its history, SWCC has taken all measures to employ the latest technologies to the best of its abilities. As manufacturing evolved, so did SWCC. It has accomplished many achievements in developing the technologies used in water desalination. Latest of which was setting a new Guinness World Records™ title for Lowest energy consumption for a water desalination plant with 2.27 kW/h per cubic meter of desalinated water. This is one of several milestones SWCC has achieved to strengthen its global standing as the leader in the desalination industry.



SWCC AI Roadmap

To reach full-scale smart desalination plants, an AI strategy aligned with a well planned roadmap is essential. Developing an effective AI strategy assures that the information and data growth translates into business value. Such a strategy can be appropriately set by defining an AI vision of the organization and a portfolio of AI use cases for the required enabling factors. AI Strategic use cases are developed to address the organization's top business priorities and tackle the pain points.

By aligning SWCC vision with the Saudi Vision 2030, SWCC seeks to transform itself into a smart organization that adopts an AI-driven strategy.

To support this initiative, his Excellency Eng. Abdullah AlAbdulkareim, SWCC's Governor, established the Data and AI Department.

The department aims to utilize Industry 4.0 technologies to advance the corporation's abilities. This new department designed a digital transformation framework that comprises both data management and AI strategies.

- ① Developing AI use cases and initiatives for SWCC Digital transformation and AI Strategy.
- ② Developing Data Mangement and Data Strategy.
- ③ Developing quick win initiatives.
- ④ Developing analysis & predictive dashboards to support decision making.



“Artificial intelligence could revolutionize the water desalination industry, We are proud to be here and discuss future opportunities to fulfill the needs of mankind and improve services in our homeland”

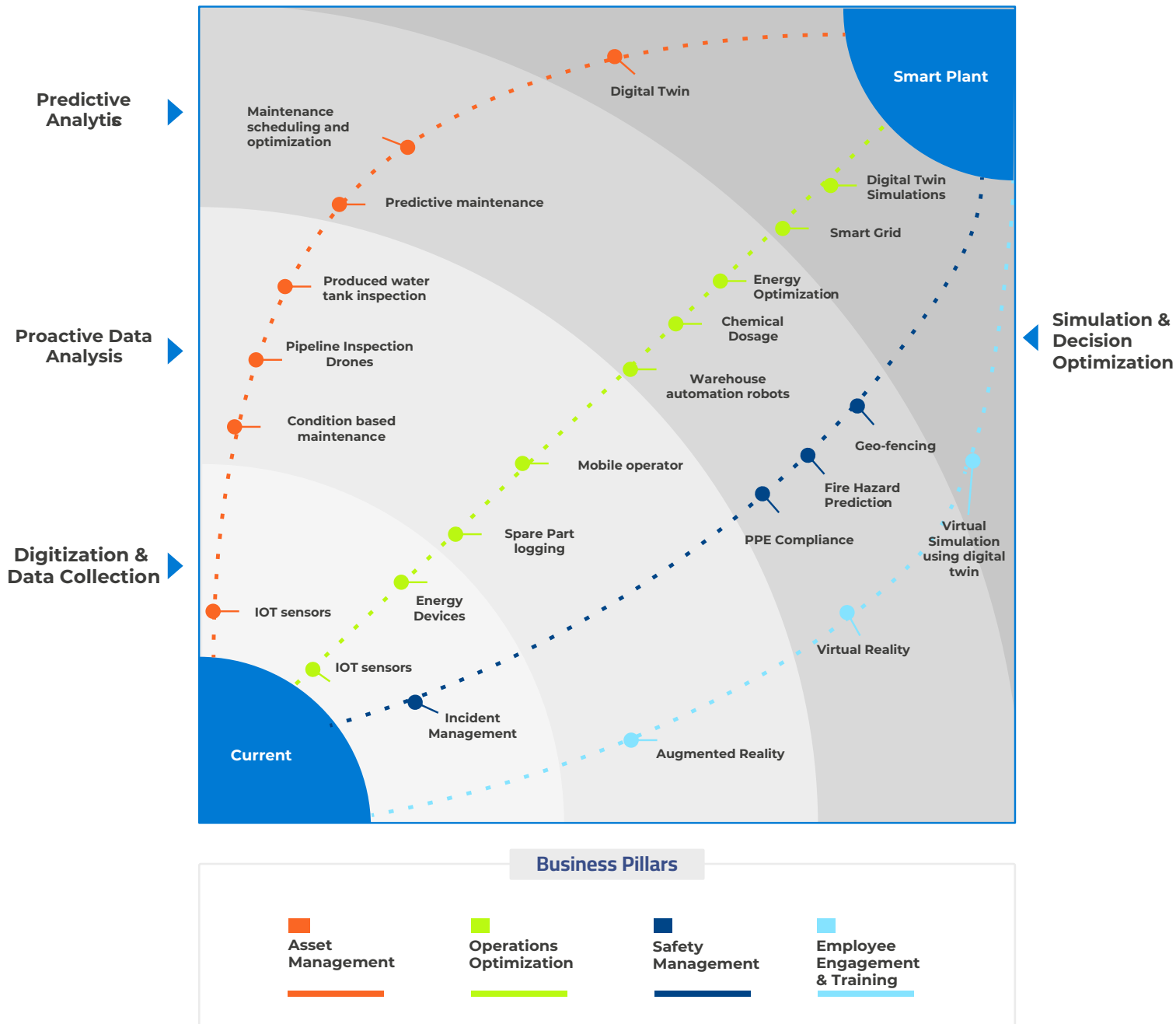
H.E. ENG. ABDULLAH ALABDULKAREIM
GOVERNOR, SWCC





SWCC AI Roadmap

SWCC's AI strategy includes a transformation roadmap divided on 4 business pillars. These AI use cases will be applied to progress desalination from it's current state into smart plant by advancing through the four smart desalination journey levels.





AI Applications



SAFETY

- ▶ **APPLICATION 2**
SAFETY AND SECURITY



ASSET MAINTENANCE

- ▶ **APPLICATION 3**
ASSET MAINTENANCE
AND PERFORMANCE
MANAGEMENT
- ▶ **APPLICATION 8**
VISUAL AI (DRONE
BASED PLATFORMS)



PROCESS OPTIMIZATION

- ▶ **APPLICATION 1**
EARLY WARNING
JELLYFISH BLOOM
DETECTOR
- ▶ **APPLICATION 5**
ENERGY AND
CHEMICAL
MANAGEMENT
SYSTEM
- ▶ **APPLICATION 6**
SMART PLANT WATER
GRID SYSTEM
- ▶ **APPLICATION 7**
WAREHOUSE
MANAGEMENT



TRAINING & ENGAGEMENT

- ▶ **APPLICATION 4**
VIRTUAL
SIMULATION



Application 1

Early Warning Jellyfish Bloom Detector

Jellyfish bloom (a massive increase of the jellyfish population) is becoming more prevalent in the world's oceans. It is believed that factors such as ocean pollution, overfishing, toxic water, lower oxygen levels, increased water temperatures and salinity changes contribute to the increased number of Blooms.

