

DESALINATION STRATEGIES



THE URGENCY OF DESALINATION MOBILIZATION TO ADDRESS DROUGHT AND FIRES IN THE WESTERN STATES

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SUMMARY



- HISTORICAL EVOLUTION OF MEMBRANE DESALINATION INNOVATION
 - BRACKISH WATER DESALTING (BWRO)
 - SEAWATER (SWRO)
 - WASTEWATER RECLAMATION (WWRO)
 - 1977 THE PIVOTAL YEAR
- DIVERSIFIED DESALINATION SOLUTIONS
- SUSTAINABLE DESALINATION INNOVATIONS – DROUGHT PROOFING AND QUALITY OF LIFE ENHANCEMENT

DESALINATION - HISTORICAL EVOLUTION



- Membrane Desalination developed in the USA
- Two Disruptive Innovations patented with the aid of the US Government:
 - The spiral-wound element in 1964
 - TFC polyamide membrane in 1979

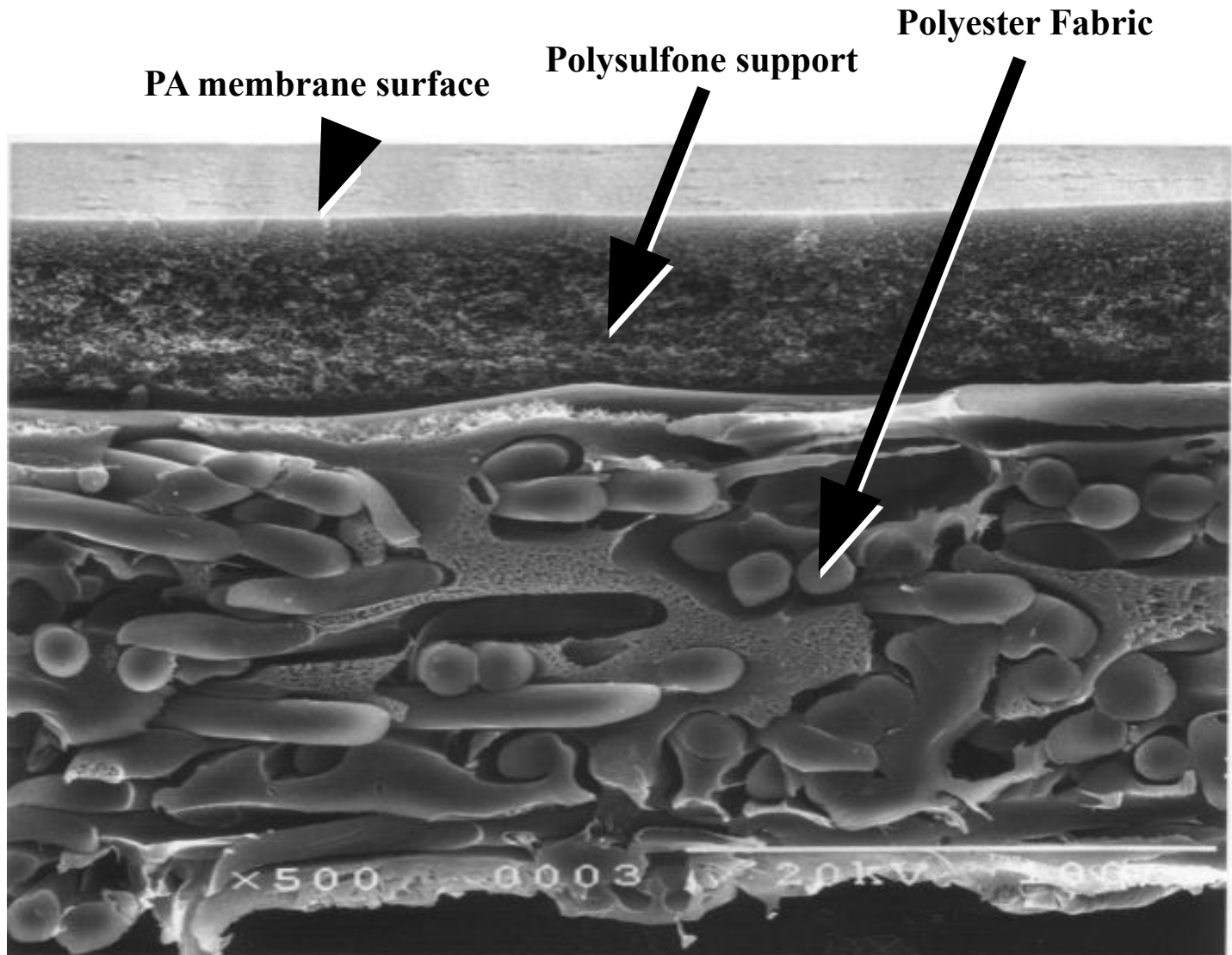
Today 99% of all desalination Membranes installed around the world use these two innovations

