



Associazione Farmaceutici Industria
Società Scientifica

Machine Learning for the optimization of energy intensive machines

65°

RIMINI 10.11.12 GIUGNO 2026



SIMPOSIO EFT

Cristian Bavuso - Bio



Cristian Bavuso
Stilmas
Sales Director

Almost 20 years of activity in Pharmaceutical industry providing equipment and complete solution at worldwide scale.

Focused on Sales and Business development, leading Stilmas Sales Dept for 5+ years

Customer-oriented and passionate about innovation, committed in delivering valuable and tailored solutions that align both customer expectations and specific needs. Focused on providing the most effective, innovative and long-term value creation.



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Saverio Mottana - Bio



Saverio Mottana
Masco Group Automation
CEO



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30+ years of experience in industrial Automation and Process Control, with a focus on Pharma in recent years.

Expert in Digitalization, leading Masco Group Automation in providing automation and digitalization solutions to Pharma customers.

Passionate advocate of innovation: IIoT, AI/ML, Plant Modeling, Software Standardization — bringing cutting-edge technology to Pharma operations.



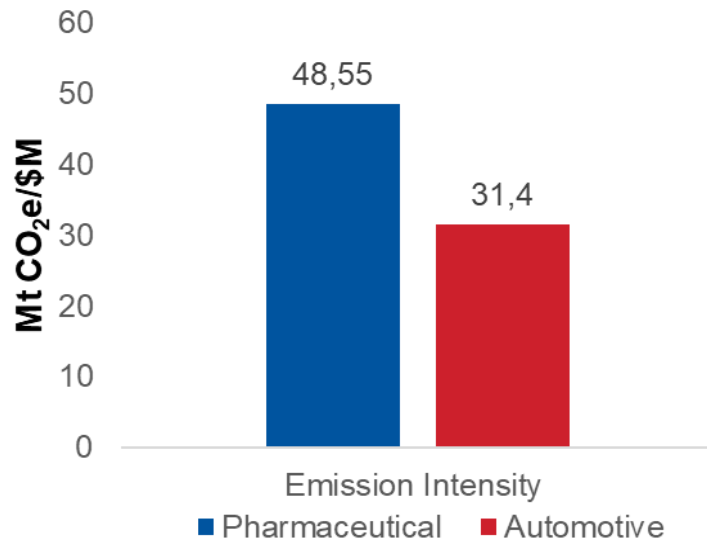
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The Water Facilities

What Innovation is possible in the Digital Age?

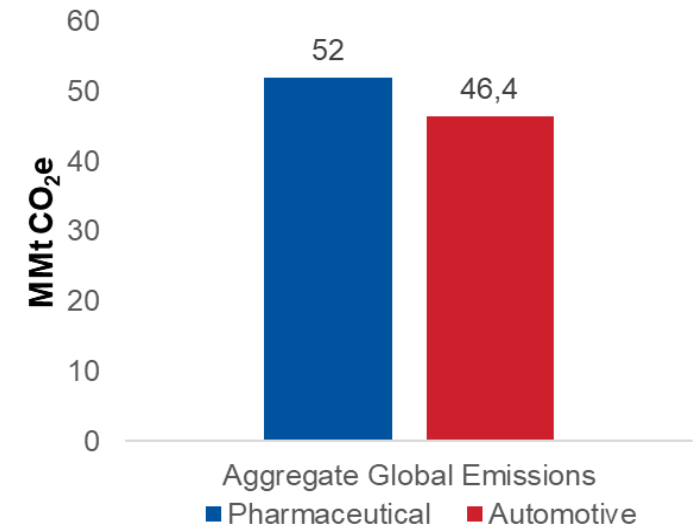
Based on an analysis conducted by Lofti Belkhir and Ahmed Elmeligi (McMaster University, Canada):

- Currently, approximately **25 major Pharma** companies reported their emissions
- (on over 200 companies representing the global pharmaceutical market)



Greenhouse gas emissions from the pharmaceutical industry are 55% higher per dollar of revenue than those emitted by the automotive sector

The pharmaceutical industry is significantly more emission intensive than the automotive industry



Total Emissions from the pharmaceutical industry are 10% higher than automotive even if the market total revenue is almost 3 times smaller