Jelly Blooms block water inlets for desalination plants forcing shutdowns. Challenges exist to detect and track blooms in the oceans, limiting opportunities to implement timely interventions.

This application objective is to notify plant managers of jellyfish blooms drifting towards the plant. The plant manager can then activate a manual intervention process to remove and prevent the jellyfish bloom damage.

Pre-Reqs

- UAV hosted classification and GEO tagging
- Computational infrastructure for model training

Technologies

- Computer Vision
- ML/Deep Learning

Business benefits

- Early alerting of impending presence of jellyfish blooms in vulnerable areas
- Detection of drift direction (drift of jellyfish bloom)

- Activation of interventions (when required)

- Layered nets to snare jellyfish and clear the water

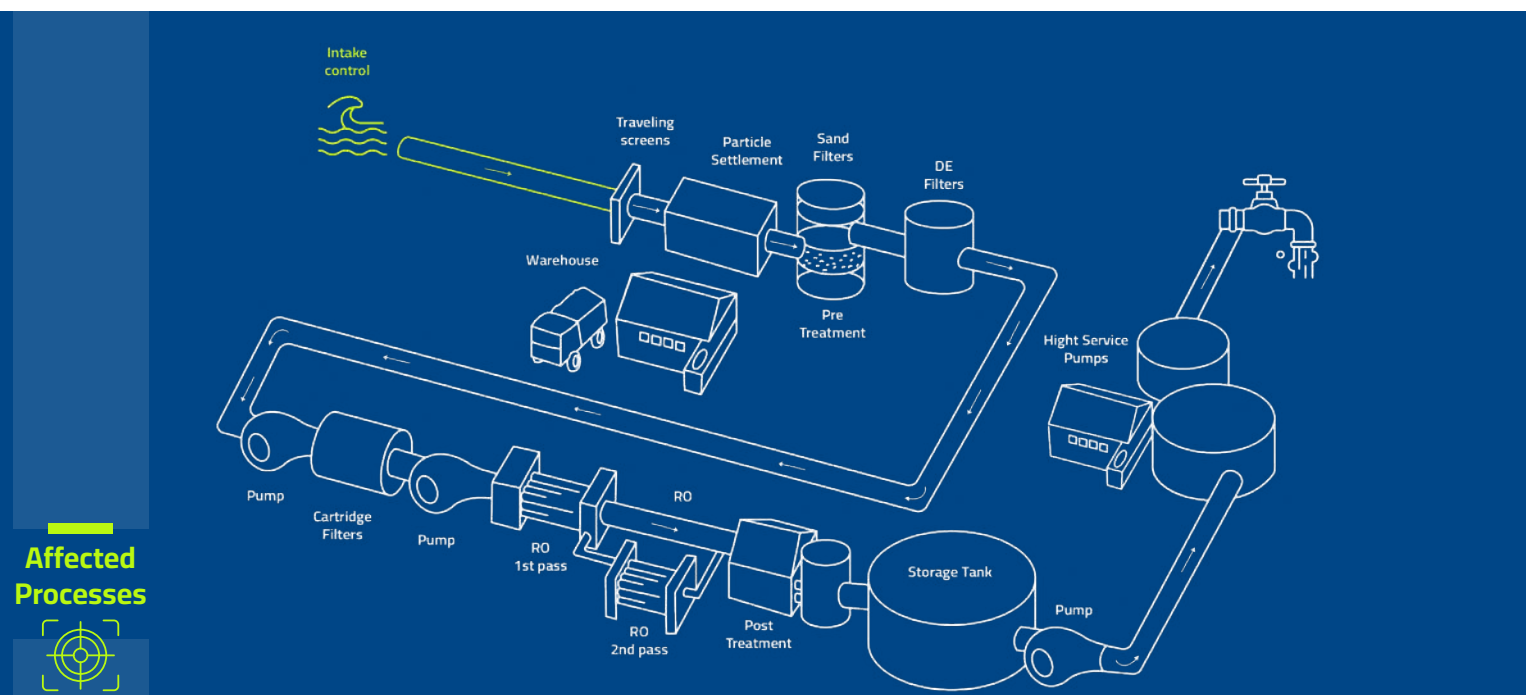
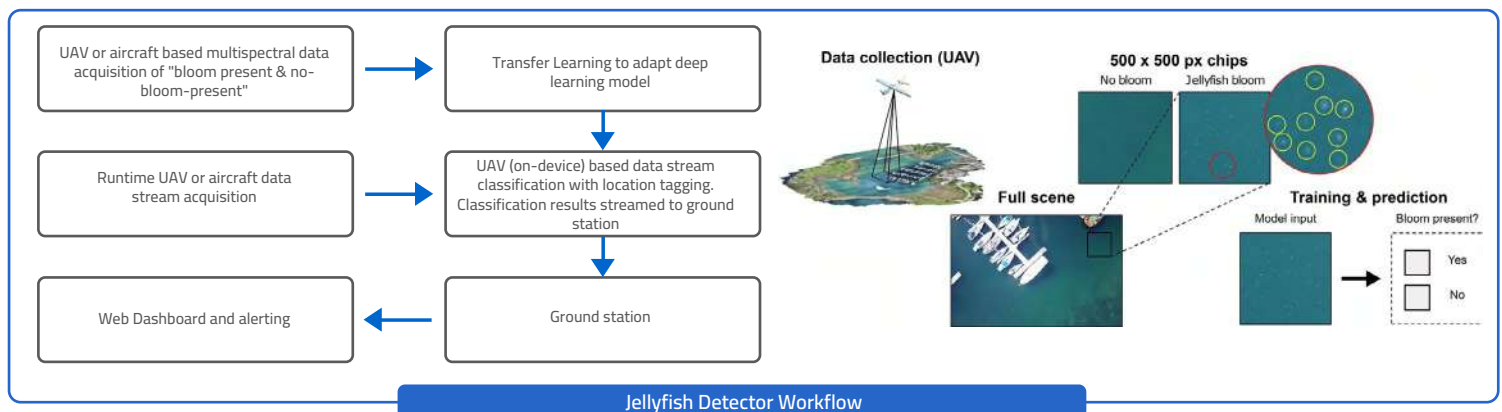
- Pump inlet management

Use Case Challenges

- This is an active research topic.

