

# **The Impact of AI and Data Analytics in Nuclear**

NAYGN Facilitator: Mark Llewellyn

# The Impact of AI and Data Analytics in Nuclear

## NAYGN Annual Meeting

**Joan Knight – Innovation Director, Exelon**

June 3, 2019



**Exelon Generation**®

# Artificial Intelligence in Pop Culture

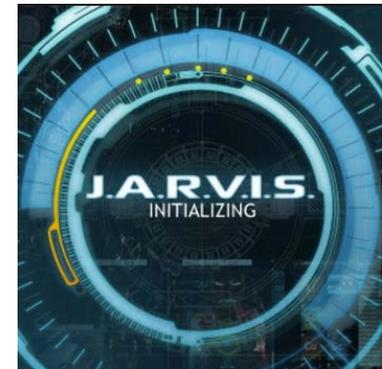
---

## What comes to mind when you hear the term 'AI'? Hollywood has an opinion...



*Stanley Kubrick brought Arthur C. Clarke's HAL9000 supercomputer to life in the 1968 classic, 2001: A Space Odyssey. It didn't work out well for the humans...*

*More Recently, Tony Stark's digital assistant, JARVIS, played a prominent role in the 2012 Marvel Universe film, Avengers: Age of Ultron, eventually becoming a physical manifestation as the conflicted Vision character.*



**The reality of today's AI capabilities is far different, but exciting and valuable nonetheless.**

# AI and Data Analytics in Today's Nuclear Industry

---

## AI in Nuclear can be broken into four general categories.

**Computer Vision** – identification of assets, people and anomalies through imaging



**Machine Learning** – use of algorithms and statistical models to perform a task *without specific instructions*



**Chat Bots** – simulation of human conversation either verbally or textually

**Natural Language Processing** – Computer processing of large amounts of data that exists only in natural language format

**Data Analytics** refers to the ability to draw insights and conclusions from raw data. It relates to AI in the sense that these insights can then be utilized to feed **Machine Learning** algorithms.

## Computer Vision - Example

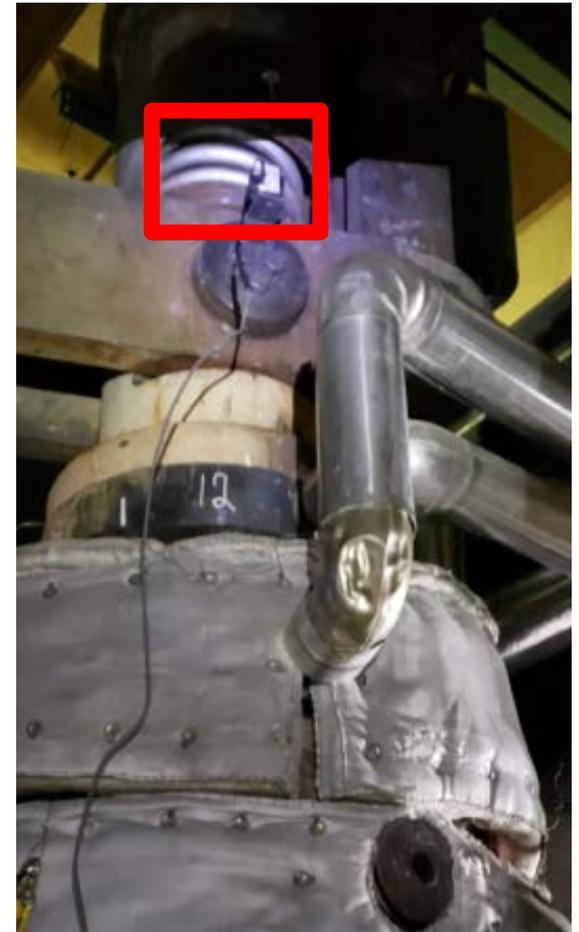
---

**Question: How might we closely monitor the relative performance of a turbine steam control valve when...**

the valve has no installed position indication and the valve stem is covered by insulation and the valve travel is only 2.5 inches and the valve is in a high dose area?

**Answer: We might...**

install a camera with a view of the closing spring and establish a boundary box around the spring develop a custom algorithm to let us know when the performance of this valve (based on minute variations in spring position) differs from the norm.



## Example – Machine Learning / Data Analytics

**Question: How might we utilize Data Analytics to drive better decision-making by...**

leveraging all data sources

moving from a reactive to a proactive stance

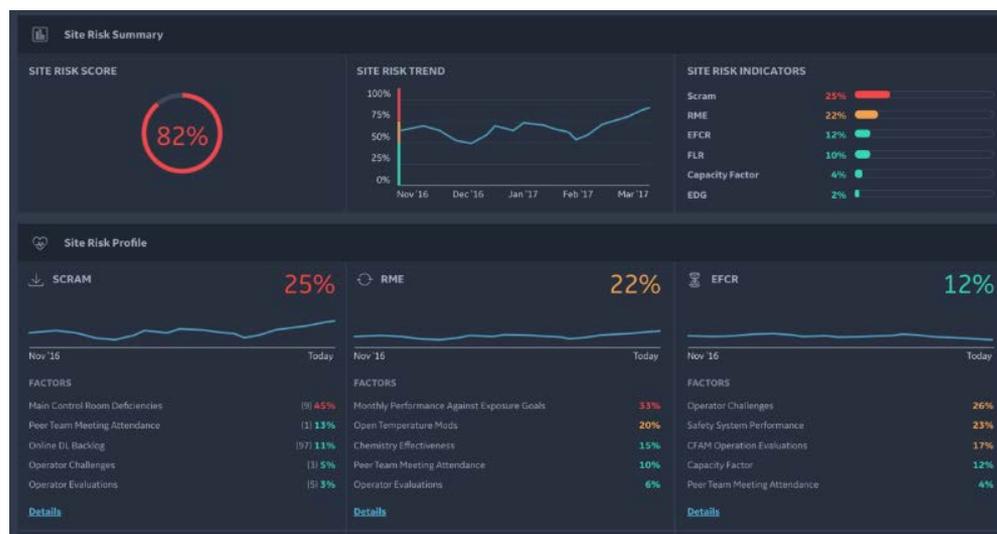
suggesting solutions to curb adverse trends

