SUSTAINABLE DESALINATION in SOUTH MEDITERRANEAN COUNTRIES

Presented by: Dr. Hosny Khordagui, Key Environment Expert, SWIM-SM

Objectives of the presentation

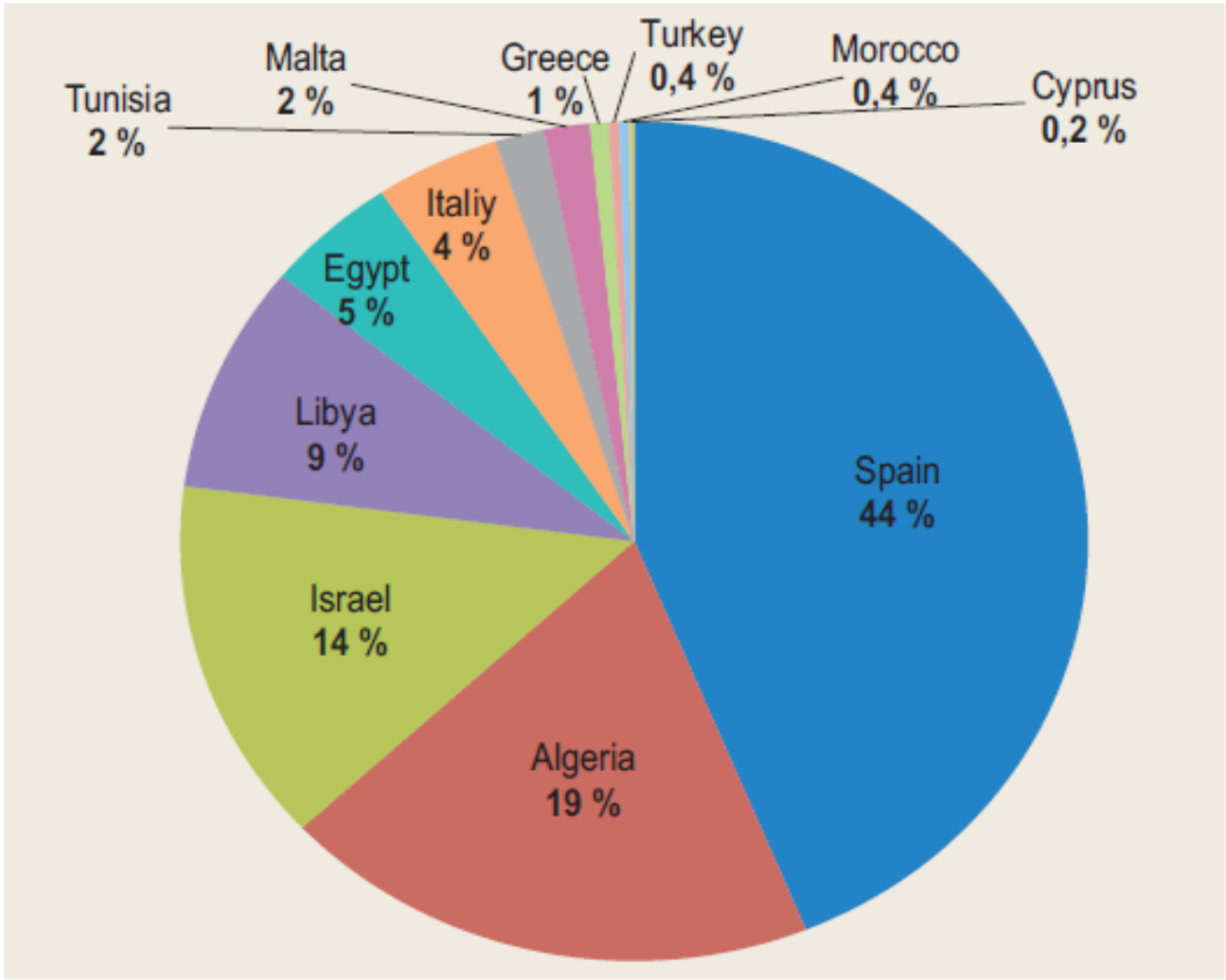
- To present the environmental aspects of desalination with emphasis on energy use;
- To address the socio-economic aspects associate with desalination as a non-conventional water resource within IWRM context;
- To suggest areas of intervention for SWIM-SM to ensure the sustainability of desalination in SMCs.