SPIRAL-WOUND ELEMENT DESIGN



First spiral-wound element developed in 1964 at General Atomic Company San Diego, CA.

THIN FILM COMPOSITE POLYAMIDE MEMBRANE



TYPICAL SWRO DESALINATORS



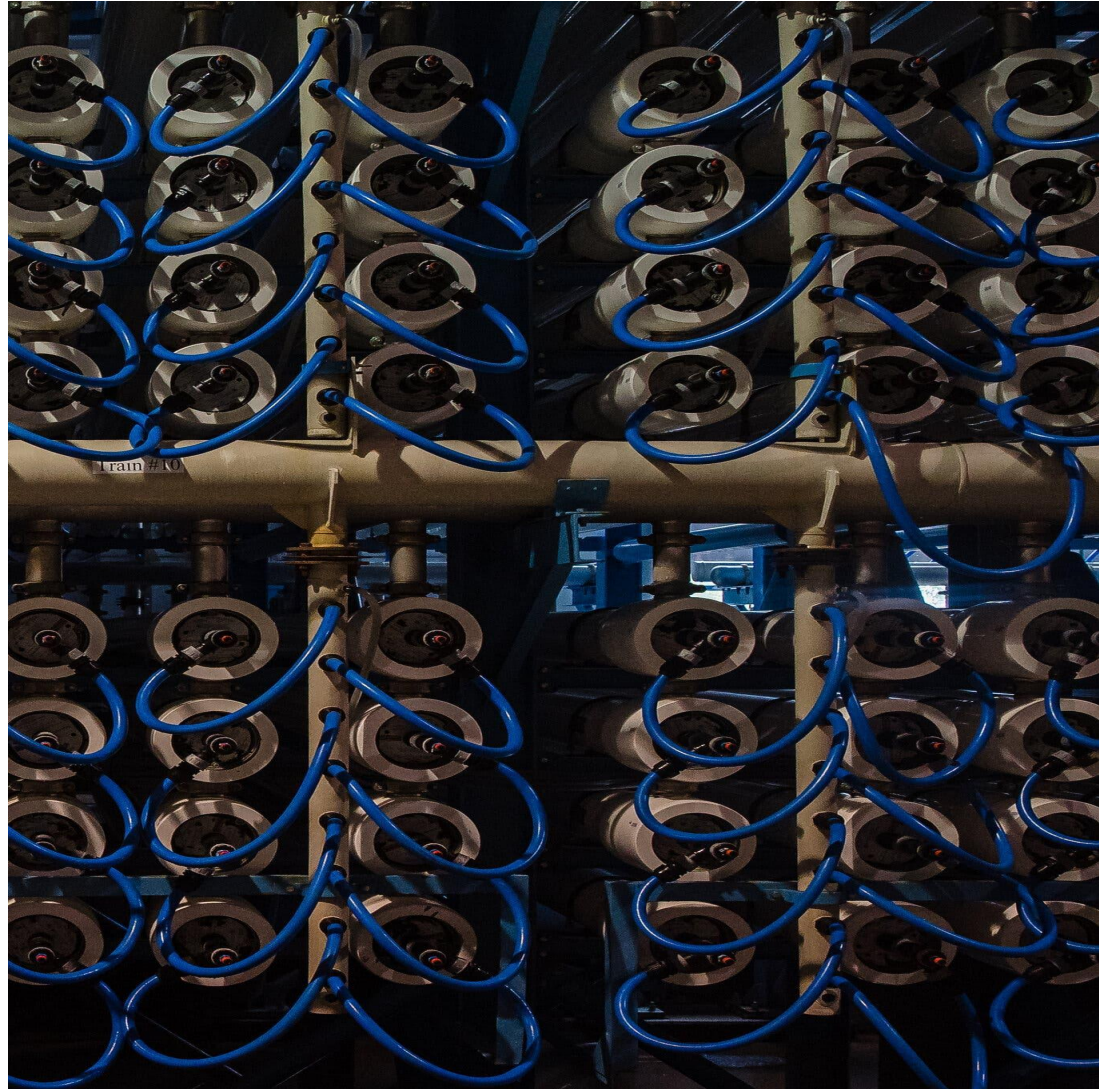
Hadera



