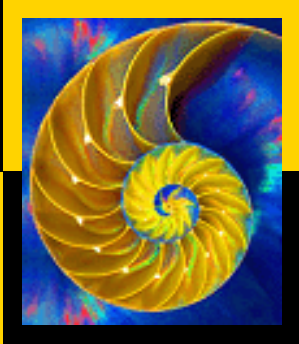


SUSTAINABLE DESALINATION



**SEAWATER REVERSE OSMOSIS
DESALINATION (SWRO)
AND
WASTEWATER RECLAIM
DESALINATION (WWRO)**

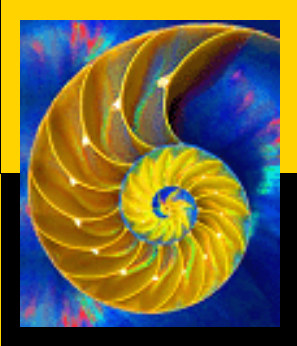
**A SOLUTION FOR SEA LEVEL
DEFENSE AND WATER
SUPPLY WITHOUT USING
FOSSIL FUELS**



SUMMARY

- INCREASING SEA LEVEL PROVIDES NEW OPPORTUNITY FOR DESALINATION PLANT UTILIZATION AND PLANT SITING
- ALTERNATIVE ENERGY CAN SUSTAINABLY DRIVE DESALINATORS
- ALTERNATIVE ENERGY DESALINATORS RECLAIM WASTEWATER
- DESALINATED WATER (SWRO OR WWRO) CAN BE STORED IN RESEVOIRS AND USED TO CREATE HYDROELECTRIC POWER

LEGISLATIVE ANALYST OFFICE (LAO) CA REPORT AUGUST 2020



- SEA LEVEL RISE (SLR) COULD COST \$8 - \$10 BILLION IN CA BY 2030
- BY 2100 SLR COULD REACH 7 FEET
- STORM SURGE, KING TIDES AND EL NINO EVENTS COULD INCREASE SLR SIGNIFICANTLY



DESALINATION GROWTH

- GLOBAL WATER DEMAND HAS RESULTED IN RAPID GROWTH OF DESALINATION
- GLOBAL POPULATION GROWTH DRIVES DEMAND
- GROWTH HAS DUAL IMPACT OF INCREASED WATER CONSUMPTION AND WASTEWATER POLLUTION

GLOBAL GROWTH IN RO DESALINATION



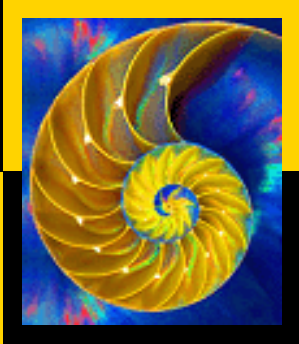
NEW CONTRACTS FOR RO TECHNOLOGY- GLOBALLY

2015--528 MGD SEAWATER (SWRO)
--264 MGD BRACKISH WATER (BWRO)

2019--2.1 BGD SEAWATER (SWRO)
--264 MGD BRACKISH WATER (BWRO)

SEAWATER RO GROWING 40% PER YEAR

TYPICAL SWRO DESALINATORS



Hadera



Ashkelon



SWRO DESALINATION CONCERNS



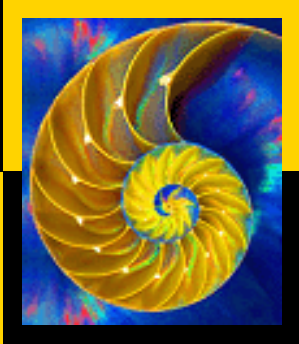
- ENERGY CONSUMPTION IS TOO HIGH
- ENVIRONMENTAL IMPACT
 - SEAWATER INTAKE KILLS PLANKTON
 - HIGH SALINITY BRINE DISCHARGE DAMAGES OCEAN FLORA AND FAUNA
- SOCIAL CONCERNS
 - ONLY WEALTHY CAN AFFORD DESAL
 - DESAL PLANTS MAY DISPLACE LOW INCOME FAMILIES FROM BEACH COMMUNITIES