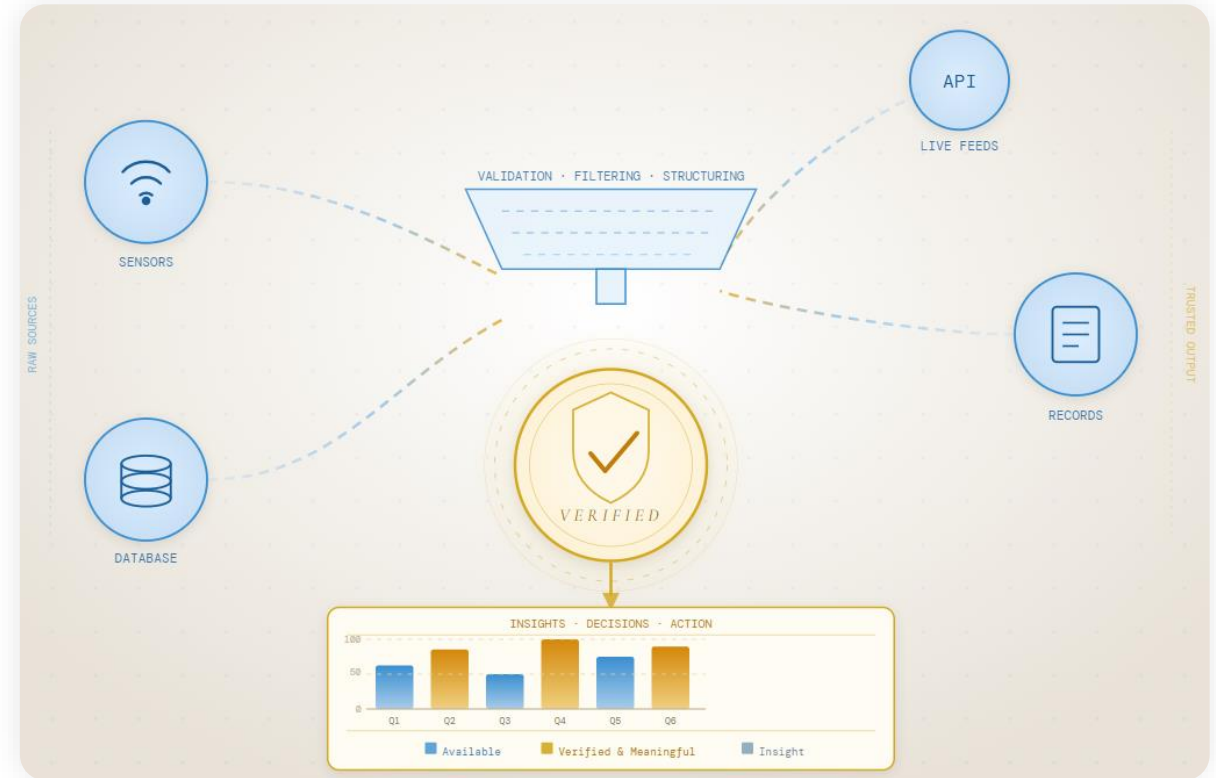
Milion of tons on million of \$

- 1) Availability of meaningful and trustworthy data
 - a. On **aged machines** in the field (brownfield case):
some relevant and meaningful data can be missing
the data are available, but the quality of the data is not available
 - b. On new machines in the field (greenfield case),
all the GMP-relevant data are available, but maybe not the data relevant for energy- and sustainability-related purposes.

Those customers have sometimes no clue about their consumption.

2) Improper Use of the equipment

- a. Live cycle and unforeseen issues



Open question:

How to come therefore to a higher level of data quality?

Water For Injection generation



DISTILLATION

“A purification process involving the phase change of water from liquid to vapor and back to liquid, leaving behind most of the impurities in the water”.



- Multiple evaporation stages or "effects"
- High operating temperatures
- **Self sanitizing process**
- DW as feed water
- No cooling water from 7 effect

HOT Production



VCS

- Single Evaporation stage
- Medium operating temperatures
- **Self sanitizing process**
- **SW as feed water**
- **No cooling water required**

HOT or **COLD** Production

MEMBRANE PURIFICATION

“A purification system composed by different chemical-physical processes able to remove effectively impurities from the water at ambient temperature”.