**Answer: we might ...**

identify symptomatic indicators & organizational behaviors correlated with early signs of performance decline

develop analytical models to predict performance challenges fleet-wide

Provide insights into mitigation strategies for identified risks



# Current Applications in Nuclear

---

Analytics are currently being applied and are bringing REAL value to the business

- Proactive predictions of equipment performance via use of historical on-line monitoring data
- Optimization of equipment maintenance frequencies based on historical maintenance and performance data
- Extension of equipment maintenance frequencies based on expected plant life/de-commissioning
- Proactive predictions of maintenance resource challenges based on current and historical resource allocations
- Proactive predictions of potential outage schedule delays through use of historical outage schedule performance data

Value:

Reductions in:

- Maintenance resources
- Maintenance material costs
- Unexpected station trips and down-powers
- Unexpected outage and startup delays



# AI and Data Analytics in Tomorrow's Nuclear Industry

---

We are just starting to scratch the surface. Imagine...



A wearable, **computer vision** system that can identify a component and provide real-time data to the wearer through an augmented reality interface.

A **chat bot** that can engage employees in real time and provide context-sensitive instruction and coaching.

A **machine learning** algorithm that can take process **data analytics** and provide suggestions for process optimizations.

A **natural language processing** AI that can review thousands of pages of corrective action program data and generate new trends and insights into equipment and human performance.

**The possibilities are both numerous and exciting!**

# Connected Solutions

Predict Performance | Prolong Asset Life | Optimize Total Cost of Operations

**XENIA MASTROPETROU, ECOLAB INC.**

June 2019

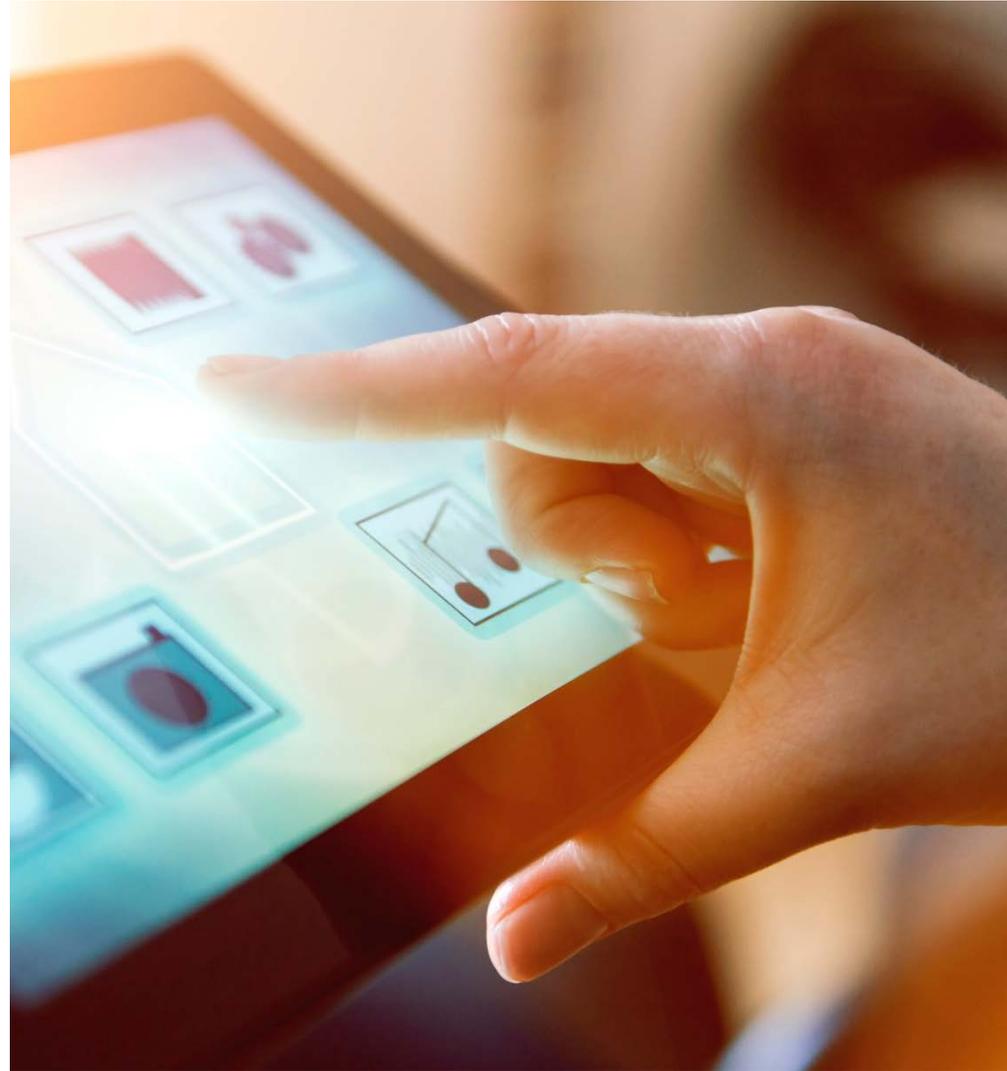
**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company

# What is the Internet of Things?

---

A development of the Internet in which everyday objects have network connectivity, allowing them to collect and exchange data.

