

الدورة 12

مؤتمر تحلية المياه في الدول العربية

19-18 شعبان 1440 | 23-24 ابريل 2019

فندق انتركونتينتال سيتي ستارز، القاهرة، جمهورية مصر العربية



CRITERIA ASSOCIATED WITH SUCCESSFUL DESALINATION PROJECTS

Presented by

Dr YAHYA ELSAIE

Vice Chairman & Executive Board Member – Consulting Engineering Co – Egypt

APRIL 2019



CONSULTING ENGINEERING CO.

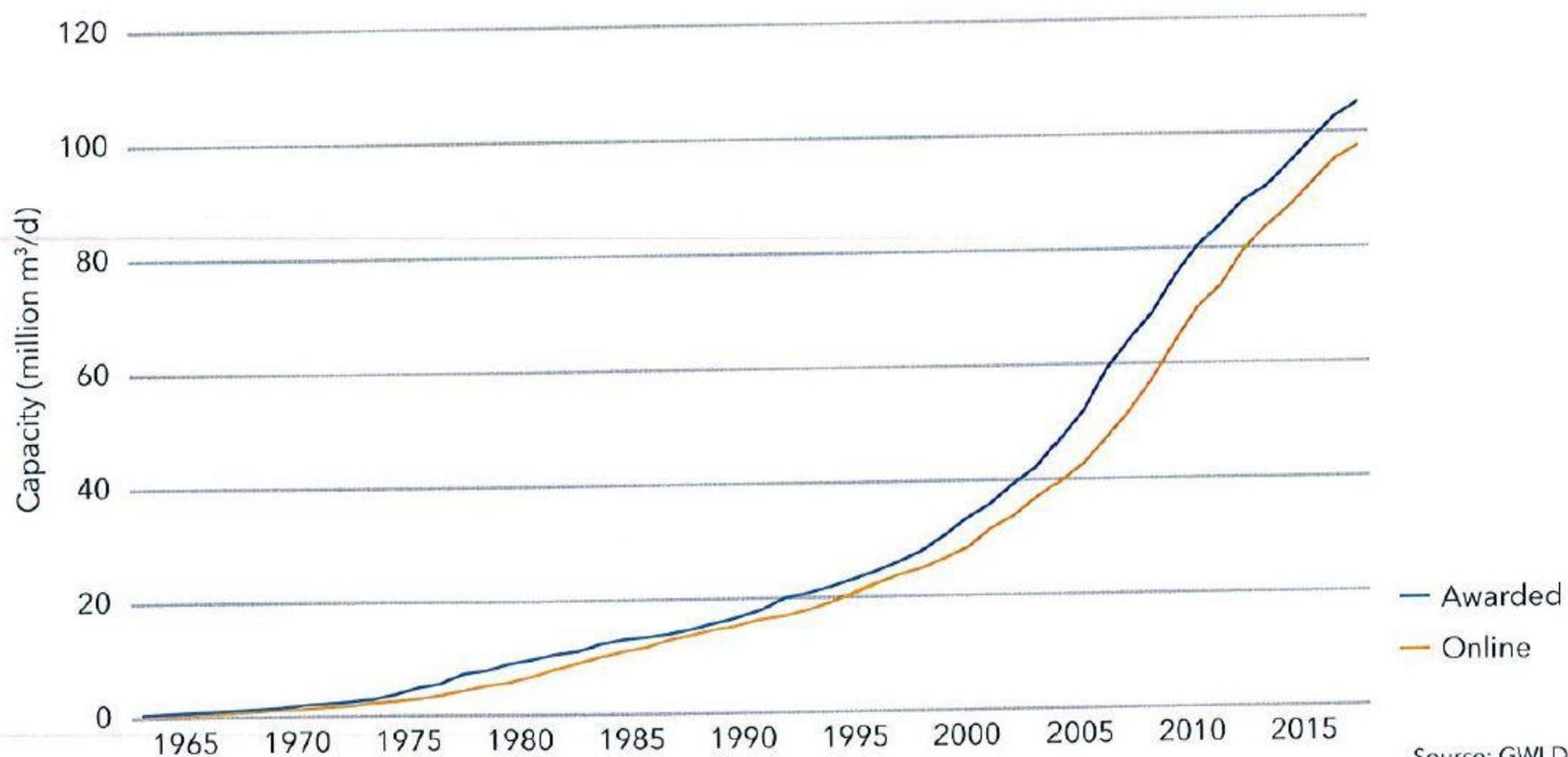
FIRST DESALINATION PLANTS

- ❑ **1955** **250,000 IGD FIRST MSF LAND BASED PLANT, KUWAIT**
- ❑ **1979** **12 MIGD TVC PLANT IN SAADIYAT, UAE**
- ❑ **1987** **1 MIGD RO PLANT IN SUR, OMAN**



CONSULTING ENGINEERING CO.

CUMULATIVE CONTRACTED AND ONLINE CAPACITY 1965 - 2018



Source: GWI DesalData / IDA

*Values through June 2018



CONSULTING ENGINEERING CO.