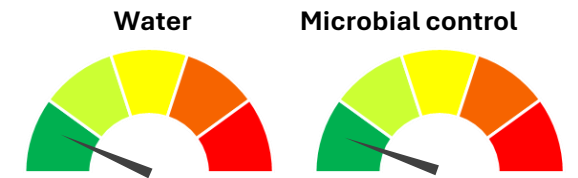
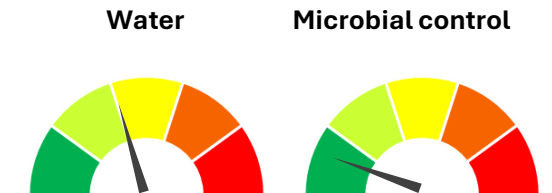
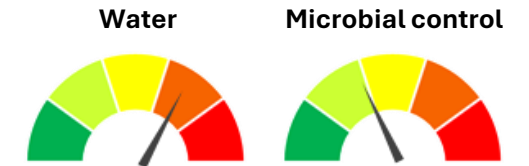
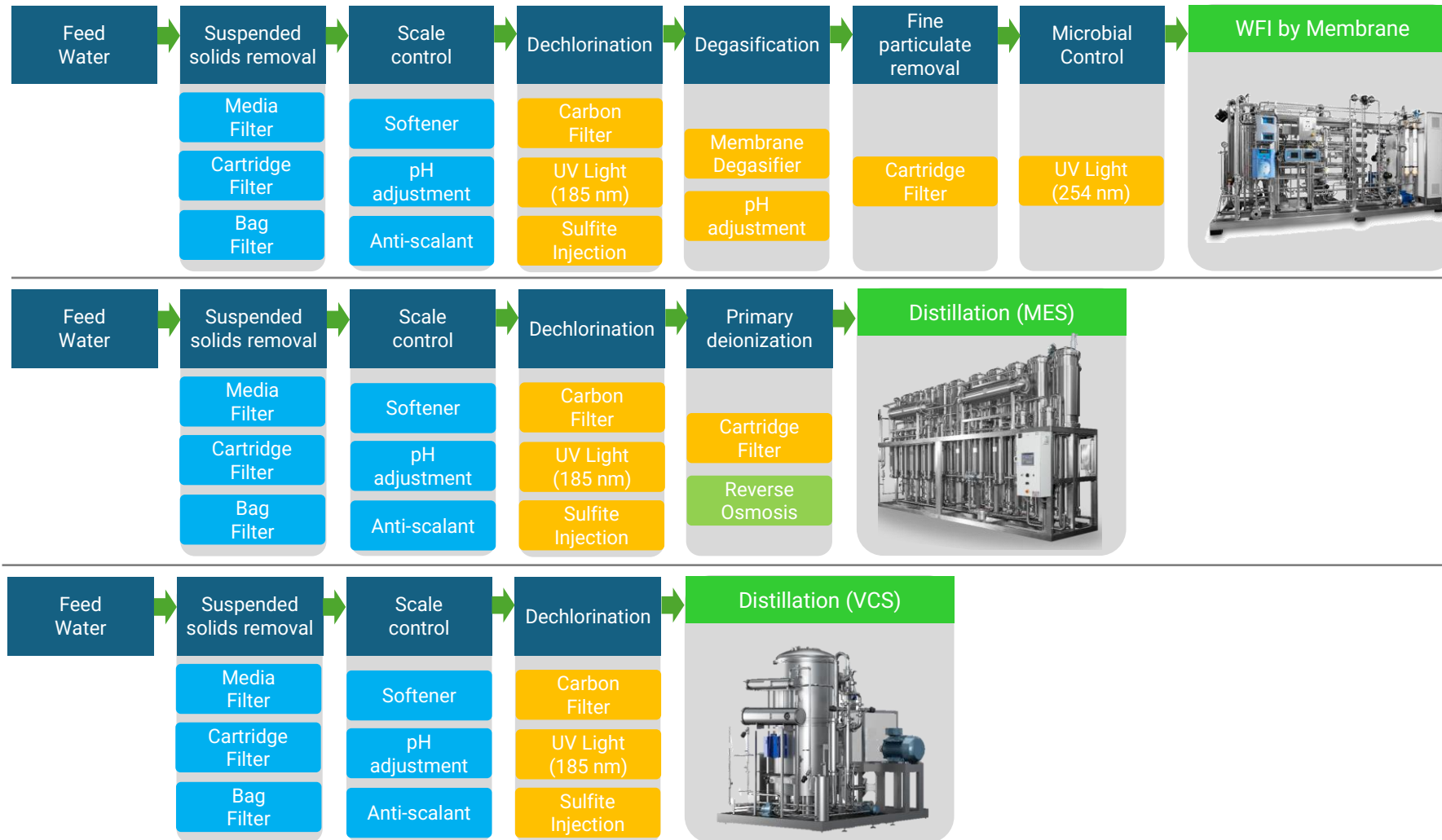
RO + UF

- RO + RO + UF or RO + EDI + UF
- Ambient operating temperature
- Hot water or chemicals for sanitization
- Pretreated water as feed water
- Small amount of cooling water required