Desalination Capacities in SMCs

COUNTRY	Fossil Fuel Desalination in Bm^3/year
MOROCCO	0.0
ALGERIA	0.5
TUNISIA	0.1
EGYPT	0.2
ISRAEL	0.4
JORDAN	0.2
LEBANON	0.0
SYRIA	0.5
PALESTINE	0.2
TOTAL	2.1

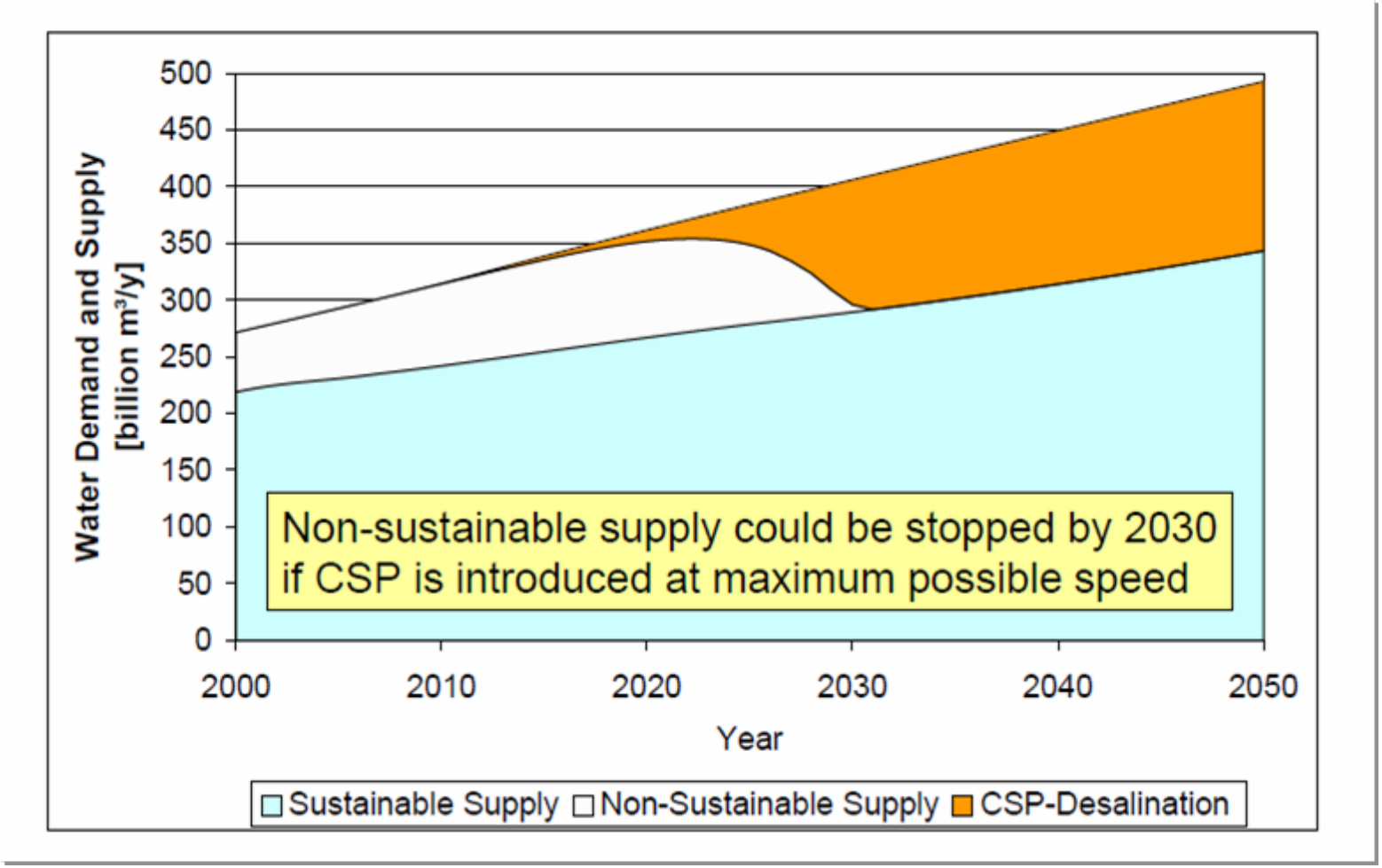
Source: Franz Trieb et al, Concentrating Solar Power for Seawater Desalination AQWA-CSP (2007)