- Ongoing research using computer vision techniques on the UAV data acquisition

- Research leveraging remote sensing techniques to detect favorable conditions for jellyfish is being conducted





Application 2

Safety and Security

Ensuring employee safety in the field is important, mainly due to electrical and chemical hazards that arise from working in desalination plants.

1. Incident Management

All procedures, risks and injury reports will need to be digitized during this stage. Risk factors and passed injuries can be analyzed to deliver a comprehensive injury plan.

2. PPE compliance

Using visual AI, personal protective equipment inspection can be made to ensure employees wear proper equipment, and notify them if they are not.

3. Geo-fencing

A geofence is a virtual perimeter for a real-world geographic area. By sending real-time alerts when a piece of equipment moves outside the geofence, this technology helps to prevent theft or unauthorised use of equipment. In addition, it can monitor employees upon entering or exiting the geofence.

4. Fire Hazard Prediction

By monitoring temperature of equipment , fire prediction systems predict the likelihood of overheating and consequently fires.

Pre-Reqs

- CCTV
- Geofencing solutions
- Software integration

PPE detection

- Safety helmet
- Safety shoes
- Safety vests/uniform

Technologies

- Computer Vision (Deep Learning)

▪ CCTV

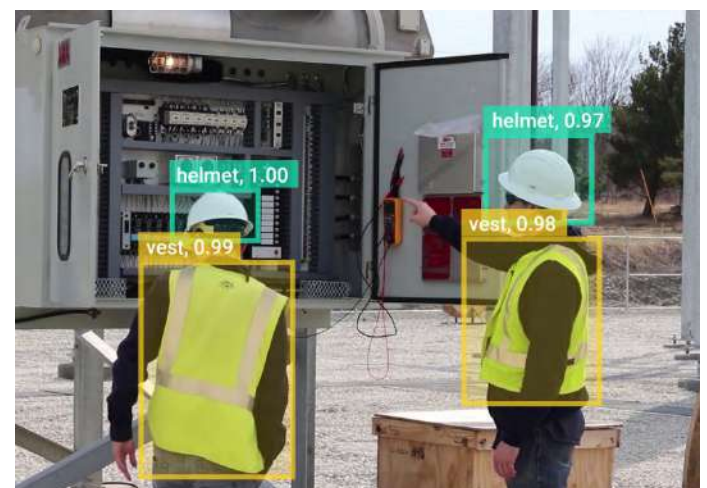
- Incident Management Software
- Geo-fencing solutions

Business benefits

- Reduce injuries
- Increase the quality of work environment
- More secure facilities : lesser risk of interruption

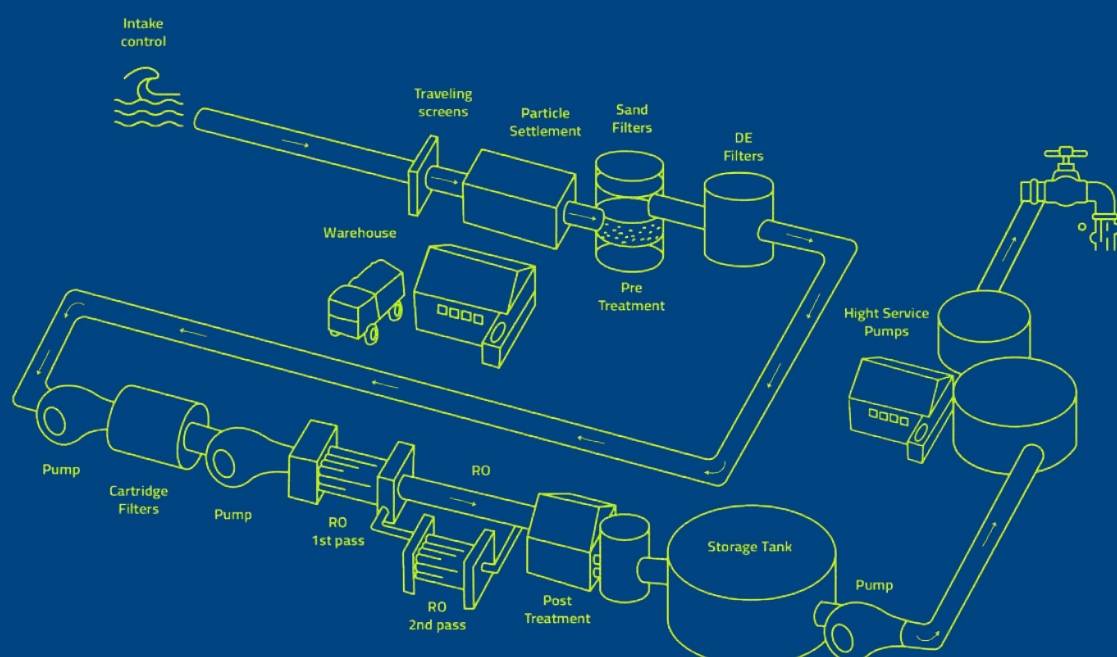
ROI

- **Up to 3%** cost savings related to security and safety personnel



AI based PPE detection

Affected Processes





Application 3

Asset Maintenance and Performance management

The main purpose of the asset performance management system is to optimize the performance of the desalination plant production assets.

1. Condition Based Maintenance

Unlike traditional interval-based preventive maintenance, condition based maintenance is based on real-time data and only performed after one or more indicators show that equipment is going to fail or that performance is deteriorating. While proactive, and not time-based, condition-based maintenance is still a preventive maintenance paradigm as it does not give a full diagnostic on the best time to perform maintenance.

2. Predictive Based Maintenance

The reactive approach to asset performance management exposes the employees to critical risks and to everyday uncertainty. Predictive maintenance aims to anticipate and address issues before they become critical incidents.

3. Maintenance Optimization

In this stage, the system optimizes and decides the best maintenance schedule (time, duration and required skill) using the preventative, reactive and predicted maintenance activities.

The optimized schedule will be sent to the mobile operator device.

4. Digital twin Based Asset Maintenance

By using digital twins, which are digital representations of real-world entities, data collected from the real device updates the "digital twin" copy of the device's properties and state in real time.