COLD Production

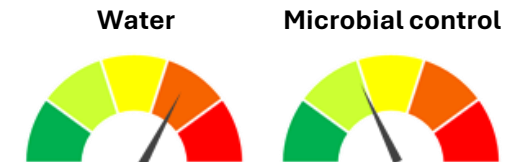
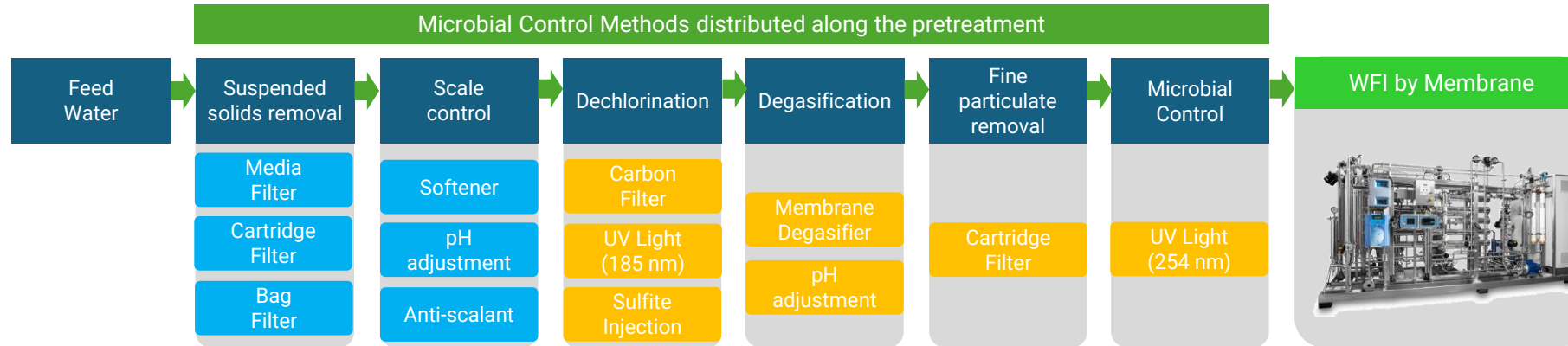


WFI generation systems - Pretreatment

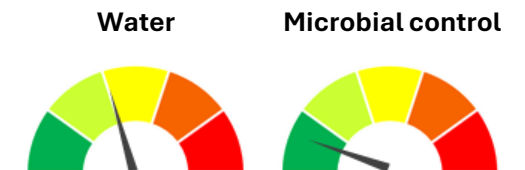
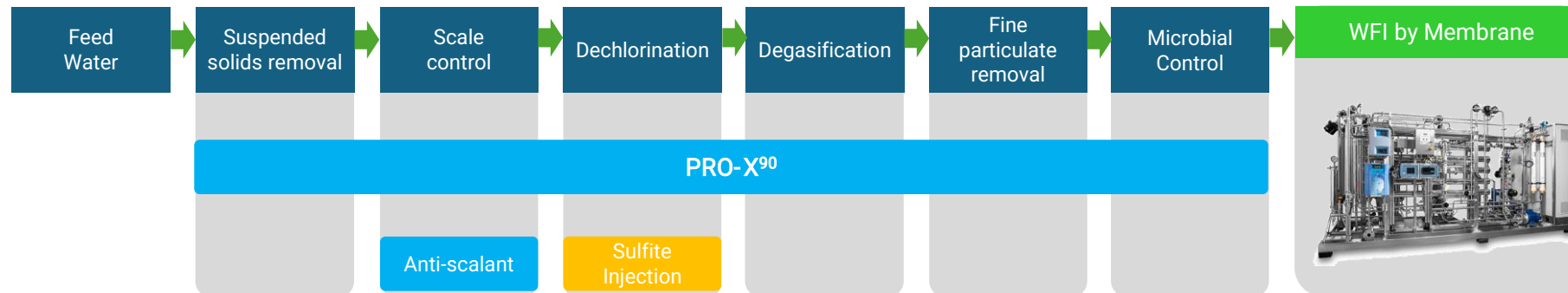