CRITERIA ASSOCIATED WITH SUCCESSFUL DESALINATION PROJECTS

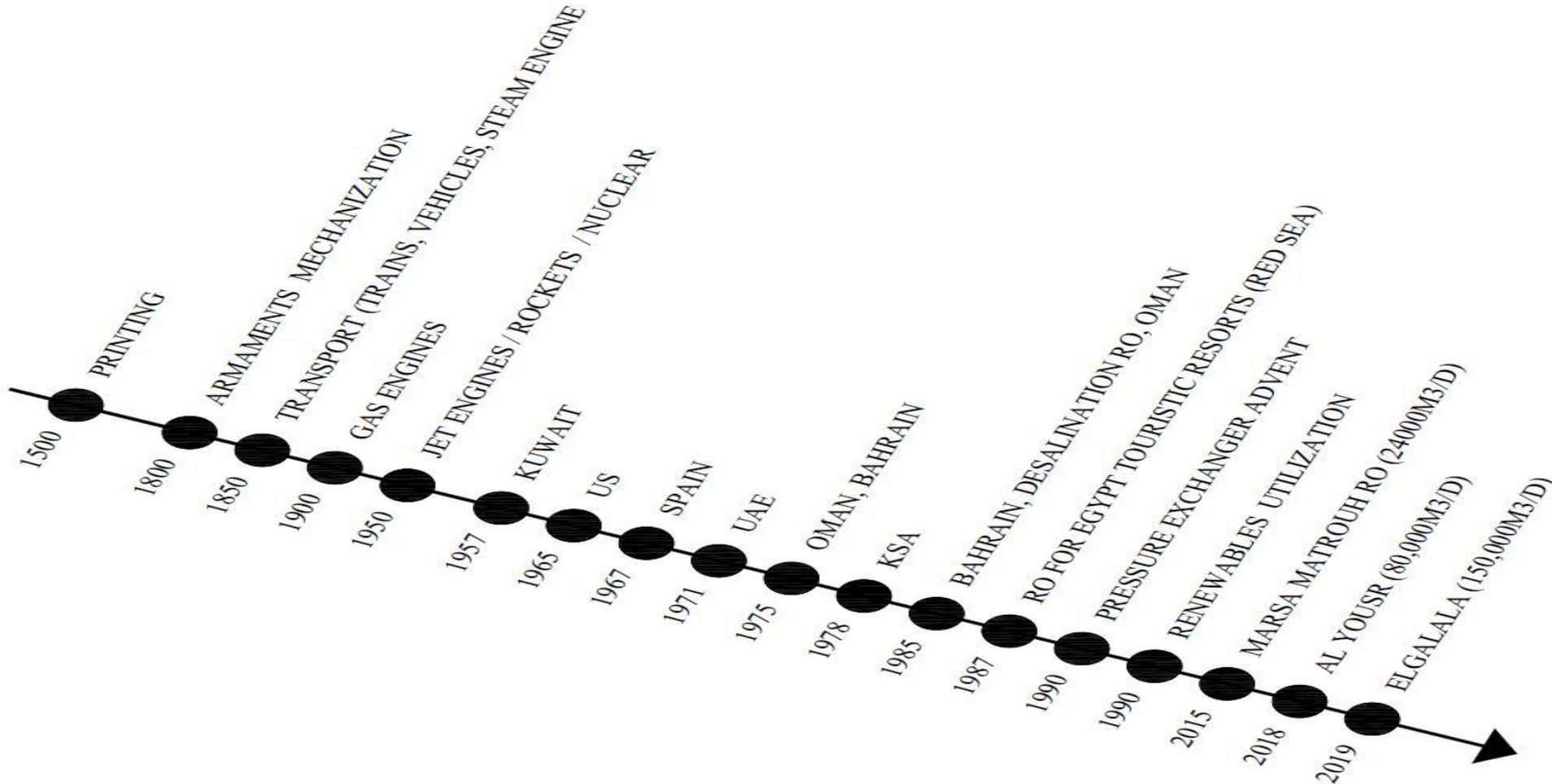
- ❖ **PLANNING & WATER SOURCES**
- ❖ **ENERGY AND DESALINATION CONFIGURATIONS**
- ❖ **FEASIBILITY STUDIES**
- ❖ **PRACTICAL SCHEDULE**
- ❖ **PERMIT FOR NATIONAL BOARD**
- ❖ **PLANNING & MONITORING**
- ❖ **COMPONENT MANUFACTURE LOCALLY**



CONSULTING ENGINEERING CO.

INTRODUCTION

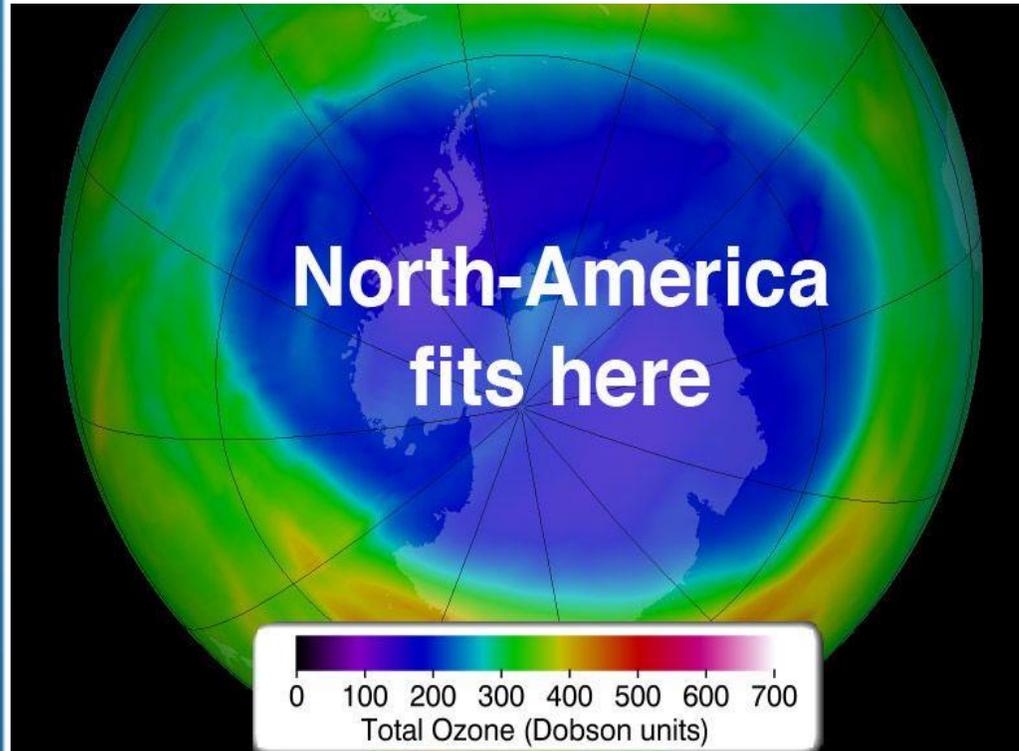
INDUSTRIALIZATION / MECHANIZATION TIME LINE