Ashkelon



CARLSBAD CA 50 MGD DESALINATION SYSTEM



OCWD WWRO RECLAMATION DESALINATOR - FIRST INSTALLATION 1977



GLOBAL GROWTH IN MEMBRANE DESALINATION



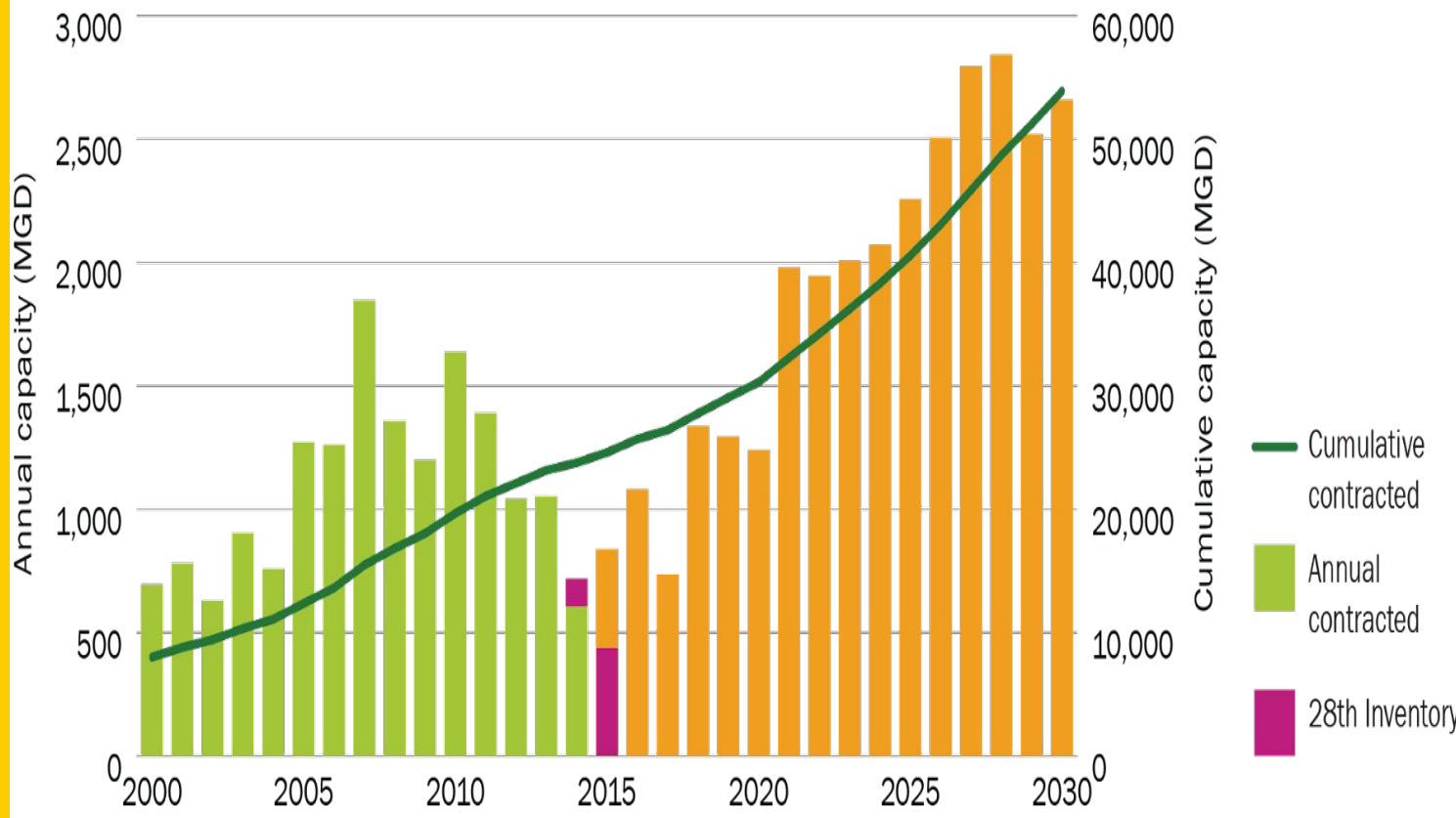
NEW CONTRACTS FOR RO TECHNOLOGY-GLOBALLY