WFI generation - Feed Water clusters - Pretreatment

Conventional configuration

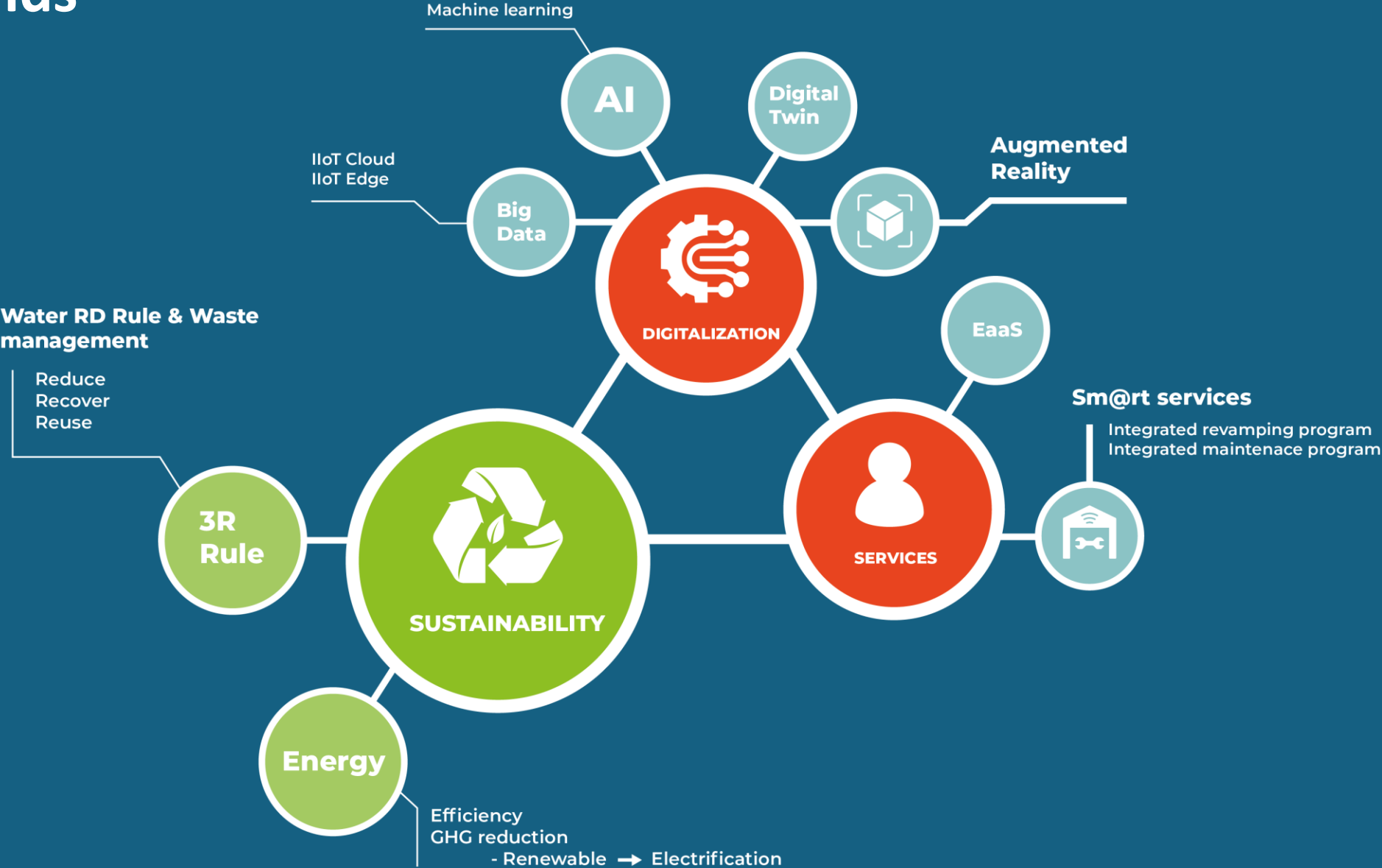


Alternative configuration



Less 30% feed water
Less 70% sanitization
No chloride

Megatrends



Reduce



Optimize water consumption through **efficient process design**, digital monitoring, and leak prevention to minimize waste generation from the start.

Recover

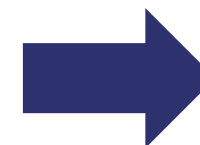


Implement advanced filtration (**e.g. ultrafiltration for organic compound separation**) and technologies to recover reusable water and valuable by products from waste streams (**e.g. RO for high purity water recovery**).

Reuse



Reintroduce treated water into utility systems or for secondary purposes (**e.g. cooling, cleaning**), significantly lowering freshwater intake and operational costs.



- Decreases environmental footprint
- Lowers treatment and discharge costs
- Enhances regulatory compliance and ESG performance

Electricity is a cleaner energy source that significantly minimizes environmental impact.



**ePSG (Pure
Steam
Generator)**

- 0–100% variable production (embedded)
- Energy recovery system (blowdown recovery)
- Smart energy monitoring



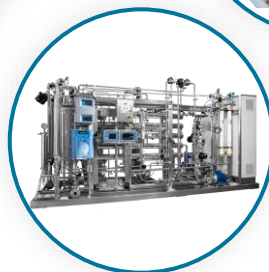
**eMES (Multi-
effect Still)**

- Variable production 0-100% embedded
- More energy reduction
- Smart energy monitoring



**eVCS (Vapor
Compressor)**

- Variable production
- High efficiency motors IE5
- Direct drive execution
- Smart energy monitoring



**Membrane
WFI**

- Variable production flows
- Multiple production ranges
- Electric heat sanitization

WFI generation - Sustainability key points – zoom in



Variable Production feature
from 30% to 100%

2-3% production saving on yearly
basis



High efficiency motors (IE5)