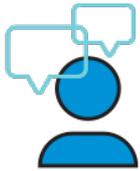




# Google



# 2020



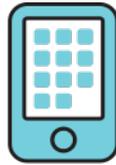
**4 Billion**

Connected  
People



**\$4 Trillion**

Revenue  
Opportunity



**25+ Million**

Apps



**25+ Billion**

Embedded and  
Intelligent Systems



**50 Trillion**

GBs of Data

Source credit: Mario Morales, IDC

70%

of potential IoT  
value is in B2B  
applications

35%

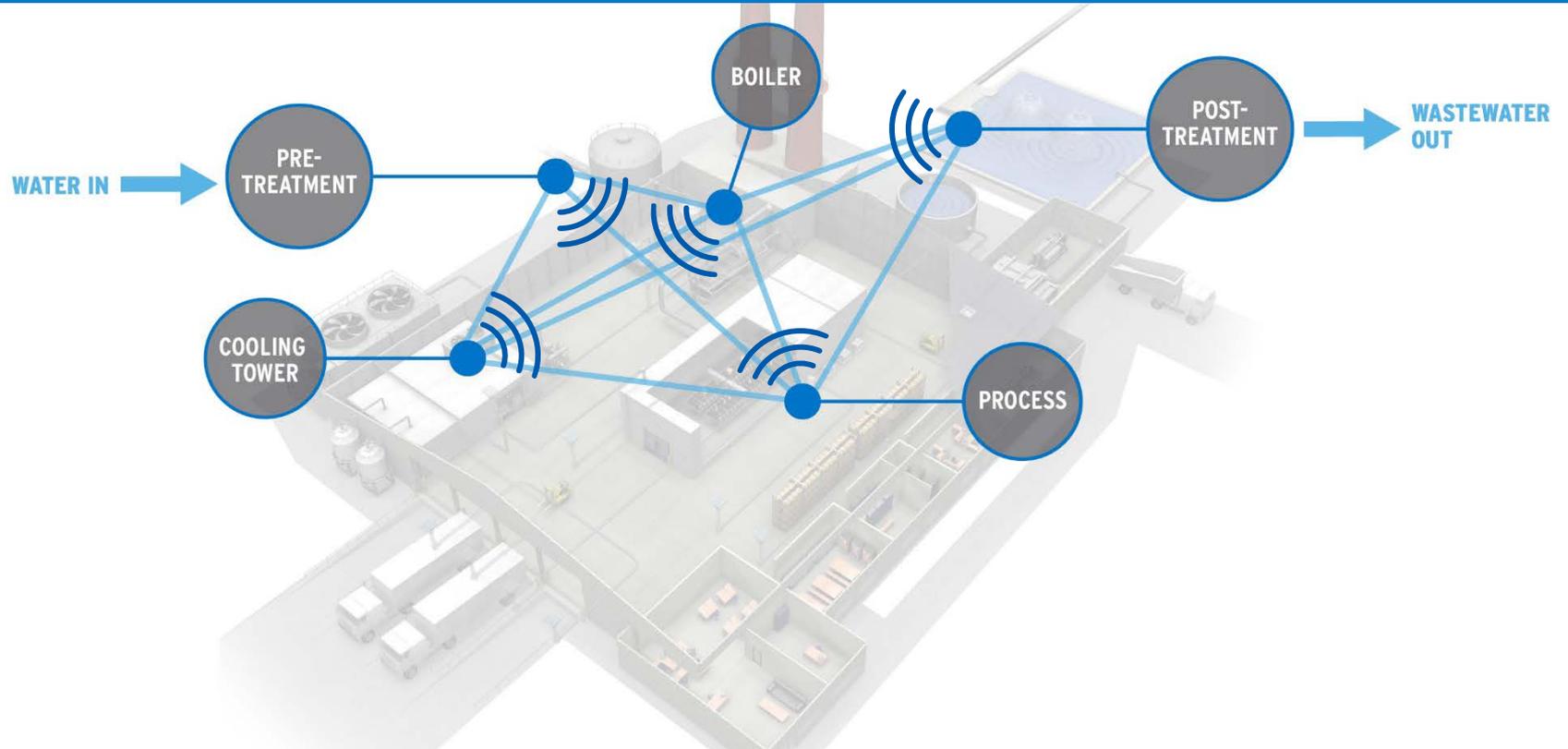
of manufacturers  
use smart sensors

10-20%

of IoT value is in  
Utility Savings and  