CONSULTING ENGINEERING CO.

INTRODUCTION



***TYPICAL OZONE DEPLETION IN
STRATOSPHERE***

- **CLEAN ENERGY ECONOMY**
- **DRIVING THE RESEARCH**
- **GLOBAL CONCERNS**
- ***INTERNATIONAL/MULTILATERAL
ENVIRONMENTAL AGREEMENTS***



CONSULTING ENGINEERING CO.

■ CURRENT RENEWABLES:

✓ HYDRO

✓ PV

✓ CSP

✓ WIND

■ DESALINATION :

- ✓ HEAT INTENSIVE (MAINLY MSF, TVC, MED)
- ✓ ELECTRICAL BASED (RO, ED).



*3 GAS TURBINE 117 MW ISO RATING,
DESALINATION UNITS 3X6/7.2 MIGD
SEAWATER INTAKE & OUTFALL, UNIT 4 7.2/8
MIGD, 160 T/HR AUXILIARY BOILER, ABU DHABI*

INTRODUCTION



CONSULTING ENGINEERING CO.

- **DESALINATION COUNTERS DROUGHT**
E.G, KSA, KUWAIT, UAE, CAPE VERDE ISLAND, CANARY ISLAND, ETC
- **WATER QUALITY FORECAST**
- **GEOGRAPHICAL LOCATION**
- **SOURCING STUDIES**
- **PERMITS**

PLANNING & WATER SOURCES



***SUR POWER AND DESALINATION PLANT
4x35.4 MW ISO RATING GAS TURBINE AND 2 MIGPD DESALINATION
PLANT INCLUDING SEA WATER INTAKE FACILITIES. 4 MG WATER
STORAGE FACILITY***



CONSULTING ENGINEERING CO.

➤ SOURCING THE RAW WATER (1)

■ LABORATORY TESTING OF WATER SAMPLES:

- ✓ TURBIDITY
- ✓ CHEMISTRY
- ✓ BACTERIOLOGY
- ✓ TEMPERATURE
- ✓ OIL AND CONTAMINANTS
- ✓ MONITORING THE VALUES OVER TIME

PLANNING & WATER SOURCES



UMM AL NAR WEST POWER & DESALINATION PLANT (UNITS 1 TO 6) 4x35.4 6x60 MW EXTRACTION CONDENSING TYPE TURBINES, 6X365 TONS/HR NATURAL GAS AND LIQUID FUEL FIRED BOILERS AT 60 BAR AND 480 C AND 6X4 MIGD DESALINATION PLANT



CONSULTING ENGINEERING CO.

PLANNING & WATER SOURCES

➤ SOURCING THE RAW WATER (2)

- PROTECTING ECOSYSTEM
- MARINE BIOLOGY
- HYDRODYNAMICS :
 - ✓ MARINE BATHYMETRY
 - ✓ TIDES
 - ✓ WAVES
 - ✓ CHARACTERISTICS OF THE SEA OVER A SUFFICIENT PERIOD OF TIME
 - ✓ NEAR SHORE
 - ✓ FAR SHORE



CONSULTING ENGINEERING C

➤ **Risks**

PLANNING & WATER SOURCES

TURBIDITY IN SOURCE WATER	MAL OPERATION SHORT MEMBRANE LIFE
OILY WATER	STOPPAGES. DAMAGE TO MEMBRANES. PLANT ECONOMICS FAILURE.
SEA INTAKE STUDIES MISSING OR INSUFFICIENT	SALT RECIRCULATION TEMPERATURE BUILD UP (THERMAL). TURBIDITY & SAND TRAPPING EROSION & SEDIMENTATION.
REMOTE OR LONG DISTANCE LOCATION	HIGH COSTS
FLOOD PROTECTION	MAJOR RISK OF DAMAGE & STOPPAGES
SEASONAL WATER QUALITY CHANGES	JELLY FISH
LACK OF BASIC KNOWLEDGE	NORTH COAST, EGYPT VOLATILE LOAD FACTOR
CASE OF CAPE VERDE	MOST UNITS OUT OF SERVICE STANDBY POWER UNAVAILABLE
SELECTION OF MATERIALS	CORROSIVE NATURE OF COASTAL REGIONS



CONSULTING ENGINEERING CO.

➤ CAPITAL COST WORRIES

- INTAKE AND DISCHARGE
- POWER SUPPLY ISSUE
- WATER DISTRIBUTION ISSUE
- ABILITY TO DEAL
- INSURANCES AND PREMIUMS
- USE OF SEA WATER INTAKE TO CATER FOR MANY STAGES IN FUTURE (EXAMPLES: AL Taweelah – MANY PHASES, INITIALLY PLANNED SWI FOR 750,000 M³/HOUR, POWER 3000MW, DESALINATION 300 MIGD – 1.4 MM³/DAY)

PLANNING & WATER SOURCES



Al-Taweelah P&D 3000MW 300MIGD

Intake 750,000 m³/HOUR

Abu Dhabi, UAE

➤ WATER SUSTAINABILITY

- **CLOSE TO THE WATER - HENCE COST MINIMAL**
- **QUALITY – ACCEPTABLE**
- **DROUGHT CAN AFFECT SUCH COMMUNITIES**



CONSULTING ENGINEERING CO.