2015--528 MGD SEAWATER (SWRO)
--264 MGD BRACKISH AND
WASTEWATER (BWRO WWRO)

2019--2.1 BGD SEAWATER (SWRO)
--438 MGD BRACKISH AND
WASTEWATER (BWRO WWRO)

SEAWATER RO GROWING 21% PER YEAR

GROWTH - MEMBRANE PROCESSES (8% CAGR)



1977 - PIVOTAL YEAR FOR MEMBRANE DESALINATION



- FIRST LARGE SWRO
DESALINATION SYSTEM - 2.3 MGD
– KINGDOM OF SAUDI ARABIA
- FIRST LARGE WASTEWATER
RECLAMATION SYSTEM - 5 MGD
– ORANGE COUNTY WATER DISTRICT
- WORLD'S LARGEST DESALINATION
SYSTEM OF ANY TYPE - 108 MGD
– YUMA DESALTING PLANT

DIVERSIFIED DESALINATION SOLUTIONS



- SINGAPORE STAKEHOLDERS APPLY DIVERSIFIED DESALINATION - SWRO AND WWRO
 - MEGA PLANTS INSTALLED THROUGHOUT THE ISLAND
- AUSTRALIA USES DIVERSIFIED SOLUTIONS IN RESPONSE TO REPEATED DROUGHT CYCLES

DIVERSIFIED DESALINATION SOLUTIONS - SAN DIEGO, CA



- *NEW YORK TIMES ARTICLE, OCTOBER 2021*
 - SAN DIEGO HISTORICALLY RELIED ON IMPORTED WATER FROM COLORADO RIVER (CRA) AND THE STATE WATER PROJECT (SWP)
 - ALONG WITH AN AGGRESSIVE PROGRAM OF CONSERVATION AND RECYCLING FOR LANDSCAPE, SAN DIEGO ADDED BWRO, SWRO, AND SOON WWRO
 - THIS DIVERSIFIED APPROACH IS GIVING SAN DIEGO A SUSTAINABLE DROUGHT-PROOF RELIABLE WATER SUPPLY

DESALINATION CONCERNS



- ENERGY CONSUMPTION IS TOO HIGH
- ENVIRONMENTAL IMPACT
 - SEAWATER INTAKE KILLS PLANKTON
 - HIGH SALINITY BRINE DISCHARGE DAMAGES OCEAN FLORA AND FAUNA
- SOCIAL CONCERNS
 - ONLY WEALTHY CAN AFFORD DESAL
 - DESAL PLANTS MAY DISPLACE LOW INCOME FAMILIES FROM BEACH COMMUNITIES

INNOVATIVE SOLUTIONS



- ***THE CLIMATE CHANGES AND SO DOES DESALINATION***
- ALTERNATIVE ENERGY
 - SOLAR, WIND AND SUBSURFACE
- ENERGY EFFICIENCY
 - 50% REDUCTION SINCE 1977
- CHANGING DESALINATION
 - COST REDUCTION (*FROM 1977 TO PRESENT IMPROVEMENTS HAVE RESULTED IN 1000-FOLD VALUE ENHANCEMENT*)
 - MEMBRANE IMPROVEMENTS
 - OPERATING IMPROVEMENTS

OPERATING INNOVATIONS - EXAMPLE



- ***SYNAUTA***
- NEW COMPANY
- GLOBAL WATER INTELLIGENCE WINNER
– WATER TECHNOLOGY IDOL 2020
AWARD
- SOFTWARE MONITORING AND
SUPERVISED MACHINE LEARNING
ALGORITHMS COMBINE TO LOWER
ENERGY COST OF DESALINATION