Labor Efficiency

Source credit: McKinsey Global Institute, 2015

# Plants that Reuse 100% Water



# This is what we do at Ecolab.



Energy  
Services



Mining



Industrial Water  
Services



Food and  
Beverage



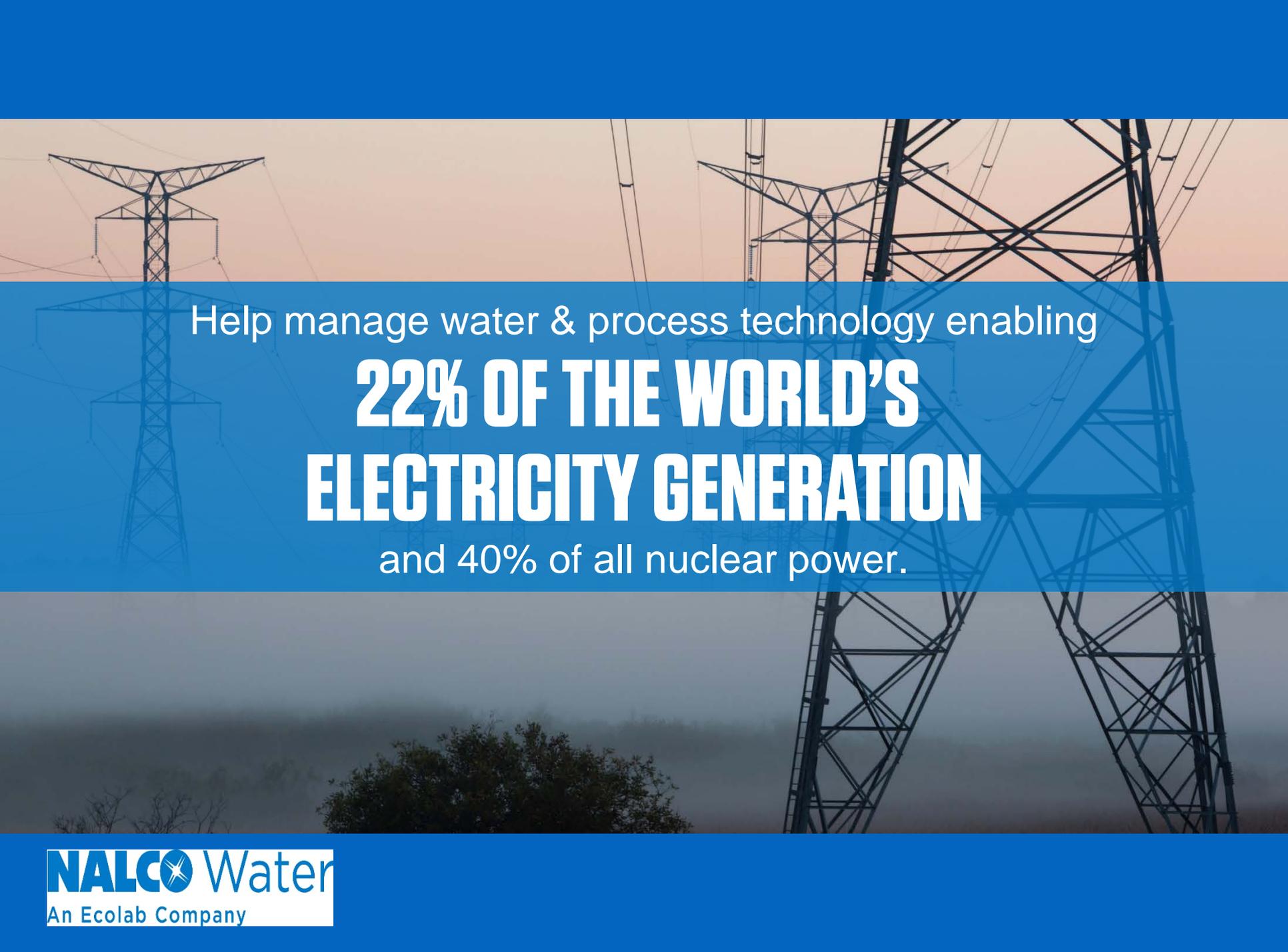
Healthcare



Retail



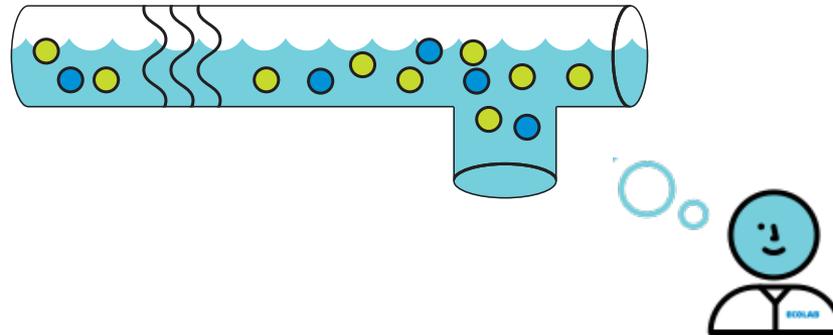
Hospitality



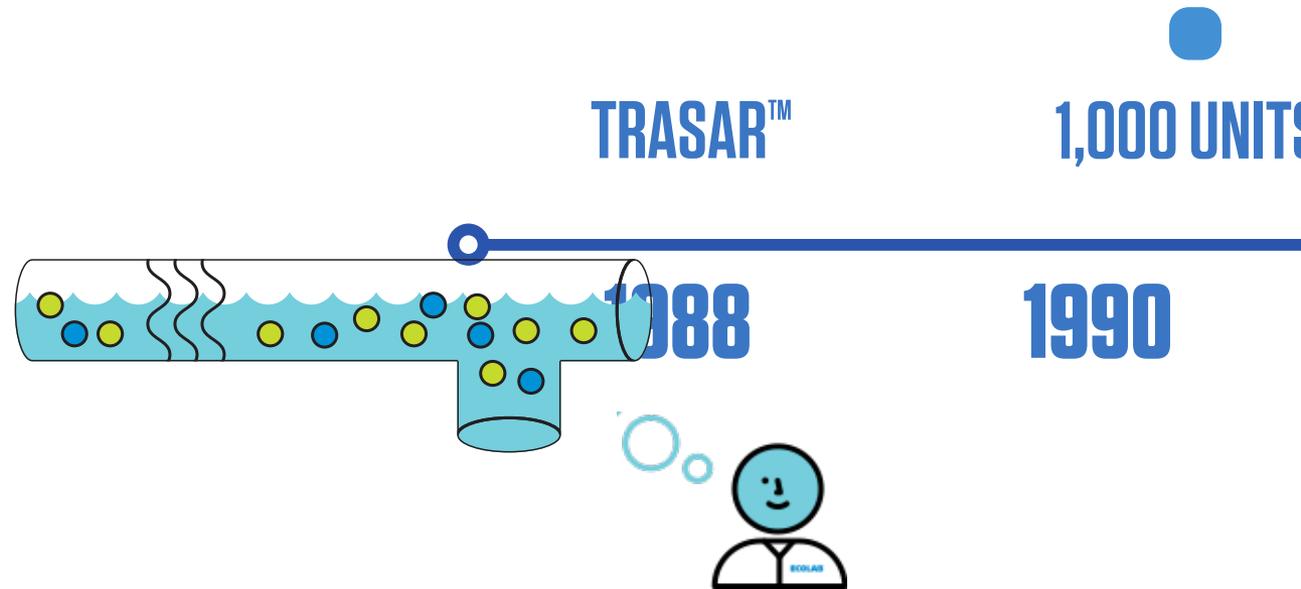
Help manage water & process technology enabling  
**22% OF THE WORLD'S  
ELECTRICITY GENERATION**  
and 40% of all nuclear power.