➤ WATER SUSTAINABILITY

WITH DESALINATION, CONDITIONS ARE:

- ✓ AVAILABILITY OF SALINE WATER
- ✓ COASTAL AREAS
- ✓ SUITABLE AQUIFER
- ✓ IRRIGATION WASTEWATER
- ✓ AVAILABILITY OF ENERGY SOURCE
- ✓ CO-LOCATE DESALINATION WITH (PP, ST, GT, HRSG, CC)
- ✓ CO-LOCATION – COOLING WATER TO DILUTE BRINE (USE OF COMMON INTAKE SOURCE)
- ✓ FUNDING
- ✓ PROPER DESIGN, CONSTRUCTION, TESTING , O&M

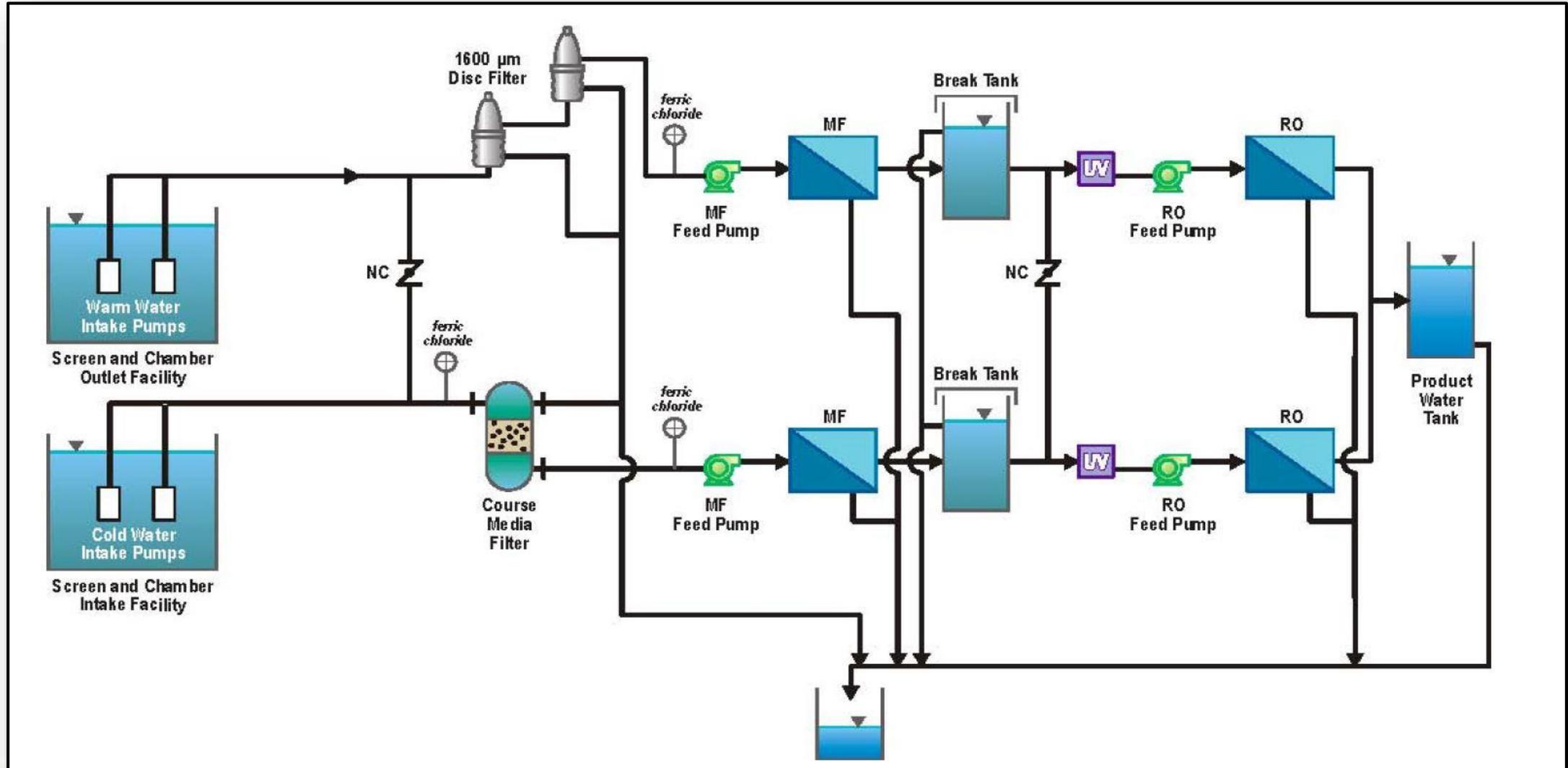


CONSULTING ENGINEERING CO.