Installed Desalination Capacity in the Mediterranean



Source: H. Boyé, Plan Bleu, 2008

Water demand scenario for MENA until 2050 and coverage of demand by sustainable resources, unsustainable resources & CSP



Source: Franz Trieb CSP for sea water desalination MINAREC Damascus 2007

Why Sustainable Desalination?

WHAT WE HAVE

- **ENVIRONMENTAL DEGRADATION**
- **NO ECONOMIC SUSTAINABILITY** (depleting fossil fuel, water & energy subsidies, no opportunity cost, no valuation of environmental externalities, etc.)
- **NO SOCIAL SUSTAINABILITY** (Competition, conflicts, inequity in distribution & participation)

WHAT WE NEED

- **ENVIRONMENTAL SUSTAINABILITY**
- **ECONOMIC SUSTAINABILITY.**
- **SOCIAL SUSTAINABILITY.**

The Problem

ENVIRONMENTAL IMPACTS OF DESALINATION

The Problem

- **Impacts of Construction**

Land-filling, digging, hammering, welding, field engineering work, transportation, settlements for laborers, testing, purging, commissioning, etc. causing, noise pollution, air emissions, sediment transport in the near shore, vibrations, etc.

- **Impacts of Operation and Maintenance**

Physical, chemical & biological impacts of intake, brine discharge & air emissions resulting from burning fuel.

- **Impacts of Decommissioning:**

Destruction & demolition, site **de-pollution (Hg),** dismantling of equipments, rubble transportation & disposal, sediment transport, noise pollution, emission of particulates, etc.

The Problem

ENVIRONMENTAL IMPACTS OF DESALINATION PLANTS INTAKES

Forebay of a desalination plant intake

Screen bar 10cm wide at entrance of forebay

Housing of traveling screen mesh of <1cm^2

Dead Pelagic fish (Sardinella) in the forebay of desalination plant resulting from chlorination for bio-fouling control

Environmental Impacts of Desalination Plants' Intakes

Impingement effects: As the seawater going into the power-desalination plant is screened & filtered, aquatic organisms are removed from water;

Entrainment effects: Smaller organisms (phyto and zooplankton, crustaceans,small fish, etc.) passing through filters find their way through the process they get exposed to chemicals, higher temperature or pressure, conditions which are endangering their existence.

The Problem

ENVIRONMENTAL IMPACTS OF BRINE REJECT DISCHARGE

Physical Impact of Brine Reject: Thermal Discharge

The temperature of the brine water effluent is typically above the feed water temperature by 5 to 8 C^{o}.

Chemical Impacts of Brine Reject

Resulting from:

- high salinity;
- Residual chemical agents remaining in the brine water added for the control of (i) bio-fouling (ii) control scale formation & (iii) antifoaming agents;
- Chemical agents formed or released during desalination: **Trace metals** & **THMs**

Salt Content in Discharged Brine

- Discharge of brine reject in well circulated open sea has minimal environmental impacts;
- Discharge of brine reject in semi-enclosed embayment's has some detrimental impacts;
- Discharge of brine rejects from **inland** desalination plants is very risky.

Environmental Impacts of Residual Chlorine

Brine reject at the outfall of desalination plant usually contains 0.1 ppm of residual Cl_2.Very toxic to living organisms in the nearshore marine environment.

Environmental Impacts of Trace Metals

- Corrosion products due to water flow, dissolved gases & treatment chemicals (acids) on the alloys utilized in desalination pipes often include harmful heavy metals such as **Ni, Cu & Mo** & less toxic metals such as **Fe & Zn**;
- **Hg** from chlorine production;
- Trace metals will last in different compartments of the marine environment forever.

Environmental Impacts of THMs & Anti-scalants in Brine Water

- Formation of **THMs** in **finished water**;
- Formation of **THMs** in brine reject;
- Anti-scalants to hamper carbonate deposition. Phosphates cause **eutrofication.**

Air Emissions

The products of combustion released by fossil fuel are ash particles, carbon dioxide (CO_2), carbon monoxide (CO), water vapor, Sulfur dioxide (SO_2), & nitrogen oxides (NOx). Except for SO_2, all other gases are GHGs.