Help manage  
**1.1 TRILLION GALLONS OF WATER.**

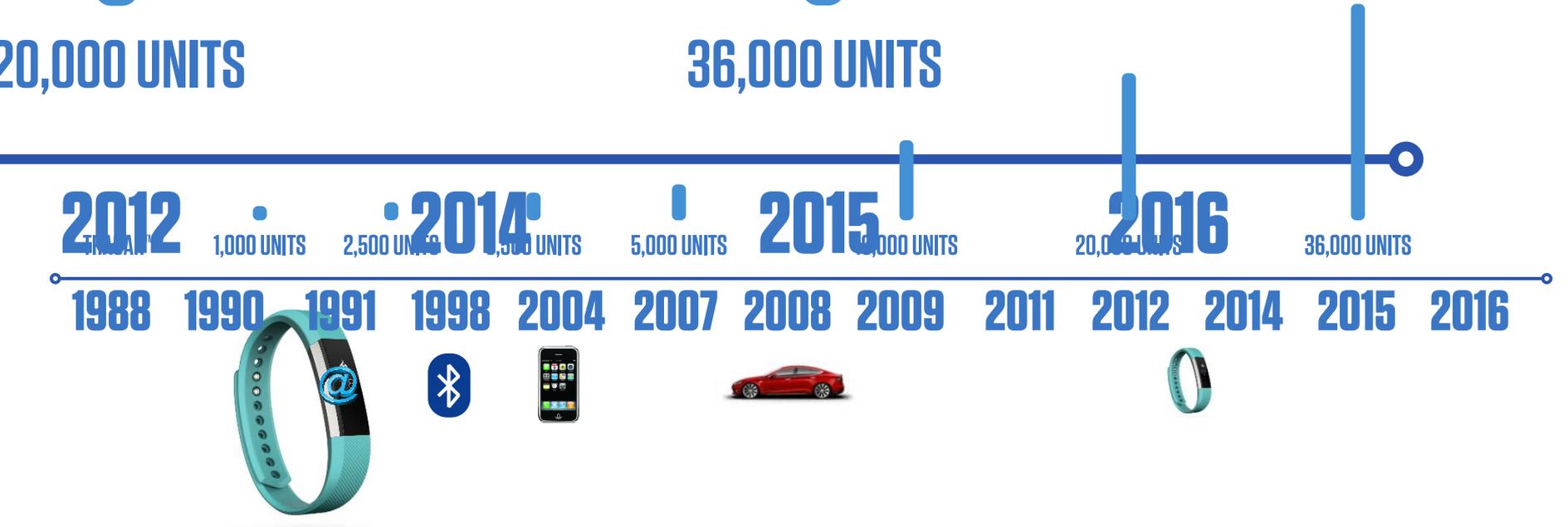
# Pioneering connected technology for nearly 30 years