A digital twin of an asset will comprise its 3D and mathematical model. Operational data coming from sensors can then be combined with engineering related aspects of the asset to provide detailed insights into performance or potential problems. Digital twins can also be used to simulate processes (e.g. RO osmosis) to adjust parameters before applying it on the plant operations.

Pre-Reqs

- Flow meters
- Pressure Transmitters
- Temperature sensors on motors

Applicable Components

- Dynamic components such as valves, motor and pumps

Technologies

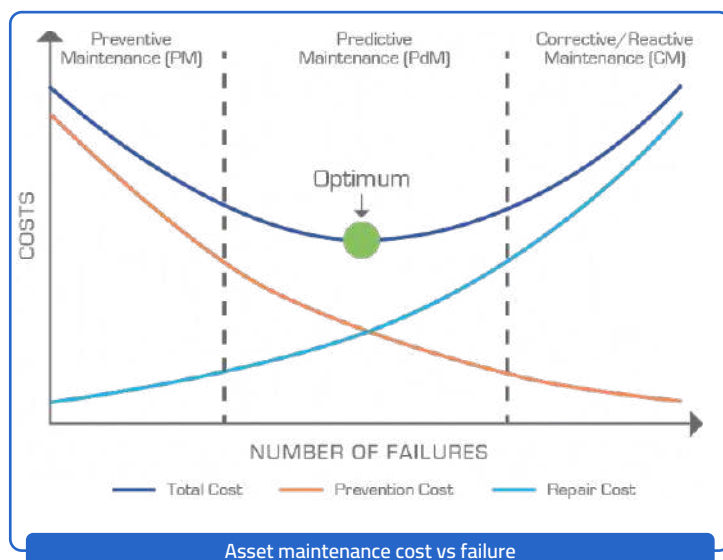
- AI & Machine Learning
- Digital Twin
- Decision Optimization

Business benefits

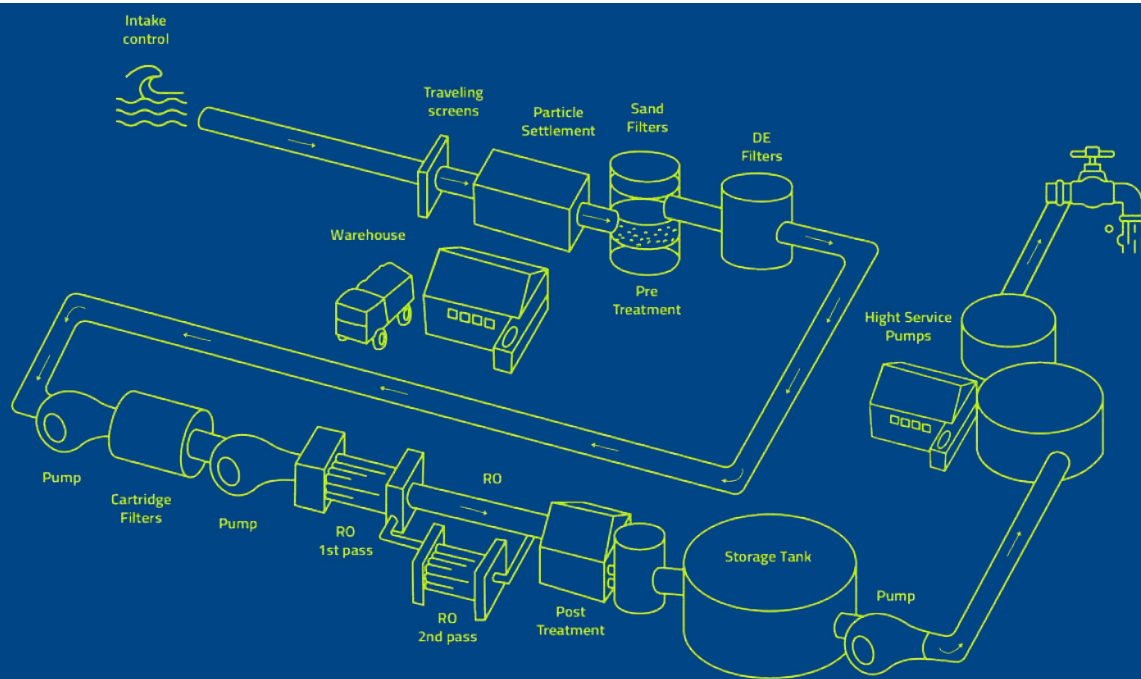
- Reduce asset downtime
- Decrease asset maintenance cost
- Optimize maintenance plan

ROI

- **Up to 8 %** Reduction in maintenance costs
- Saves the cost of restarting the production line or equipment



Affected Processes





Application 4

Virtual Simulation

Classroom training is far from real life situations and training in the field is costly and time consuming. In this application, virtual simulation and augmented reality system will be used to train employees and trainees by simulating operational processes and safety procedures.

1. Augmented Reality

By adding digital information to the physical plant world, engineers can remotely diagnose plant operations, and give work instructions onto physical machinery without being present onsite.

2. Virtual Reality

Using VR systems, on-the-job plant training can be provided in an immersive environment without disrupting production, nor the work of other workers. Also, dangerous situations can be simulated using VR to increase worker safety awareness.

3. Digital Twin VR simulation

AR can show a digital twin on top of a physical machine which helps in understanding the data coming from the machine. On the other hand, VR of a digital twin can be used to simulate various operational procedures.