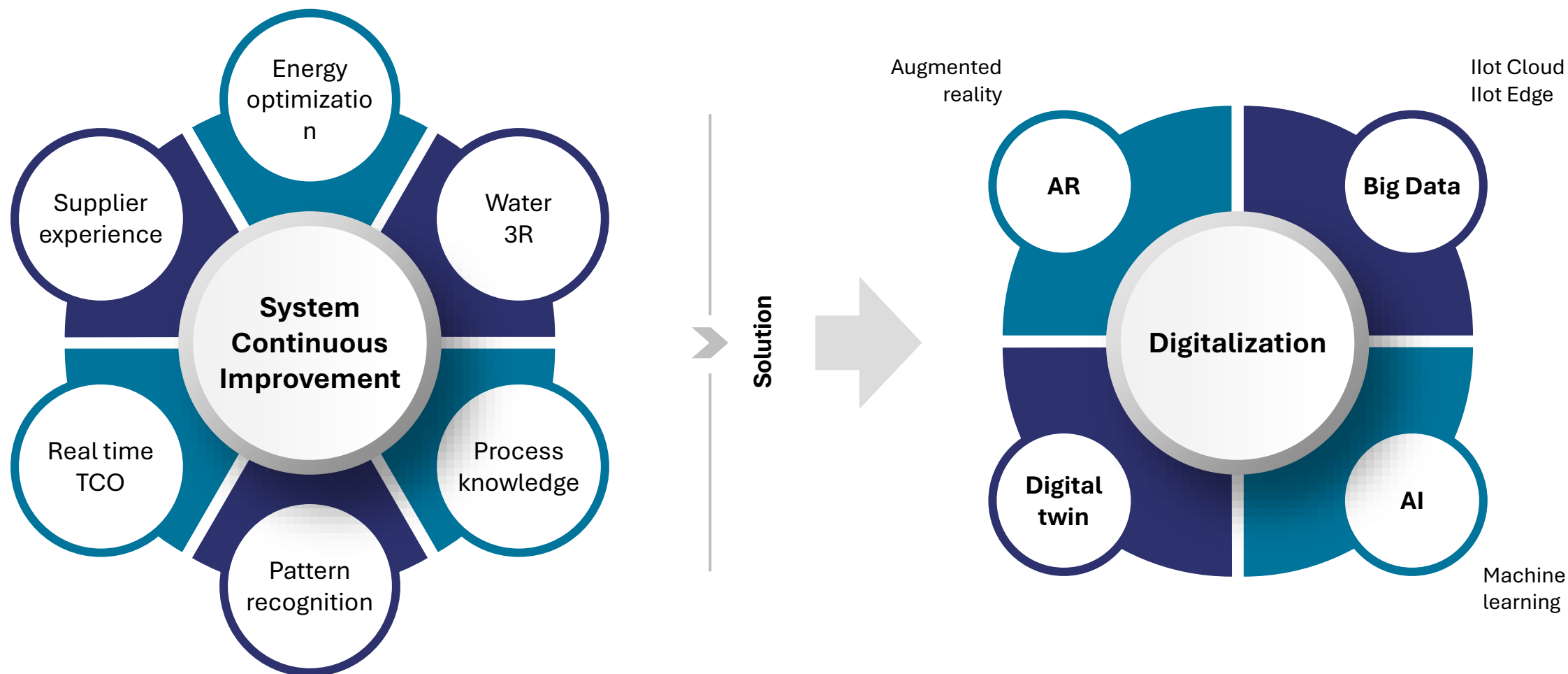
5% yearly energy recovery for
compressor and pumps

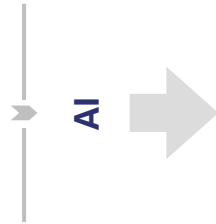
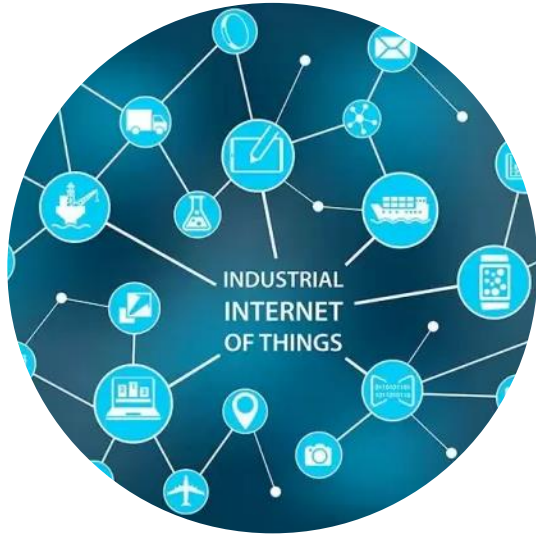
Driven by



Is that all we can do? Where's the Innovation? What Solutions?