# Pioneering connected technology for nearly 30 years

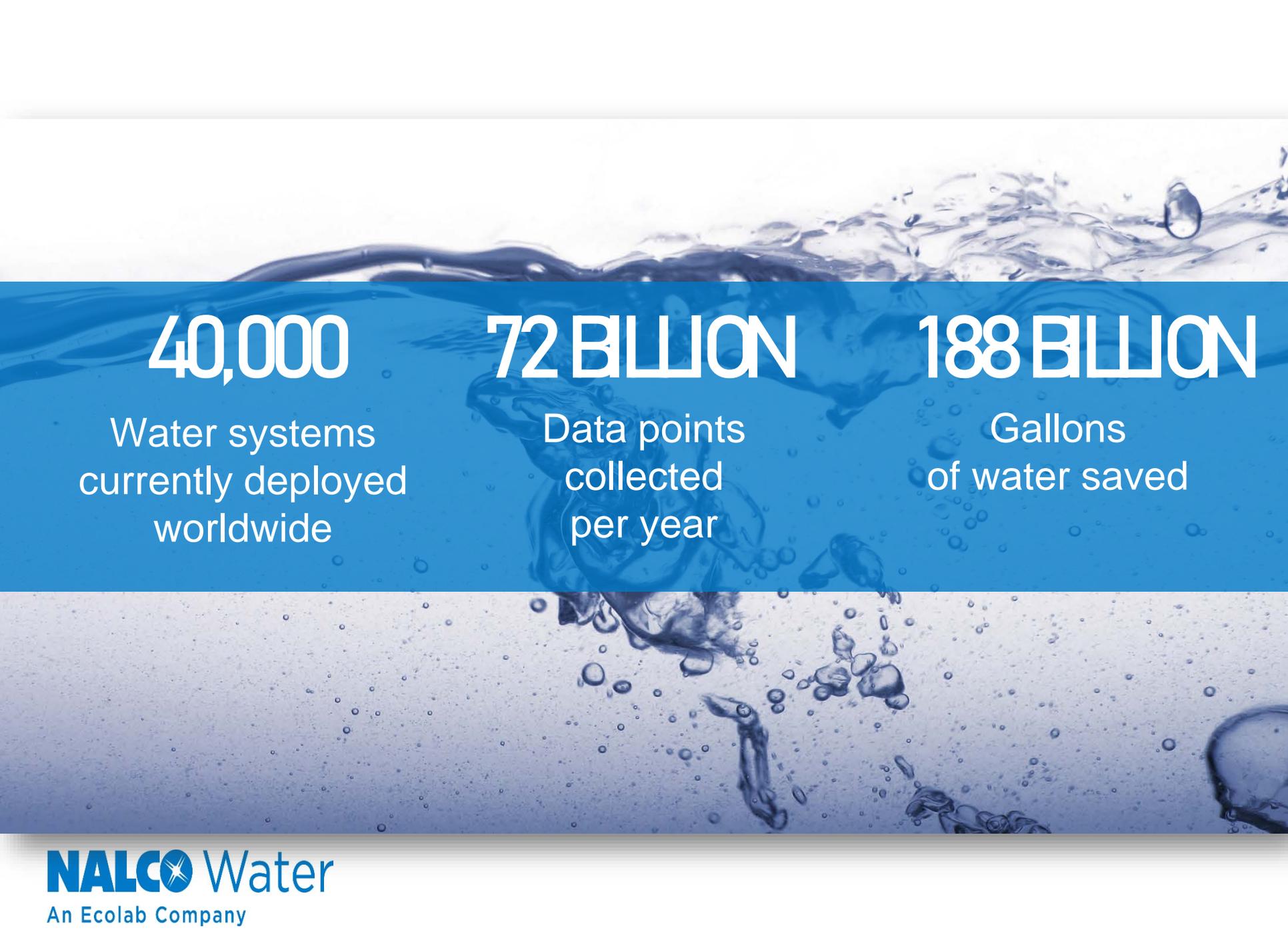


# Pioneering connected technology for nearly 30 years



# How it Works from Pipes to People





**40,000**

Water systems  
currently deployed  
worldwide

**72 BILLION**

Data points  
collected  
per year

**188 BILLION**

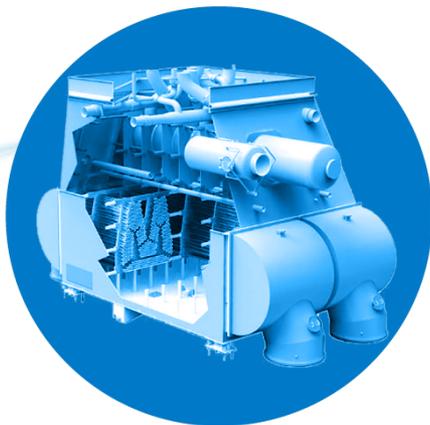
Gallons  
of water saved

**Data is like oil.**



# SURFACE CONDENSERS

are the heart of your  
**production efficiency**



Keeping the CONDENSER at  
**design performance:**



**minimizes**  
fuel costs &  
environmental impact

&



**maximizes**  
profitability

**1"** of increased  
condenser  
backpressure

**1%** increase in  
energy use  
for combined  
cycle plants

**\$700K**  
per year in  
fuel cost  
savings

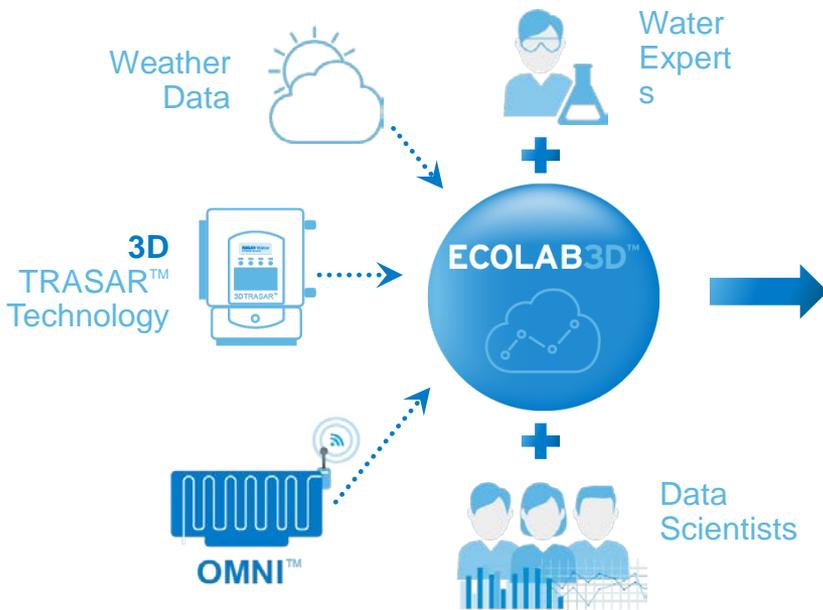
**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company

# OMNI™ CONDENSER PERFORMANCE

Combining chemistry, automation, sensors & data analytics

# OMNI Analytics



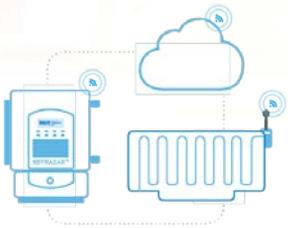
This section displays three key metrics and their resulting outcomes. Each metric is represented by an icon and a label: 'PROFITABILITY' (upward arrow and grid icon), 'PRODUCTIVITY' (upward arrow and clock icon), and 'COSTS' (downward arrow and downward arrow icon). Below these, three light blue boxes list the outcomes: 'Predict performance of critical assets', 'Prevent unscheduled downtime & lost production', and 'Prolong asset life & production runtime'.