Pre-Reqs

- AR & VR Equipment
- 3D modelling of assets

Technologies

- Digital twin software
- VR software
- AR software

Business benefits

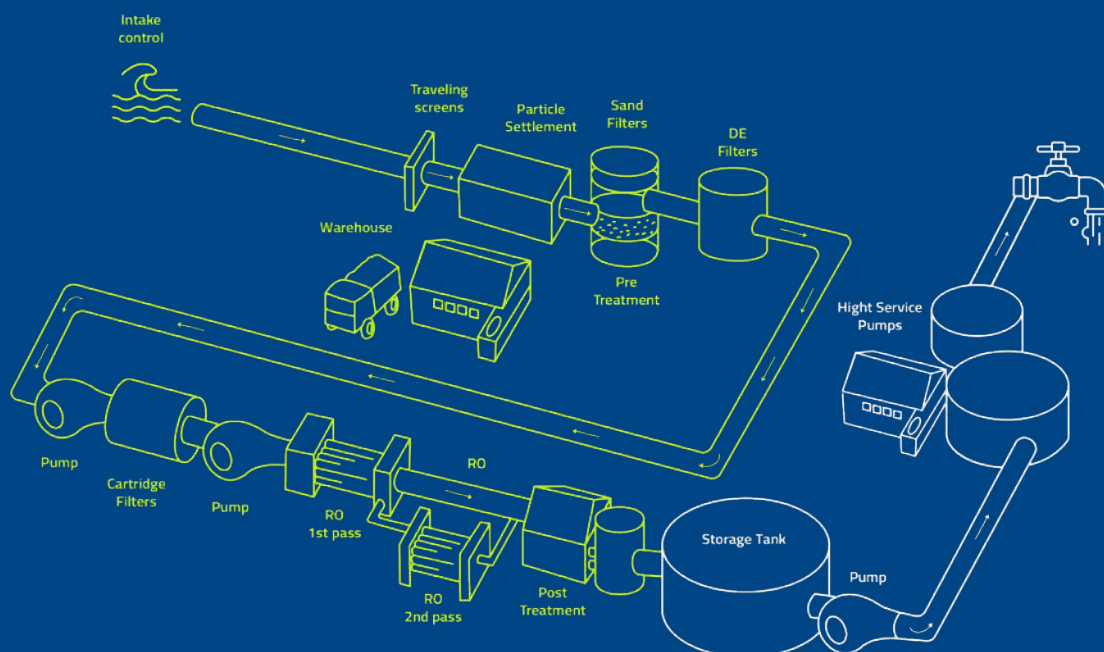
- Enhance product and operation efficiency
- Remote on-site guidance
- Improve the capabilities of employees

ROI

- **2% increase** in worker efficiency



Digital Twin AR simulation



Affected Processes





Application 5

Energy and Chemical management System

The main purpose of the Chemicals Management System is to digitize the chemical tracking and Cleaning-In-Place (CIP) processes. Thus, enabling and providing CIP management, real-time insights for consumption (chemicals, water, time & resources) rate, available inventory, and enable usage optimization.

In energy management, ML algorithms can predict energy inefficiency and alert managers when the occur.

1. Chemical dosage

By continuously monitoring both the water quality using analyzers and the previous chemical consumption of material, the system can advise the DCS operators on the recommended set points for chemical consumption based on historical consumption patterns and water quality measurements.

2. Energy consumption optimization

Energy IOT sensors collect energy consumption information from the different devices. The information is used to generate insights about the energy management effectiveness also suggest scenarios to optimize the energy consumption

Pre-Reqs

- Analyzers for Water quality
- IOT sensors
- Energy devices
- Technologies
- Machine Learning
- Trend Analysis
- IOT

Chemicals

- Chlorine
- Lime
- Co2
- Ferric Chloride
- Sulfuric Acid

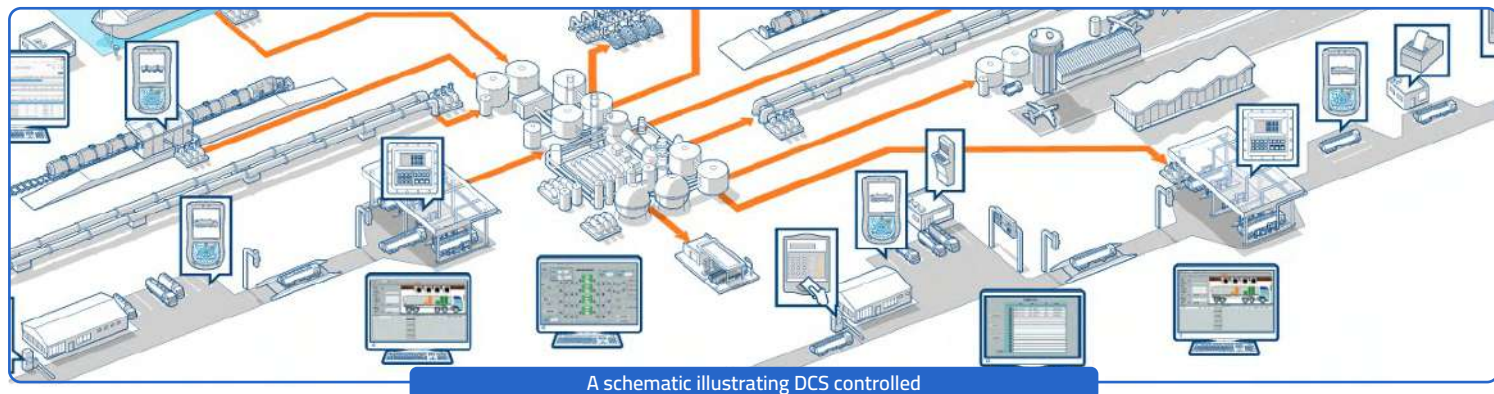
- Sodium Bisulfite
- Antiscalant
- Caustic Soda

Business benefits

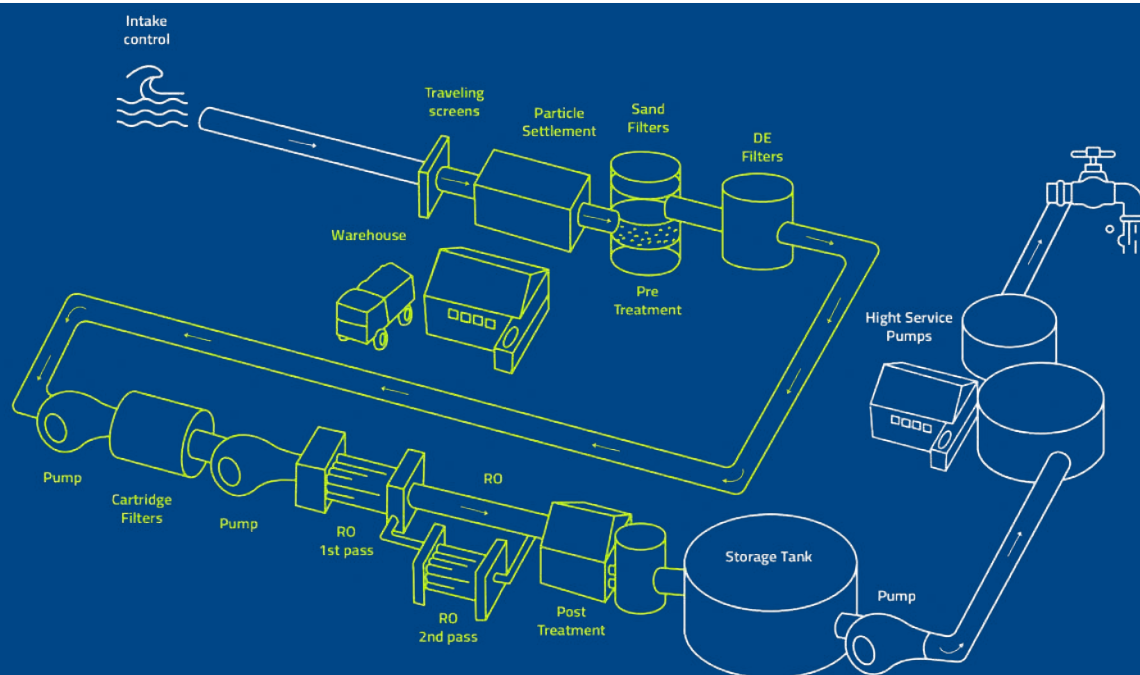
- Optimize the use of chemicals
- Reduce chemical consumption related costs
- Reduce energy waste which promotes eco-friendliness
- Reduce energy related costs