????? The Question ?????

How can we render Desalination Sustainable?

<u>Through</u>:

- **Social Sustainability**
- **Environmental Sustainability**
- **Economic Sustainability**

Social Sustainability: HOW?

- Construction & operation of desalination plants consumes considerable community resources that are not reflected in the investments & operating costs. **Desalinated water should therefore be valued as a community asset with preferential social benefits to the community;**
- Negative social impacts of desalination plants on local communities in coastal zones such as fishermen, operators of marine & eco-tourism resorts, divers, aquaculture, etc. need to be mitigated at the onset of the project;
- Community including women, beneficiaries & stakeholders need to be involved in the planning & management of desalination plants & provided with the sense of **ownership** of the project.

Environmental Sustainability: HOW?

By Enforcing EIA Policies for Desalination Projects:

- EIA is a policy designed to predict all impacts related to the implementation of a desalination project
- It is designed to **offer feasible mitigation measures** for the negative impacts

EIA for Desalination

An International group of experts developed a comprehensive EIA guiding manual for desalination plants.

This International effort was spearheaded by WHO & UNEP

Published in 2008

Economic Sustainability: HOW?

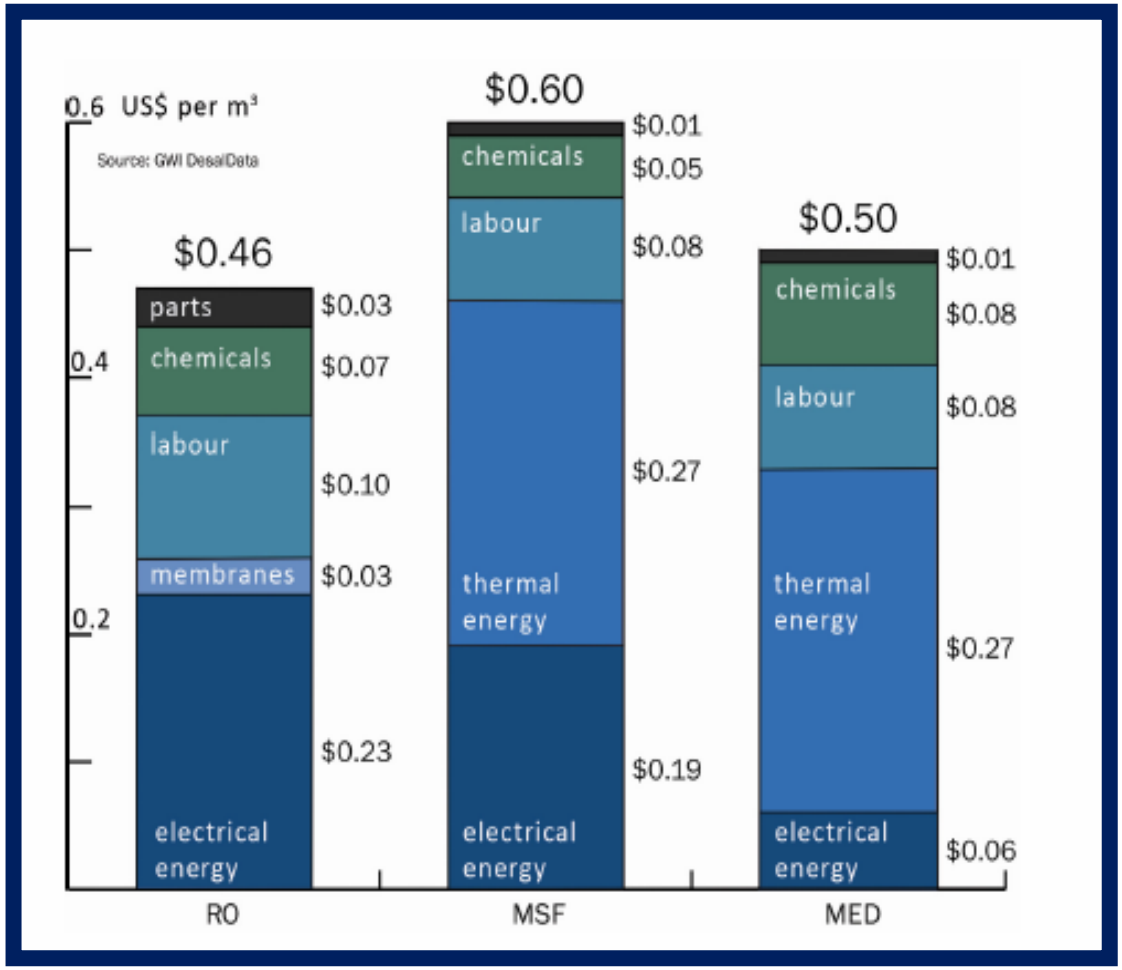
- Desalination in SMCs should be considered only after more efficient options, including recycling and conservation, are **exhausted**;
- Prior to reaching decision to desalinate an **opportunity cost analysis, including societal cost,** needs to be undertaken to compare cost of desalination **versus**:

1. Cost of water conservation, reuse & recycling.
2. Reduction in virtual water exports (rice, cotton, cane sugar, etc.)
3. Cost of water resources reallocation (from agriculture to supplies).
4. Cost of improving compliance with water legislations (non-revenue water, pollution control, etc.)
5. Cost of activating economic instruments such as incentives/disincentives, application of service cost recovery, etc.

Cost of Desalination are often Deceiving

These figures are:

1. At point of production not point of use
2. Without environmental externalities.
3. At design not production capacity
4. Without depreciation of infrastructures

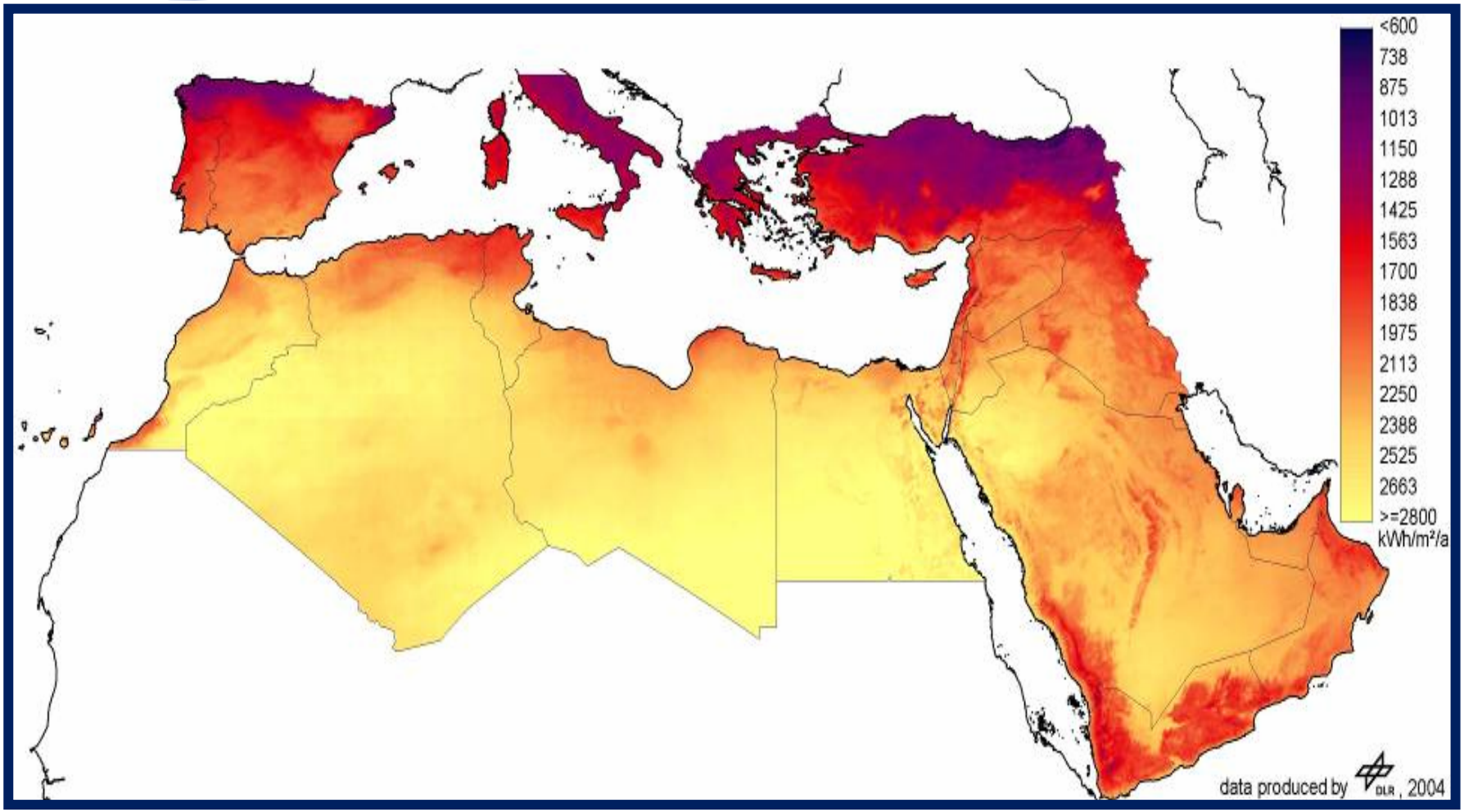


Source: WHO & UNEP Manual 2008

A Glimpse of Hope

- A change in paradigm is urgently needed aiming at sustainable energy & water supply for sustainable development & poverty eradication in SMCs;
- Fortunately, most PCs have a dazzling potential for solar energy. Using concentrating solar thermal power (CSP) plants to power seawater desalination to solve the water scarcity is tested & achievable;