**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company

# SUCCESS IMPERATIVES

# OMNI Analytics



Real-time  
Monitoring



Secure  
Networks



Predictive  
Analytics



24/7  
Response



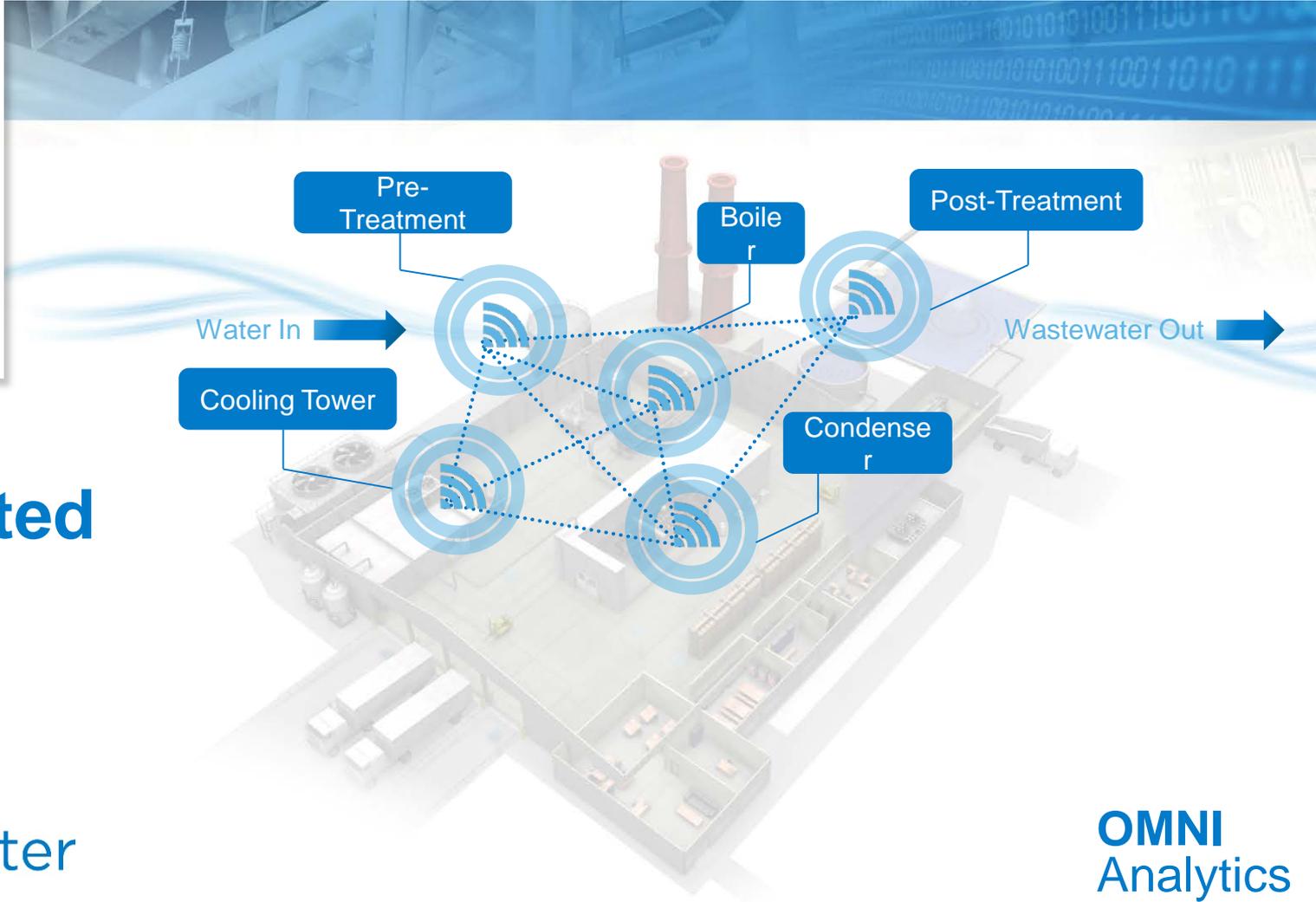
On-site  
Expertise

**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company



Real-time  
Monitoring



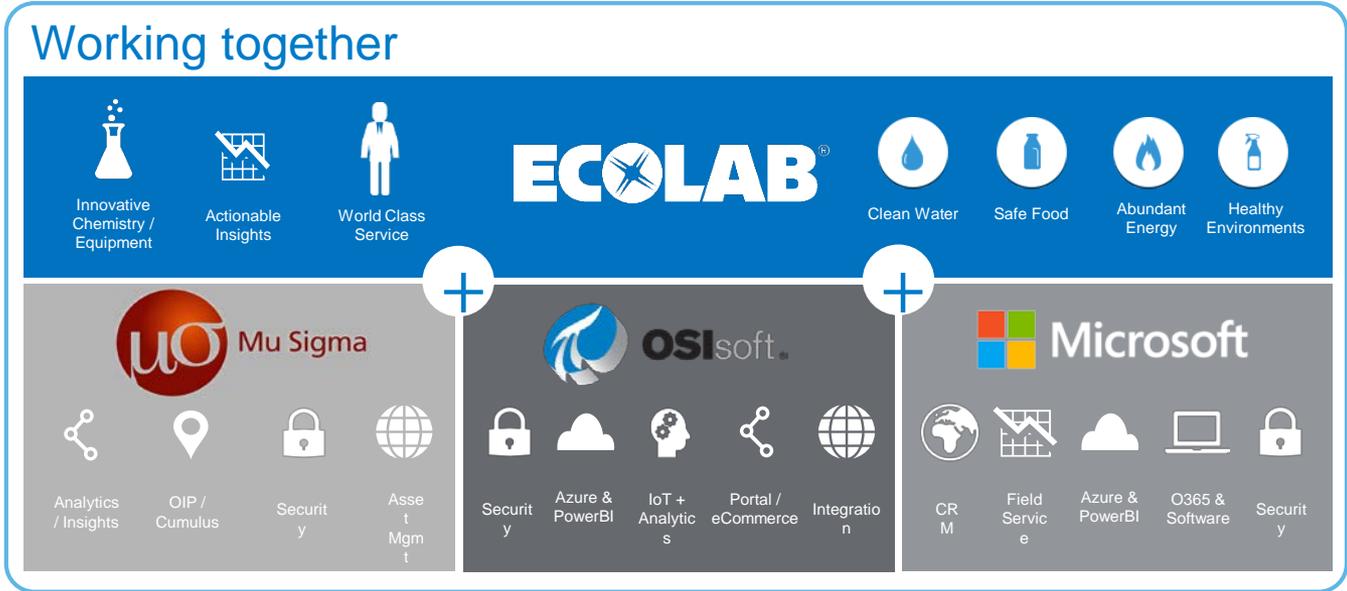
# Connected Power

Leads to Reliable  
High Performance

**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company

**OMNI**  
Analytics



Built through a partnership

of global leaders

to deliver secure, intelligent and scalable solutions to minimize water, maximize results and optimize total cost of operations