Synauta's solution



Optimize

Optimization software saves energy for water utilities



Easy to use

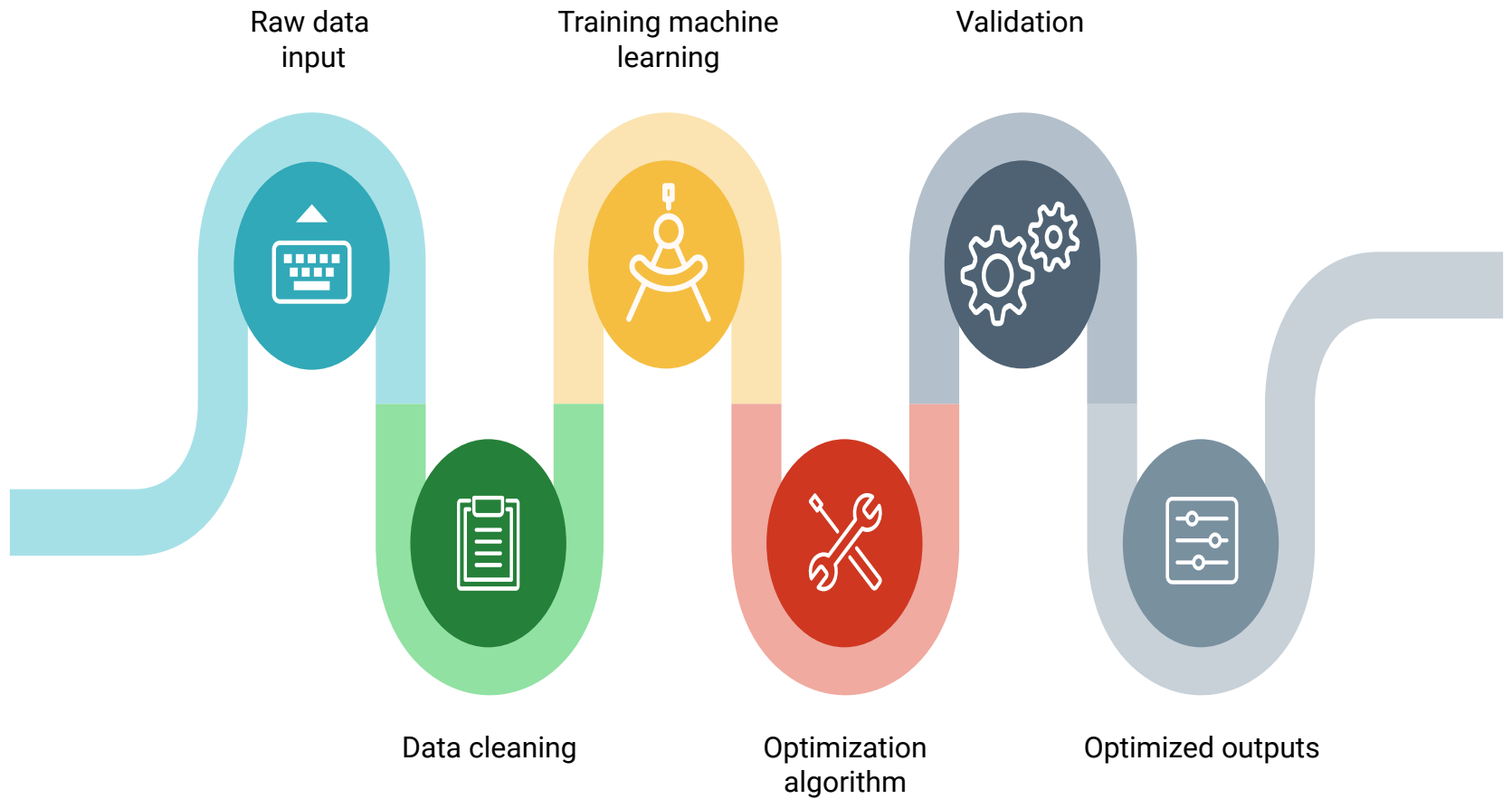
Automatically adjusts plant operating conditions to match design