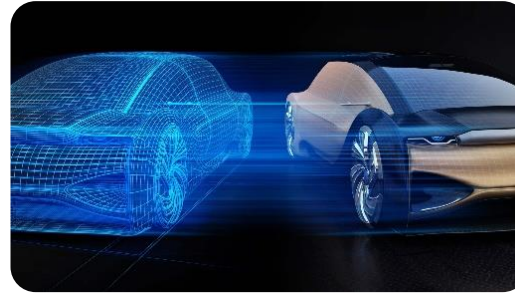
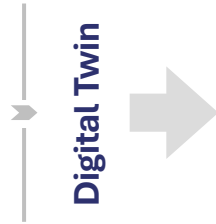




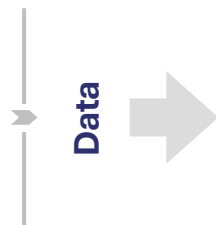


Descriptive	Diagnostic	Predictive	Prescriptive
What happened	Why it happened	What will happen	What action to take
Reactive	Preventive	Predictive	Prescriptive
Maintenance			

- Energy pack
- Consumption pattern optimization
- Process optimization



- Design optimization → no prototype
- Electronic FAT
- Production Optimization
- New Production Opportunities



- Machine recorder
- Machine analytics
- Smart notifications

New technological trends in summary



Different Megatrends are driving today the technological evolution of Clean Utility Systems

Sustainability is the main Megatrend where CO2 foot print is the first pillar.

The conscious consumption of water has the same importance, even if it is less publicised

Digitization and the relevant new generation services complete the technological evolution panorama of clean



CU are nowadays faced with an evolutionary quantum leap linked to new technologies and new solutions

New technologies are present in the panorama of CUs with great potential and expectations.

Also, existing technologies are experiencing a new youth with the introduction of new solutions that make them more efficient.



Different Megatrends are driving today the technological evolution of Clean Utility Systems

IIoT, Artificial Intelligence, Digital Twin are the most important resources in process improvement and optimization.



SUSTAINABLE

- Circular Economy
- Carbon Footprint Targets
- Environmental Responsibility



HUMAN-CENTRIC

- AI & Robotics supporting humans
- Collaborative Industry
- Operator empowerment



RESILIENT

- Ability to adapt to change
- Resistance to disruptions
- Robust, flexible architecture

- Evolution, not disruption
- *"Only a better focus — not a disruption at all."*

Use Case: energy reduction and costs savings through AI support

**Energy-Intensive Machines**

Most equipment in water facilities consumes significant energy during operation.

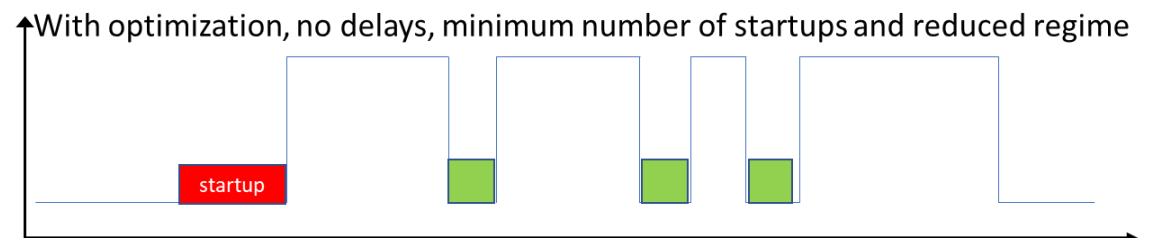
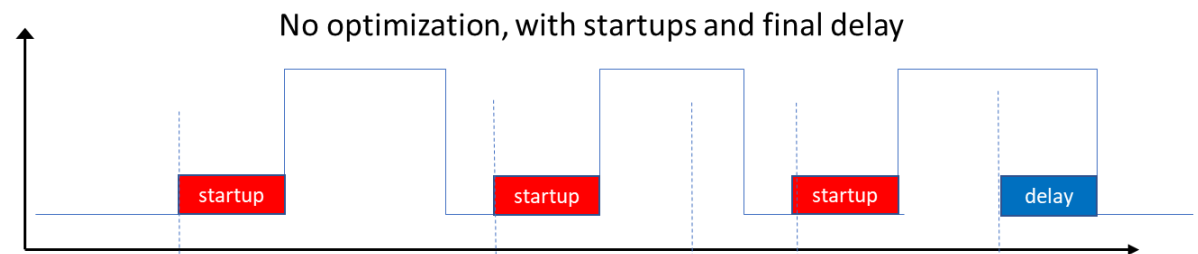
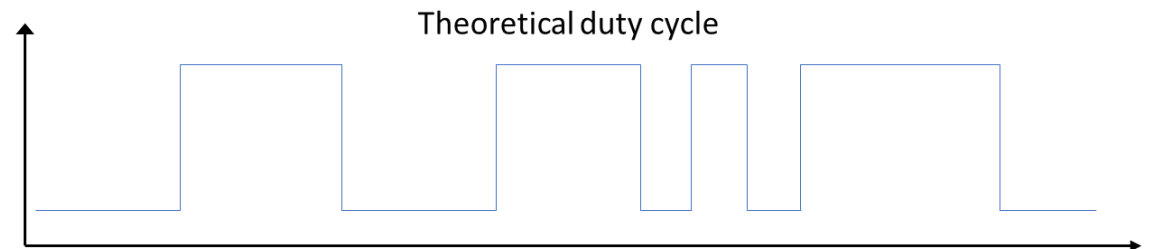
**Costly Warm-Up Cycles**