PLANNING & WATER SOURCES

- THE ENERGY COSTS ARE A MAJOR EXPENSE**
- THERMAL DESALINATION TECHNOLOGIES COUPLED WITH WASTE HEAT OR THERMAL RENEWABLES OFFER HIGH RELIABILITY**
- RO TECHNOLOGY IS PROVEN AND REQUIRES GREAT CARE FOR SUSTAINABILITY**
- SAFETY FACTORS REGARDING SOURCE WATER, SPARES, PRESERVATION OF SPARES (EG MEMBRANES) AND EQUIPMENT IS OF PARAMOUNT IMPORTANCE**
- RESPONSIBILITY FOR ELECTRICAL CONSUMPTION, MEMBRANE EXCHANGE, PRODUCTIVITY, QUALITY OF PRODUCT WATER, CHEMICALS CONSUMPTION SHALL BE MONITORED BY OPERATOR & MONITORING DATA PRESENTED AT REGULAR INTERVALS FOR AVAILABILITY, CAPACITY AND QUANTITY**
- RO PLANTS PERMITS INCLUDE SAFEGUARD FOR SUSTAINABILITY**

RO PILOT PLANT



➤ DESALINATION SOURCES & PRODUCTS

SOURCE WATER FOR DESALINATION PLANTS :

- COASTAL – SEA WATER OPEN INTAKE
- COASTAL – SHORE WELLS
- INLAND – BRACKISH WELL WATER
- INLAND – HIGH SALINITY WELLS
- SALINE INDUSTRIAL WATER

➤ DESALINATION SOURCES & PRODUCTS

DESALINATED PRODUCT CAN BE:

- **POTABLE WATER.**
- **DEMINERALIZED WATER.**
- **IRRIGATION WATER.**
- **WATER REQUIRED FOR CONCRETE AND SERVICE WATER**



CONSULTING ENGINEERING CO.

ENERGY AND DESALINATION CONFIGURATIONS

➤ ENERGY SOURCES

ENERGY SOURCES AVAILABLE:

- RENEWABLE – CSP
- RENEWABLE – PV
- WIND – OFFSHORE
- WIND – ONSHORE
- HYDRO
- DEEP EARTH THERMAL
- NUCLEAR
- SOLID BIO FUELS
- BIOGAS
- OTHER FOSSIL FUELS (NATURAL GAS, LPG, LNG, HFO, LFO)

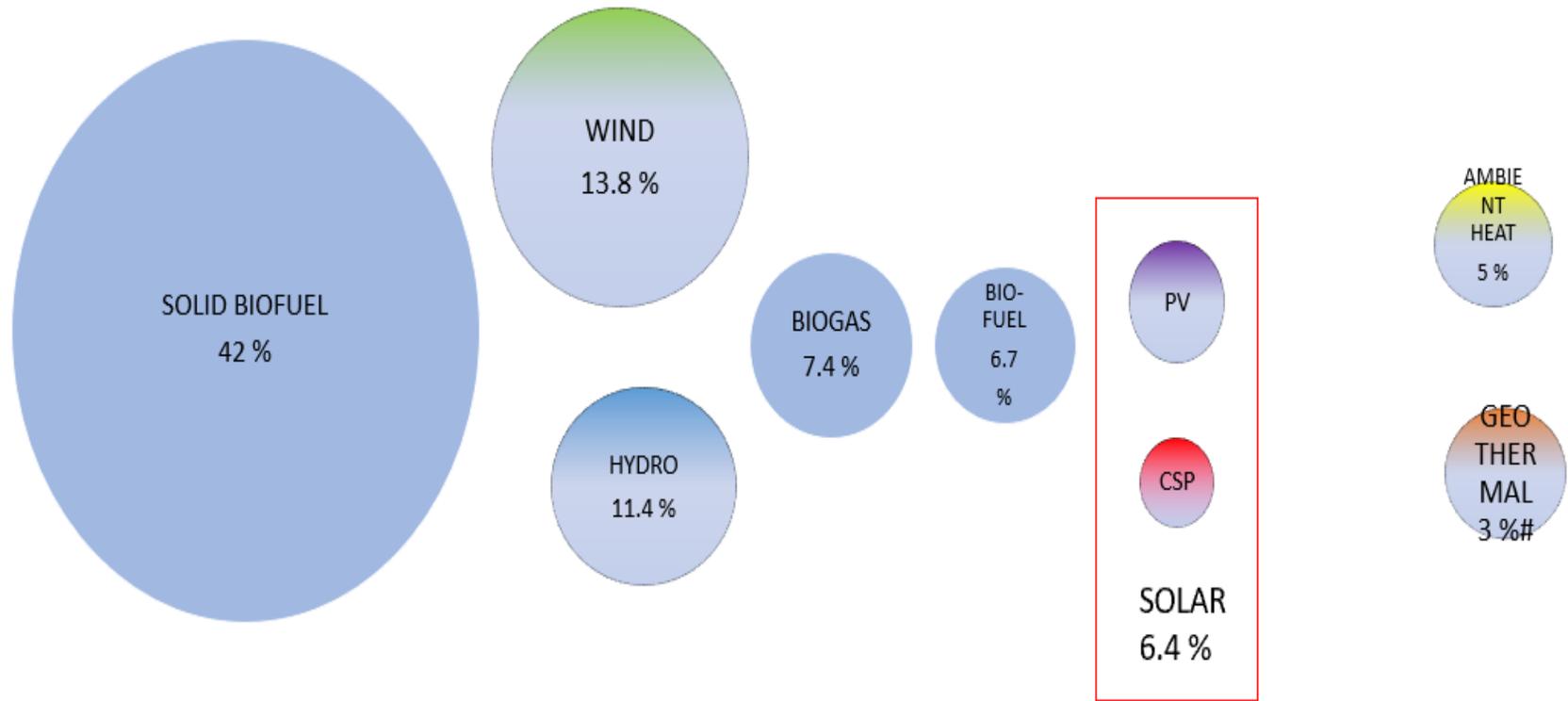


CONSULTING ENGINEERING CO.