NON-FOSSIL FUEL DESALINATION SOLUTION



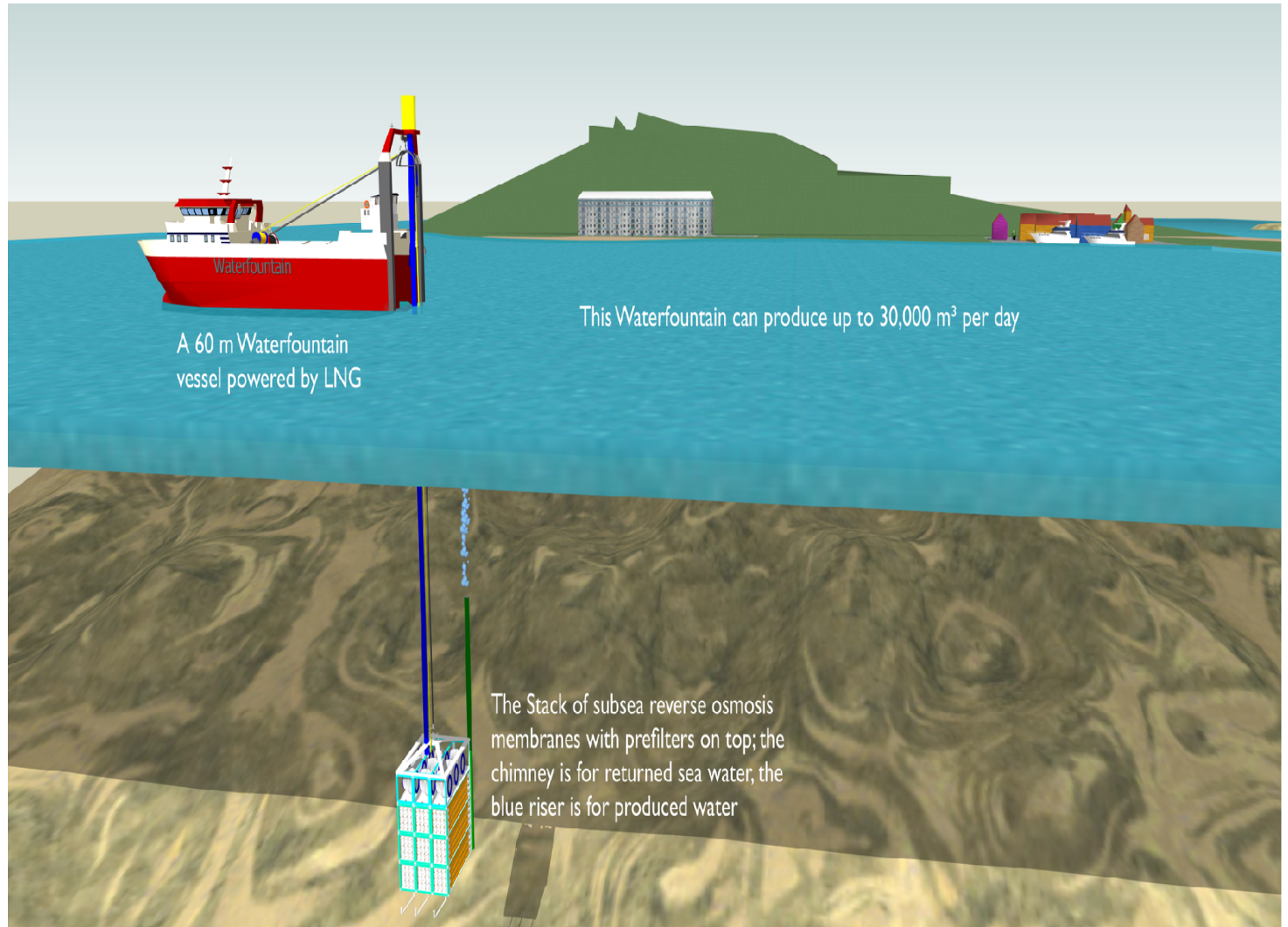
- SUBMERGED DESAL SYSTEMS OPERATE WITHOUT FOSSIL FUEL CONSUMPTION
- HYDROSTATIC WATER PRESSURE DRIVES PROCESS
- SOLAR OR WIND POWER TRANSFERS FRESH WATER TO SHORE

CHALLENGE OF SUBMERGED SWRO DESALINATORS



- SUBMERGED SWRO INTRODUCED IN 1970'S BY DR. THOMAS PETERS
- WATER FOUNTAIN IS EUROPEAN COMPANY PROVIDING TECHNOLOGY TODAY
- ADOPTION HAS BEEN SLOW AS SHORE BASED DESAL POWERED BY CONNECTION TO THE GRID HAS LOWER CAPITAL COST