Secure

Designed to protect operations against software errors and cyber attack

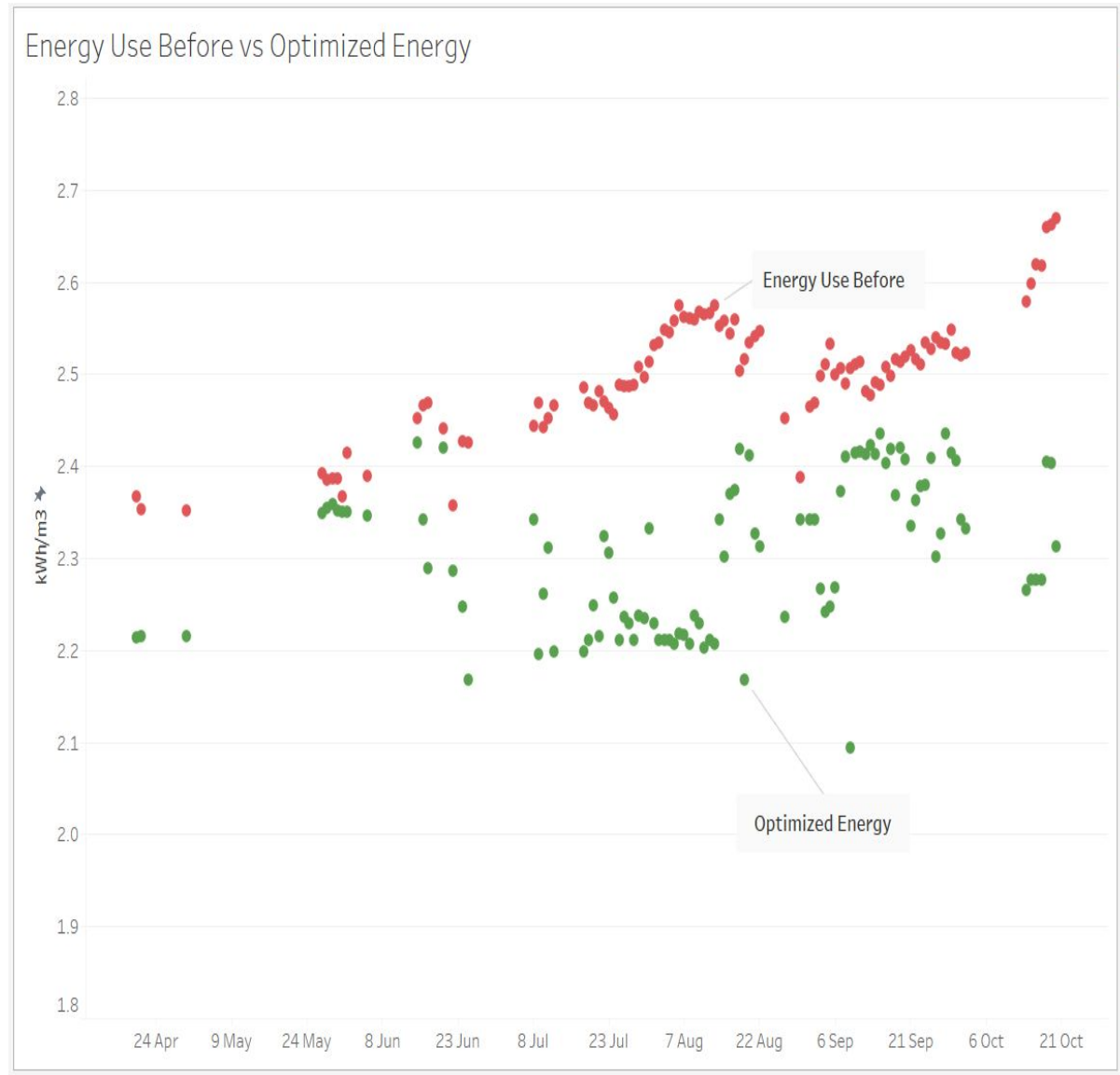
How it works: supervised machine learning