ROI

- **Up to 7%** reduction in chemical consumption



A schematic illustrating DCS controlled



Affected Processes





Application 6

Smart Plant Water Grid System

Some processes in desalination are energy-intensive leading to high financial and environmental costs. This makes energy consumption efficiency an important factor for keeping production costs at their minimum. Thus, it is profitable to provide the desalination plant with artificially intelligent smart grids that can decrease energy consumption and chemical costs while improving operational performance.

This use case aims to optimize both the energy consumption especially the energy used by high pressure pumps and the chemical consumption through the management of the different production units. By monitoring the consumption profile during the day, the grid system turns on/off the different components accordingly while meeting the daily production target.

This smart grid system unifies all SWCC production units into one platform where AI/ML is utilized to:

- Optimize power consumption.
- Optimize chemical consumption.
- Find areas of possible savings.
- Provide recommended actions to the operators.

Pre-reqs

- Energy meters on main and sub devices
- Consumption profile in reservoirs
- A smart grid solution

Technologies

- AI/Machine learning
- Recommendation engine
- IoT

Applicable Components

- High pressure pumps
- Chemical dosage system

Business benefits

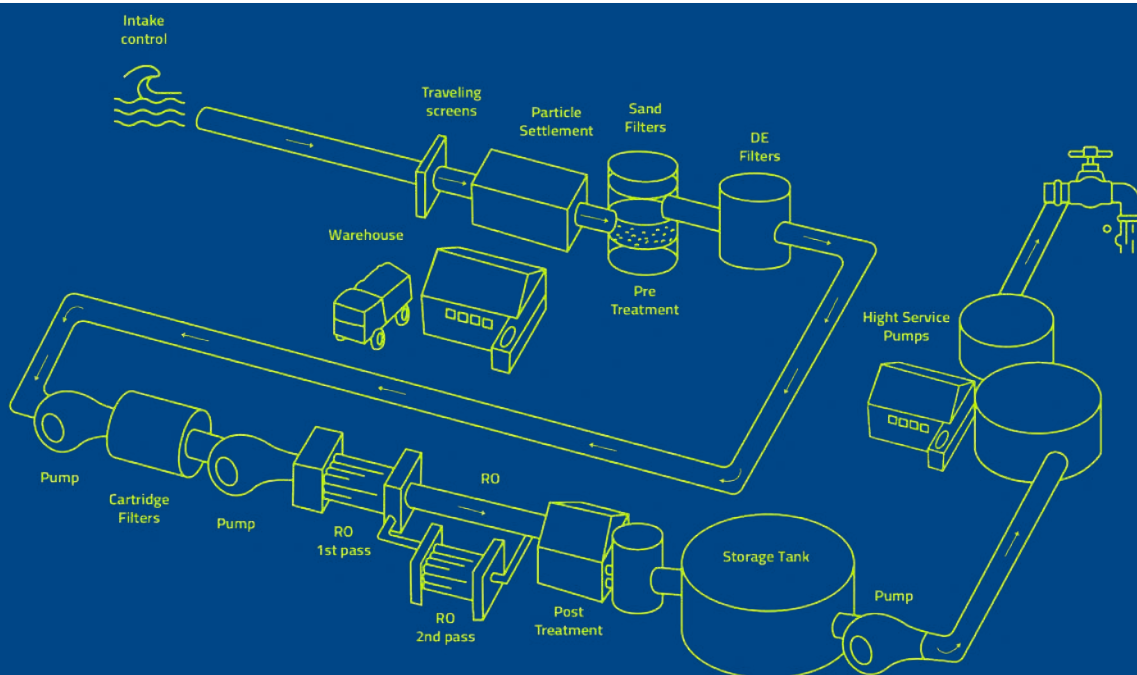
- Lower production and energy costs
- Better sustainability
- Increase pumps lifetime

ROI

- **Up to 3.5%** decrease in energy consumption



Affected Processes





Application 7

Warehouse Management

1. Spare Part logging

Managing inventory (e.g spare parts) in and out of the plant warehouse with barcodes and QR codes allows warehouse managers to track and review inventory in real time

2. Warehouse automation robots

Using VR systems ,on-the-job plant training can be provided in an immersive environment without disrupting production nor the work of other workers .Also dangerous situations can be simulated using VR to increase worker safety awareness.