ENERGY AND DESALINATION CONFIGURATIONS

RENEWABLES – DISTRIBUTION OF DIFFERENT TYPES (SOURCE EU STATISTICS 2018)

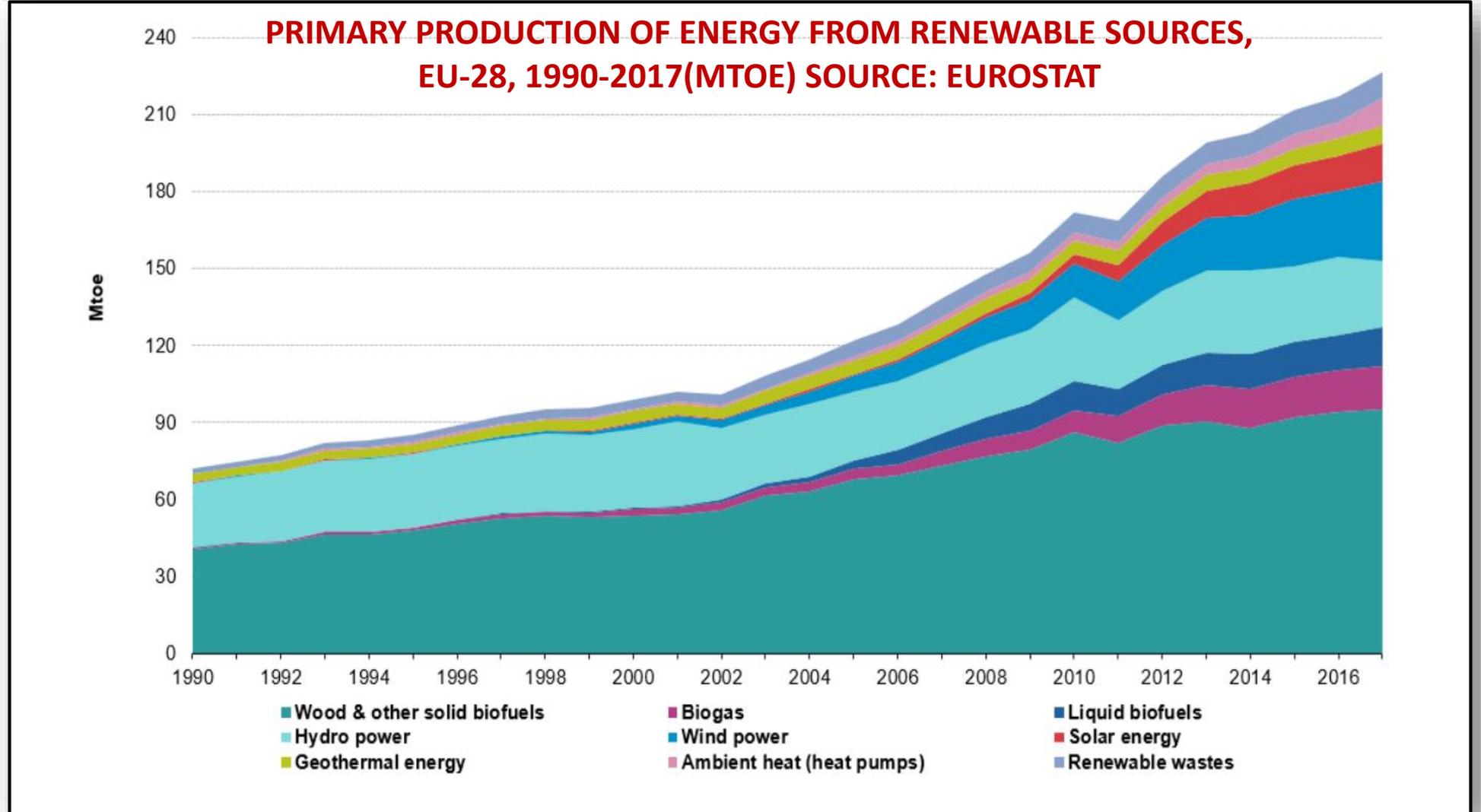
EU DISTRIBUTION OF RENEWABLE ENERGY BY UTILISATION - 2017





CONSULTING ENGINEERING CO.