Phase 1: Example output

Graph with energy efficiency

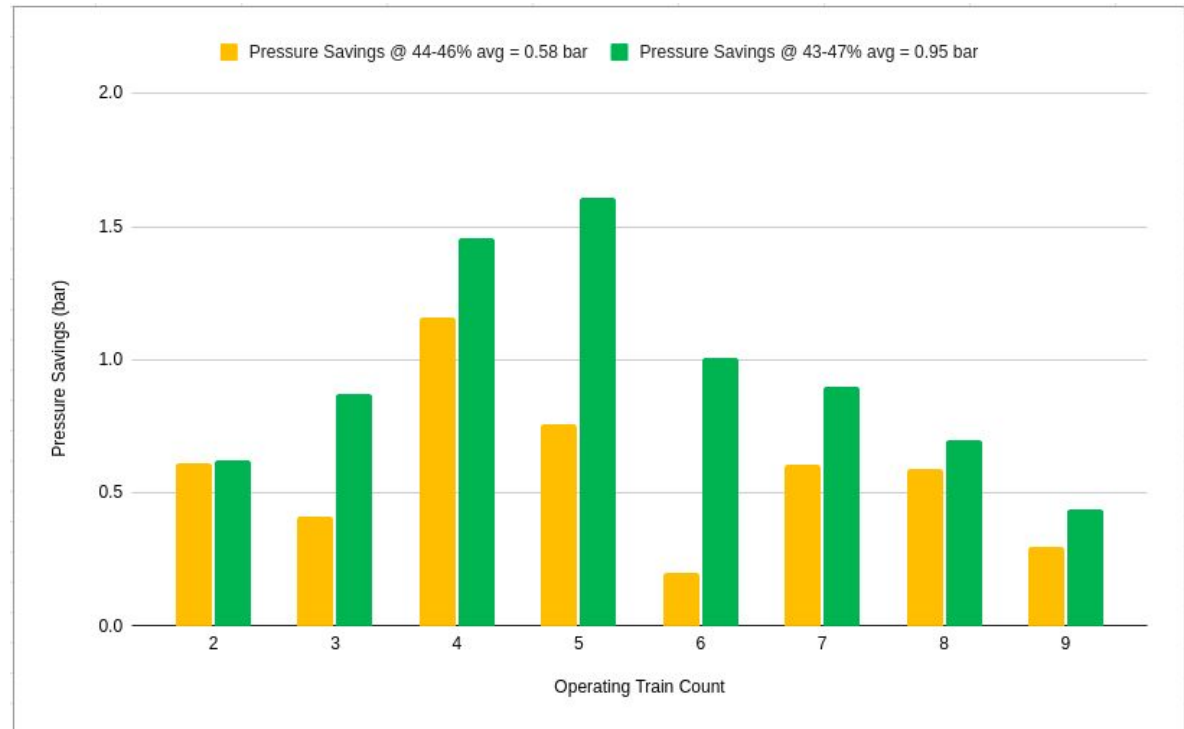
Example: Energy per day at
4,000 m³/day industrial
SWRO system



Large Desal Plant Historical Audit Results

Feb 2019 - Feb 2021

- 0.4 - 1.2 bar savings for tighter recovery range
- 0.55 - 2.0 bar for extended range
- Up to 2 bar savings with wider recovery range, 50% more savings on average



SYNAUTA – IMPACT ON A SINGLE 300,000 M³/DAY SWRO



- IMPROVED PLANT OPERATION CAN REALISTICALLY REDUCE ENERGY CONSUMPTION BY AS MUCH AS 10%
- THAT WOULD BE EQUIVALENT TO REMOVING 13,000 TONNES OF CARBON DIOXIDE
-OR-
- TAKING 4546 CARS OFF THE ROAD
(CALCULATIONS BASED ON \$0.15/kWh AND 2.5 kWh/M³)

CONCLUSION



- DESALINATION IS A TOOL THAT HAS CHANGED AND IMPROVED OVER THE LAST 50 YEARS
- DESALINATION OFFERS A DIVERSIFIED BENEFIT TO WATER STAKEHOLDERS
- DESALINATION CAN BE PART OF A SUSTAINABLE, RELIABLE WATER SUPPLY ENHANCING THE QUALITY OF LIFE INCLUDING COMBATING WILDFIRES AND DROUGHT