Pre-reqs

- ERP software module
- QR scanners

Technologies

- Computer Vision
- QR scanners
- Robotics

Business benefits

- Reduce costs

- Reduce waste

- Better storage level tracking

- Reduced duration from item request to on-site delivery

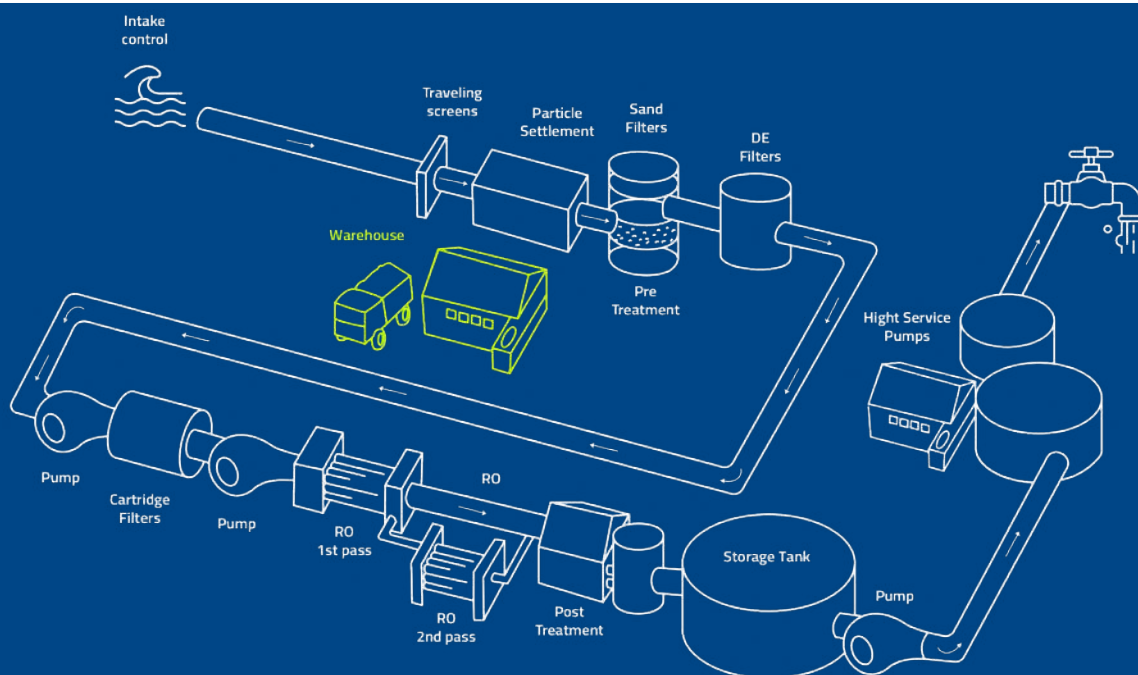
ROI

- Up to 2% decrease in warehouse related costs

- Up to 2% overall increase in supply chain efficiency



A warehouse automation robot



Affected Processes





Application 8

Visual AI (Drone based platforms)

Drones can be part of desalination plants maintenance procedures to carry out several functions like asset inspection, defect detection and surveillance tasks. By using a drone to collect visual data on both the physical condition of an asset and its security aspects, drone inspections can prevent inspectors from being exposed to dangerous or harsh situations.

1. Pipeline Inspection Drones

Drones can be used to inspect water transmission lines and search for any defects or leakage.

2. Produced water tank inspection

If left unattended, many common tank materials are subject to corrosion, cracking, or rusting. Drones can obtain a detailed visual and thermal inspection of the inside of the tank and report any abnormalities found.

3. Drone Surveillance

Drones can detect any intruders/vandals either inside the plant or around the water transmission pipelines.

Pre-reqs

- Drones equipped with cameras or surveillance cameras
- Drone integration with mobile operator software

Technologies

- Computer Vision
- Image recognition

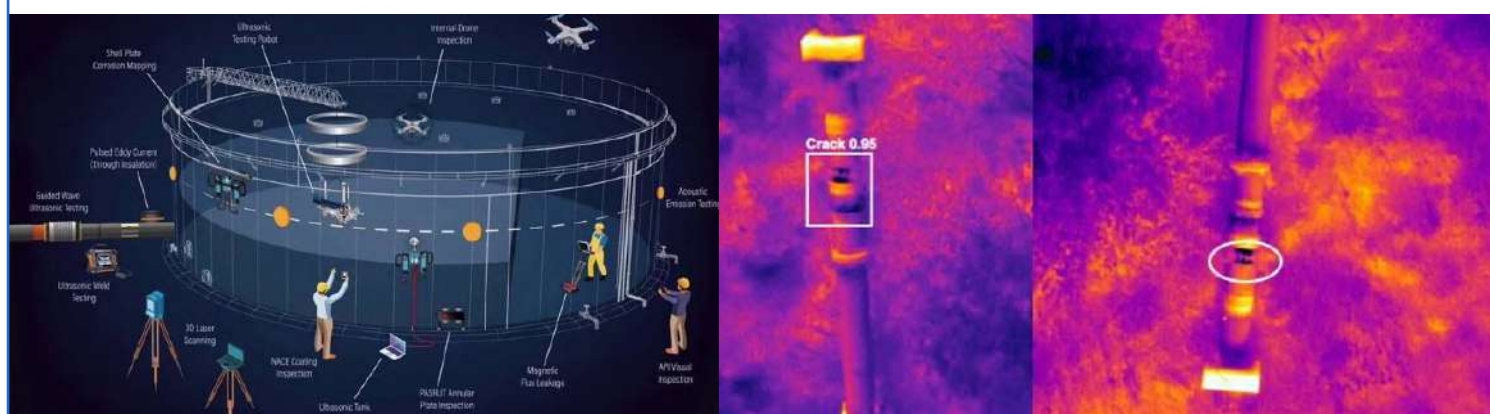
Business benefits

- Increase the reliability and availability

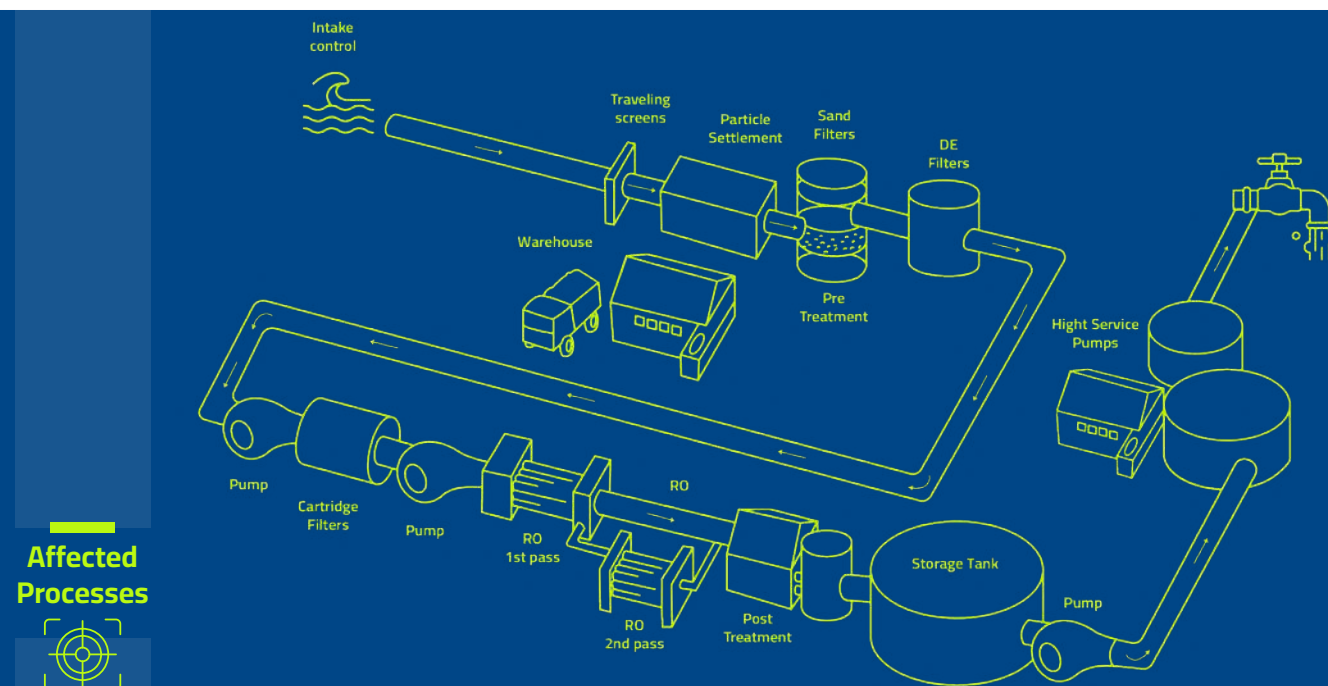
- Enhance operational performance
- Reduce operational and maintenance costs
- Improve security and safety of SWCC plants and water transmission systems