Many machines require a start-up sequence before reaching production — consuming energy without output.

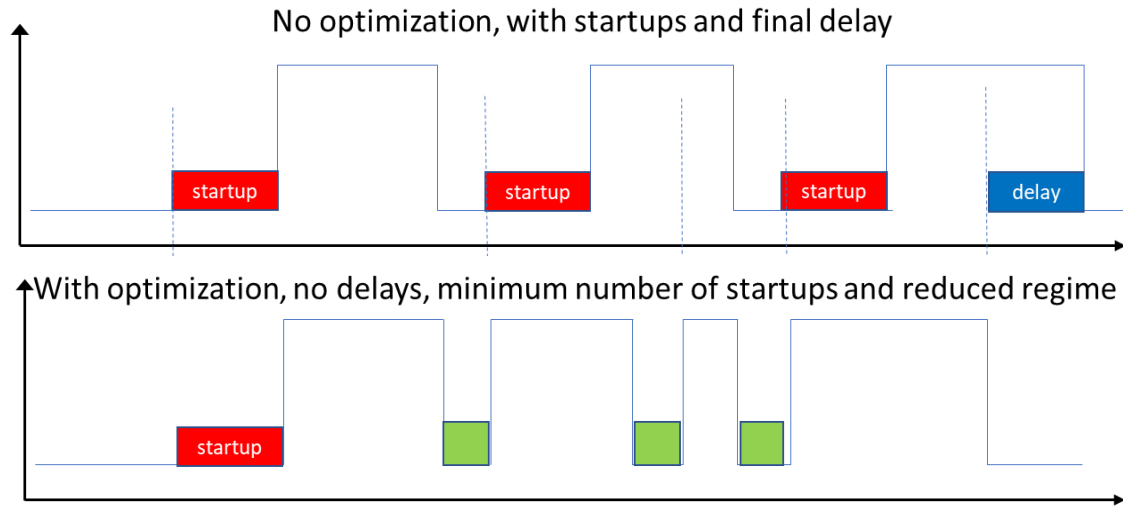
**Historical Pattern Data – Machine Learning**

Start/stop patterns have occurred many times in the past — this data is available and can be learned from.

ON TOP: Reduced Operating Regime: During the keep-on period, the operating regime can be lowered even further.



ASSUMPTIONS

**100 kWh****Start-up energy waste**

200 kW (full regime) × 30 min

5 kWh**Keep-running cost**

30 kW (reduced regime) × 10 min

BENEFITS / ADVANTAGES

∞**Production delay cost**

Not measurable

**185
kWh****Net saving per cycle**

(2×100 – 3×5) kWh



Over a 20-year TCO horizon, cumulative savings can easily reach a 6-digit figure.



AI must support, not substitute the human (looking back at the Industry 5.0...)

- Some situations cannot be easily quantified and must remain within the autonomy and responsibility of the operator.
- A preliminary evaluation of scenarios — analysing pros and cons without time pressure — must always precede the deployment of any AI-guided strategy.
- **AI proposes; humans decide.**



Saving energy is a shared responsibility — even for 1 cent

- This principle applies beyond economics.
Every kWh saved contributes to collective sustainability goals.
The same approach can be adapted to analogous situations wherever historical patterns can inform smarter operational strategies.

Digitalization - Centricity of the Data

Key Concepts

01

Existence
of the Data is
essential

02

Connection
to the data is the
next maturity step

03

Data Analytics
provides
transparency and
gives meaning to
the data
(contextualization)

04

Forecasting
through Machine-
Learning provides
added value,
learning from the
past

05

Next to come...
Agentic AI
to act
automatically,
based on data
analytics and ML



Grazie per l'attenzione

Nuova Sezione