**NALCO Water**  
An Ecolab Company

**NALCO Water**  
An Ecolab Company

**OMNI Analytics**



Predictive  
Analytics

# OMNI Analytics

## Predictive Indication of:

Scaling Conditions

Microbial Fouling

## Identification of:

Air Inleakage

Macrofouling

Tube Leaks

Misc Issues:

Low CW Flow

- Sensor Error
- Operational Limits
- Rapid Trend Changes
- Design Limits

High CW Temp

**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company

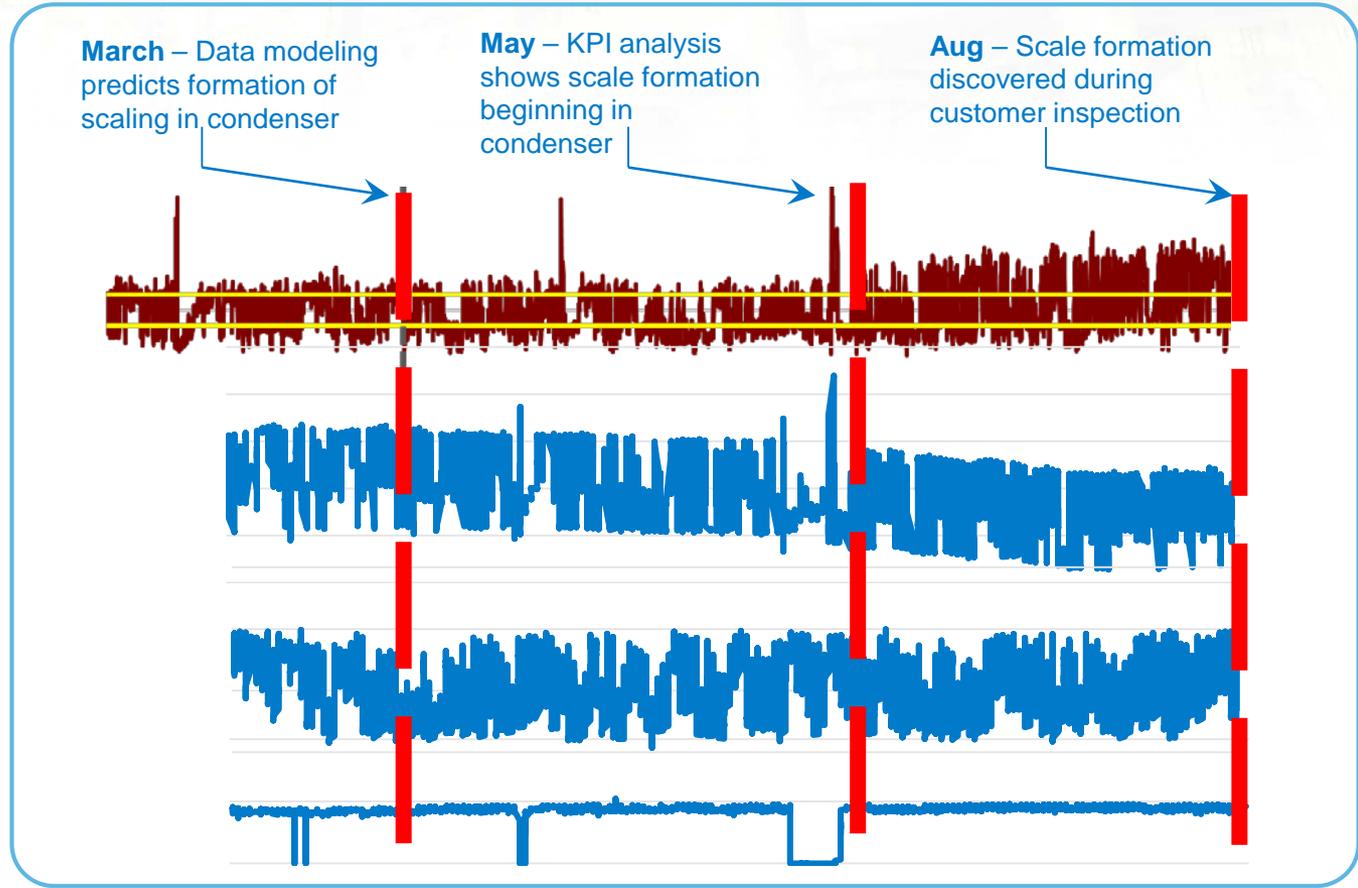


Predictive Analytics

# Predicting Scaling

**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company





24/7  
Response

Site Performance  
Enterprise Performance  
Value Delivered



# ECOLAB3D Digital Platform

**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company

**OMNI**  
Analytics



On-site  
Expertise

# The AI + Human Factor

Technology can bring  
“**personalized service**” to  
a whole new level

- Technology “**does the work**”
- The human being provides “**essential expertise**”



**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company

**OMNI**  
Analytics

# OUTCOMES

## 2 Unit Nuclear Power Plant

- Uses brackish water for once through condenser cooling
- OMNI identified inlet tube sheet fouling leading to higher temperature rise and backpressure on the condenser



Reduced labor costs for cleaning

**\$100,000**



**\$3M** Generating revenue restored



Reduced costs to mitigate reactivity control risks

**NALCO** Water  
An Ecolab Company

**NALCO** Water  
An Ecolab Company

**OMNI**  
Analytics

---

# THANK YOU!

**XENIA MASTROPETROU**

XENIA.MASTROPETROU@ECOLAB.COM

---



**Questions?**