ROI

- Up to 30 % decrease in labor inspection costs



Drone based water tank inspection / pipe leak inspection

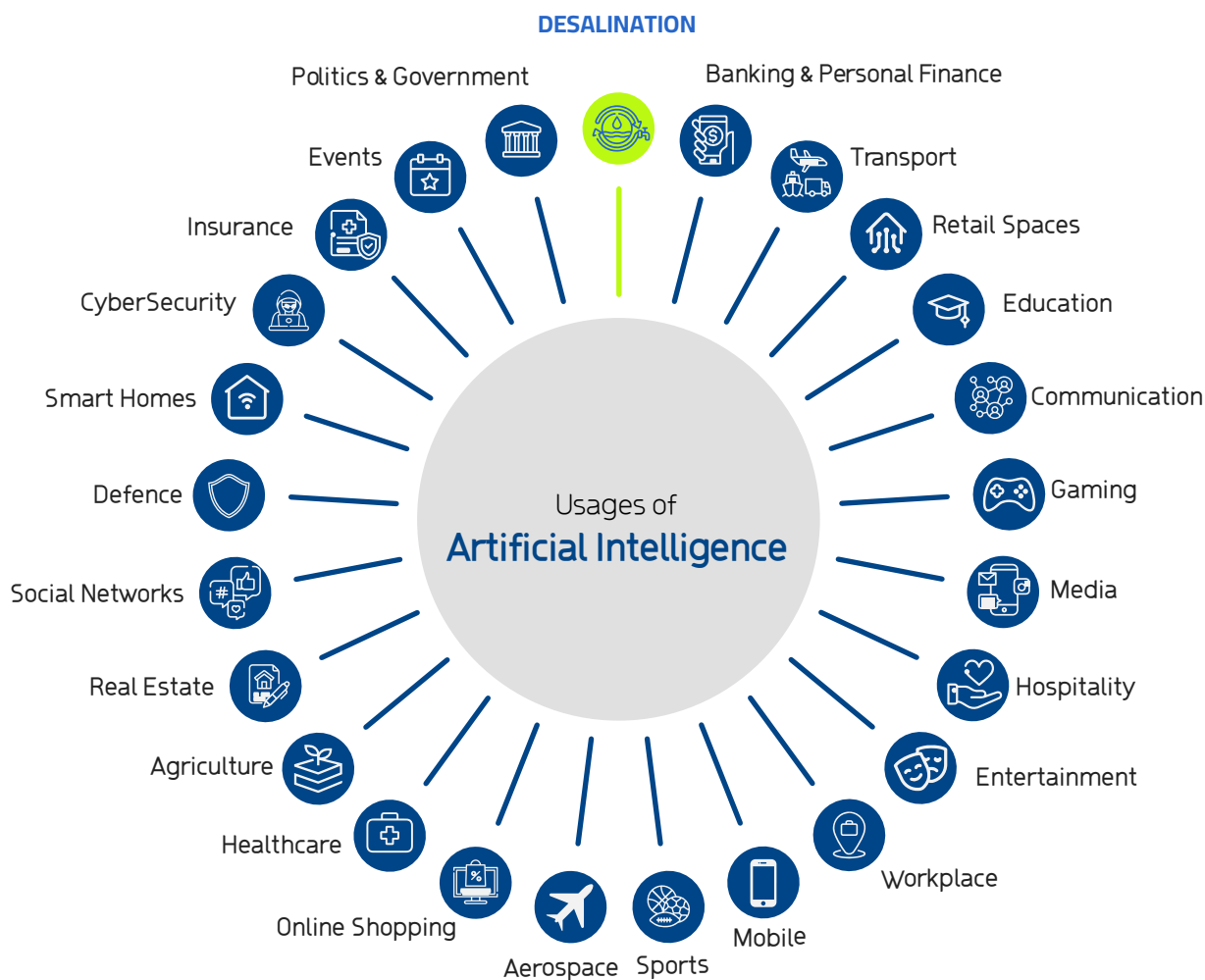


Affected
Processes

Conclusion

Empowering desalination with AI technologies not only improves production efficiency but also improves employees productivity and environmental sustainability. Such an approach helps the industry solve real-world desalination problems and promptly make more informed decisions moving forward.

Nowadays, and in the foreseeable future, AI will continue to play a pivotal role in society. This paper promotes counting desalination as one of the key industries to which AI can revolutionize. Lastly, the future direction of this work is to lay the ground for other white papers to present the outcomes of the AI applications following their implementation in SWCC plants.





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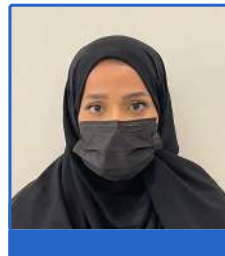
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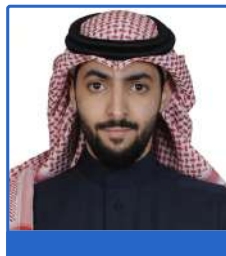


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