WATER FOUNTAIN SUBMERGED SWRO



A 60 m Waterfountain
vessel powered by LNG

This Waterfountain can produce up to 30,000 m³ per day

The Stack of subsea reverse osmosis
membranes with prefilters on top; the
chimney is for returned sea water; the
blue riser is for produced water

SUBMERGED SWRO ADDRESSES CONCERNS



- ENERGY IS PROVIDED BY HYDROSTATIC PRESSURE AT A DEPTH OF 1000 TO 1500 FEET
- PLANKTON AND OTHER ORGANISMS NEAR SURFACE ARE NOT IMPACTED
- BRINE DISCHARGE IS NEAR NATURAL SEAWATER SALINITY
- SOLAR POWER CAN TRANSFER FRESH WATER TO THE SURFACE AND TO STORAGE ON SHORE
- BATTERY STORAGE NEEDED FOR NIGHTTIME OPERATION

SUBMERGED SWRO DESALINATION--DIFFERENTIAL



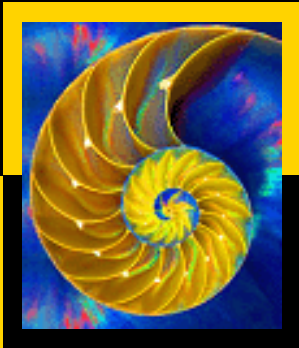
- CAPITAL COST IS HIGHER
- LOCATION REQUIRES 1000 FOOT SEA DEPTH NOT TOO FAR OFF SHORE
- SOLAR ENERGY SYSTEM MUST BE COUPLED WITH DESAL PLANT
- BATTERY ARRAY REQUIRED TO POWER DESAL WHEN SUN IS NOT AVAILABLE
- NEW WATER SUPPLY WITHOUT FOSSIL FUEL CONSUMPTION

WWRO DESALINATION CAN BE DRIVEN BY ALTERNATIVE ENERGY



- WASTEWATER (WWRO) RECLAIM IS USED GLOBALLY TO RECYCLE MUNICIPAL AND INDUSTRIAL WASTEWATER
- WWRO IS GROWING AS FAST AS SWRO
- APPROX. \$800 MILLION INVESTED IN 2019 ON WWRO INSTALLATIONS
- WWRO USES LESS ENERGY THAN SWRO

OCWD WWRO RECLAIM DESALINATOR-FIRST INSTALLATION 1977



WWRO DESALINATION IS A SUCCESS GLOBALLY



- OCWD FIRST LARGE WWRO INSTALLED IN 1977 AND HAS SINCE EXPANDED TO OVER 130 MGD
- SULAIBAYA KUWAIT, CHANGI SINGAPORE, LUGGAGE POINT AUSTRALIA AND OTHER LARGE SUCCESSFUL WWRO DESALTING PLANTS ARE IN OPERATION GLOBALLY

ALTERNATIVE ENERGY AND WWRO DESALINATION



- MOST WWRO RECLAMATION SYSTEMS ARE “INDIRECT” RECYCLERS. TREATED WATER IS STORED IN RESEVOIRS AND BLENDED WITH OTHER SUPPLY
- WWRO PLANTS OPERATE CONTINUOUSLY 24 HOURS PER DAY
- WWRO DESALTORS CAN EASILY BE POWERED BY ALTERNATIVE ENERGY WITH SOME FORM OF BATTERY STORAGE



OPTIONAL FUTURE SOLUTION

- DISCHARGE WWRO EFFLUENT INTO RESEVOIRS WITH HYDROELECTRIC GENERATORS AT THE OUTFALL
- THE WATER FILLING THE RESEVOIR WOULD CONSUME NO FOSSIL FUEL AND THE ENERGY CREATED AT THE OUTFALL WOULD HELP OFFSET THE ALTERNATIVE POWER CONSUMED
- HYDROELECTRIC POWER IS AVAILABLE AT NIGHT AND/OR WHEN NO WIND IS AVAILABLE



PROPOSITION

- SEAWATER LEVELS ARE RISING
- THE USE OF FOSSIL FUEL AND THE INTERNAL COMBUSTION ENGINE ARE BEING RESTRICTED
- NEW SOURCES OF FRESH WATER ARE NEEDED
- **DESALINATION POWERED BY ALTERNATIVE ENERGY PROVIDES A SOLUTION ADDRESSING ALL OF THESE CRUCIAL ISSUES**