ENERGY AND DESALINATION CONFIGURATIONS



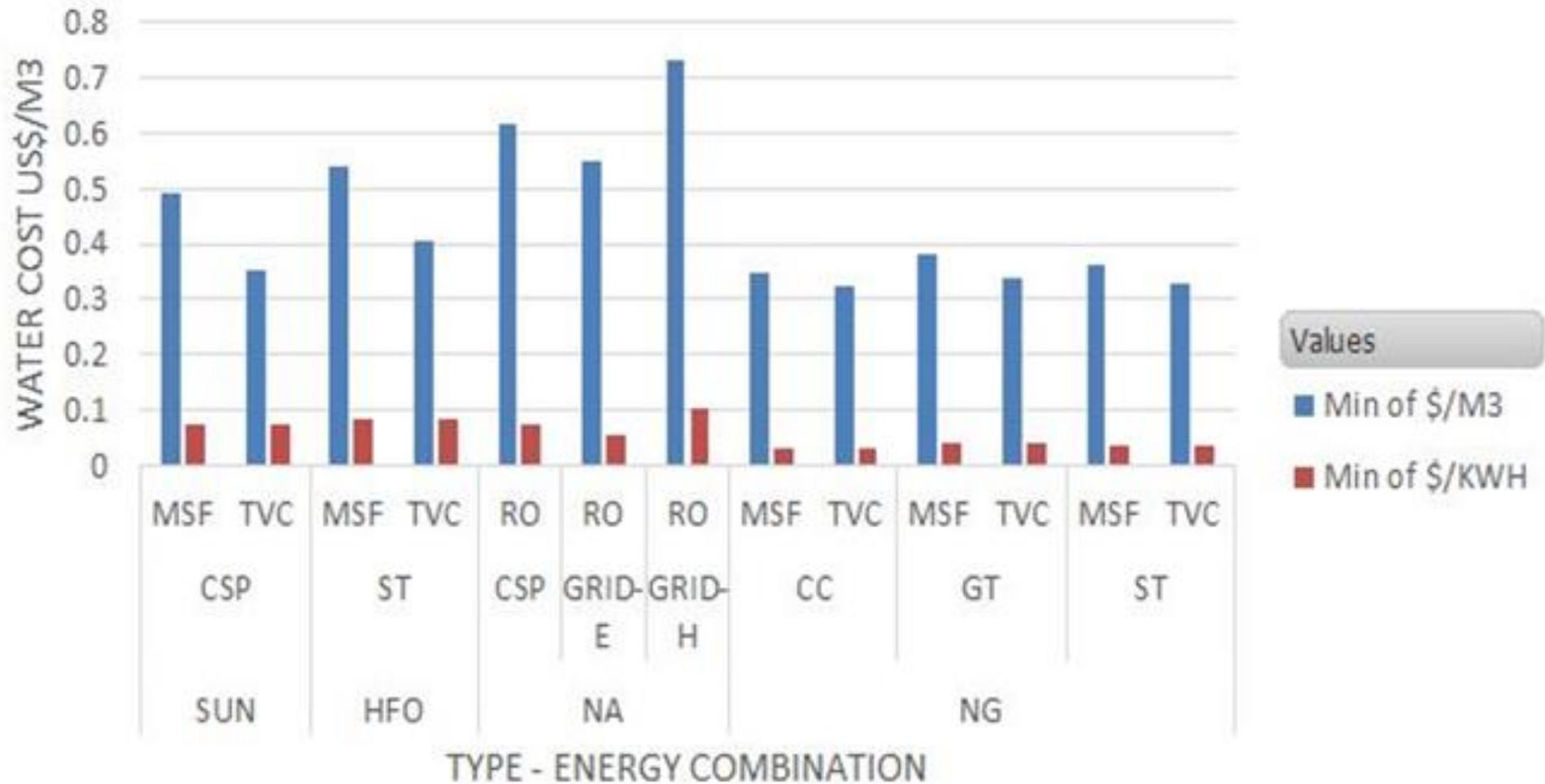
MATRIX OF COMBINATIONS TYPES

	MSF	TVC	RO
Desalination Raw Water Sources & Products	L (LARGE)	M (MEDIUM)-L	S (SMALL)-M-L
<u>Source for desalination plants can be :</u>			
• Coastal – sea water open intake / Pipe Trestle / Sea Pipe	X	X	X
• Coastal – shore wells			X
• Inland – brackish well water			X
• Inland – high salinity wells		X	
• Saline industrial water	X	X	X
<u>Desalinated product can be :</u>			
• Potable water	X	X	X
• Demineralised water for boilers or industrial use	X	X	
• Irrigation water (to augment reused water)	X		X
• Water required for concrete and service water	X	X	X
<u>Energy Sources</u>			
• Renewable – CSP	X	X	X
• Renewable – PV			
• Wind – Offshore			
• Wind – Onshore			
• Hydro	X	X	X
• Deep earth thermal	X	X	
• Nuclear	X	X	
• Solid Bio Fuels	X	X	
• Biogas	X	X	
• Other fossil fuels (natural gas, LPG, LNG, HFO, LFO)	X	X	
• Electricity	X	X	X
• Thermal Energy	X	X	
Reliability	H	M	V

ENERGY AND DESALINATION CONFIGURATIONS

TYPICAL COMPARISON OF CSP / FOSSIL FUEL POWER PLANTS COMBINATIONS

WATER UNIT COSTS FOR DIFFERENT SCENARIOS





CONSULTING ENGINEERING CO.

ENERGY REQUIREMENTS

Table 2 - Key, typical energy data for desalination technologies (Main source: EU, 2008)

	MSF	MED	SWRO ¹	ED
Operation temp., °C	90-110	70	Ambient	Ambient
Electricity demand, kWh/m ³	2.5 -3.5	1.5–2.5	3.5–5.0	1.5-4.0 feed water with 1500-3500 ppm solids
Thermal energy demand, kWh/m ³	80.6 (290 kJ/kg)	80.6 (290 kJ/kg)	0	0

SWRO: Spiral wound reverse osmosis

FOR A SUCCESSFUL PLANT :

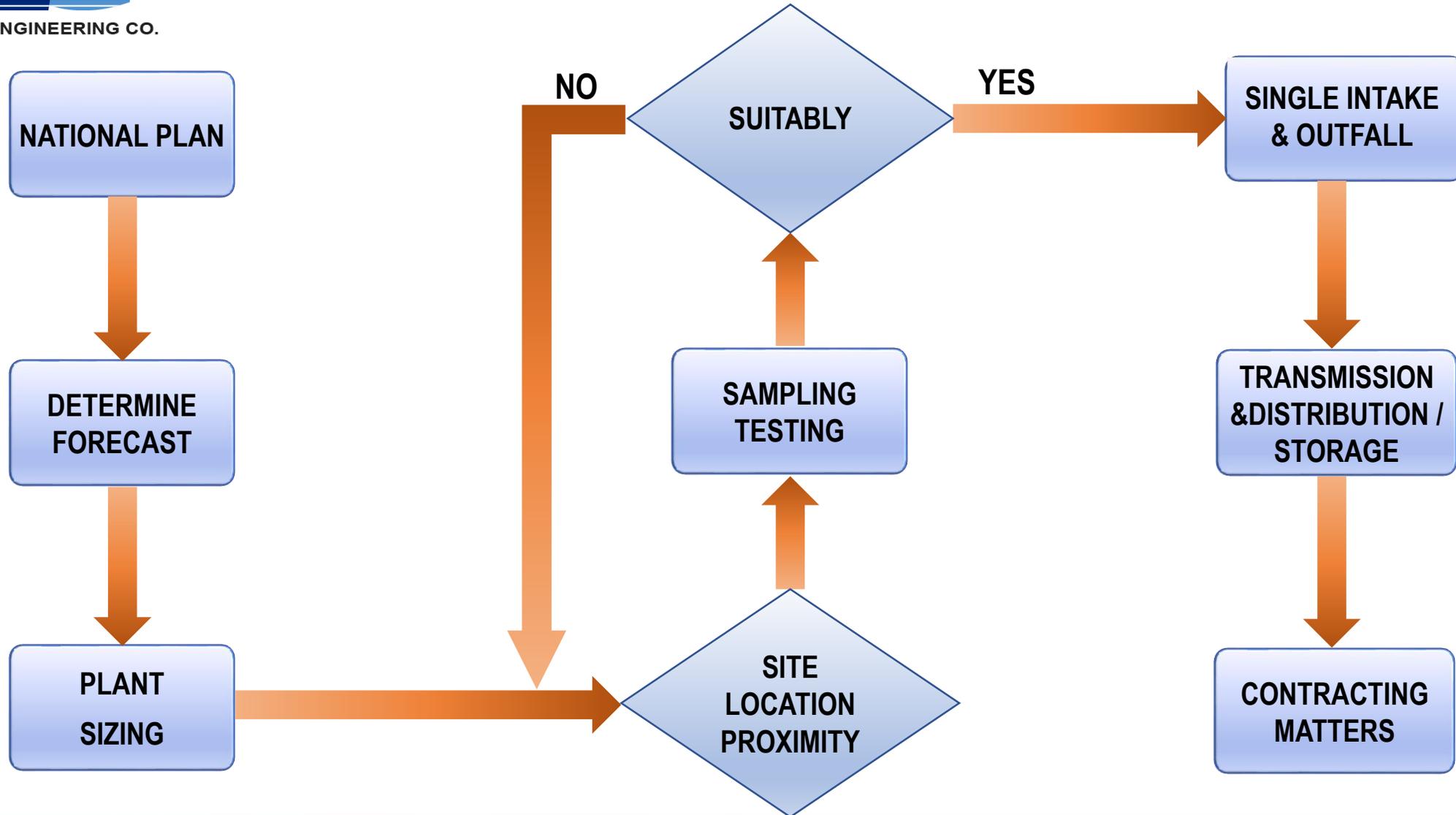
- **A FEASIBILITY IS NECESSARY FOR EACH PLANT**
- **LONG TERM VIEW**
- **INTAKES AND OUTFALLS**
- **ENVIRONMENTAL IMPACT.**
- **HYDROGEOLOGY (GW)**
- **GEOPHYSICAL EXAMINATION (GW)**





CONSULTING ENGINEERING CO.

TIMELINE FOR A TYPICAL SUCCESSFUL PROJECT



TIMELINE FOR A TYPICAL SUCCESSFUL PROJECT

- **STAKEHOLDERS TO BE INVOLVED AND DISCUSS REQUIREMENTS WITH :**
 - FINANCIERS
 - CONSTRUCTION CONTRACTOR
 - MAIN EQUIPMENT SUPPLIERS
 - O&M COMPANY.
 - INSURANCE & LEGAL REQUIREMENTS
 - GUARANTEES IN PLACE
 - SPARES
 - TIME FRAME TILL PRODUCTION
 - STORAGE / TRANSMISSION AND DISTRIBUTION
- **BUDGET AND FUNDING.**
- **IMPLEMENTATION IN THIS CONTEXT WILL HIGHLY HAVE A BETTER CHANCE
OF SUCCESS**



CONSULTING ENGINEERING CO.

FORMATION OF A NATIONAL DESALINATION BOARD

PERMIT CHECKLIST TO BE FILLED & APPROVED (BY BOARD):

- PLANT LOCATION AND AREA
- SOURCE WATER
- GEOLOGY
- GEOPHYSICAL AND HYDROGEOLOGY MODELLING
- SEA WATER STUDIES FOR INTAKE / OUTFALL
- TOPOGRAPHY AND SOIL INVESTIGATION
- WATER SOURCE PROXIMITY
- DESALINATION PROCESS CALCULATIONS
- TREATED POTABLE WATER
- BUSINESS MODEL
- STAFFING AND TRAINING FACILITY
- MONITORING FACILITY
- ENERGY SOURCES AND TERMINAL POINTS
- SUBSTATION / TL AVAILABILITY
- SIMPLICITY OF OPERATION

CASE OF O&M FOLLOWING A DESIGN BUILD CONTRACT

TYPICAL REQUIREMENTS:

- SUFFICIENT PERIOD FOR THE CONTRACT
- CAPACITY CHARGE & PRODUCTION CHARGE
- PERFORMANCE TESTS
 - SUITABLE PERFORMANCE
 - DURABILITY AND EFFICIENCY TERMS
- SPARES TO HAVE
- MTBF SCHEDULE

✓ **DESALINATION IS A DROUGHT PROOF SOLUTION**

✓ **TO AVOID FAILURES:**

**PROPER CHOICE OF TYPE, LOCATION, ENERGY, SOURCE
RAW WATER**



THANK YOU FOR YOUR ATTENDANCE

BEST WISHES FOR A BETTER FUTURE



CONSULTING ENGINEERING CO.