- Currently, CSP offers a sustainable alternative to fossil fuels for large scale seawater desalination.

Solar energy irradiated on the deserts & coasts of SMCs



Source: Dr. Franz Trieb, Concentrating Solar Power for Seawater Desalination, MINAREC 2007

Go Solar!

The EU Med Solar Plan indicated that the Mediterranean region has an enormous, and largely untapped, potential in the field of renewable energies;

Each Km^2 of land in SMCs receives every year an amount of solar energy equivalent to 1.5 million barrels of crude oil;

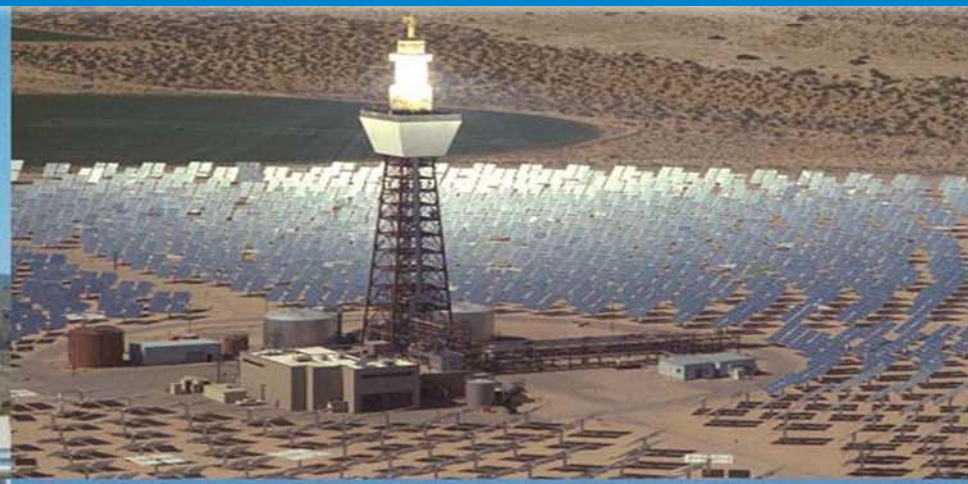
Solar energy received on each Km^2 of desert land is sufficient to desalinate 60 million m^3 per year;

MSP intends to increase the use of solar energy for power generation, improve energy efficiency and energy savings, and develop electricity grid interconnections.

ource: Saghir, J., et al. The Way Forward, The World Bank, Middle East and North Africa Region, Infrastructure Development Group, 2000. EU Mediterranean Solar Plan Strategy Paper (MSP Expert Group 10/02/2010).

parabolic trough

solar tower



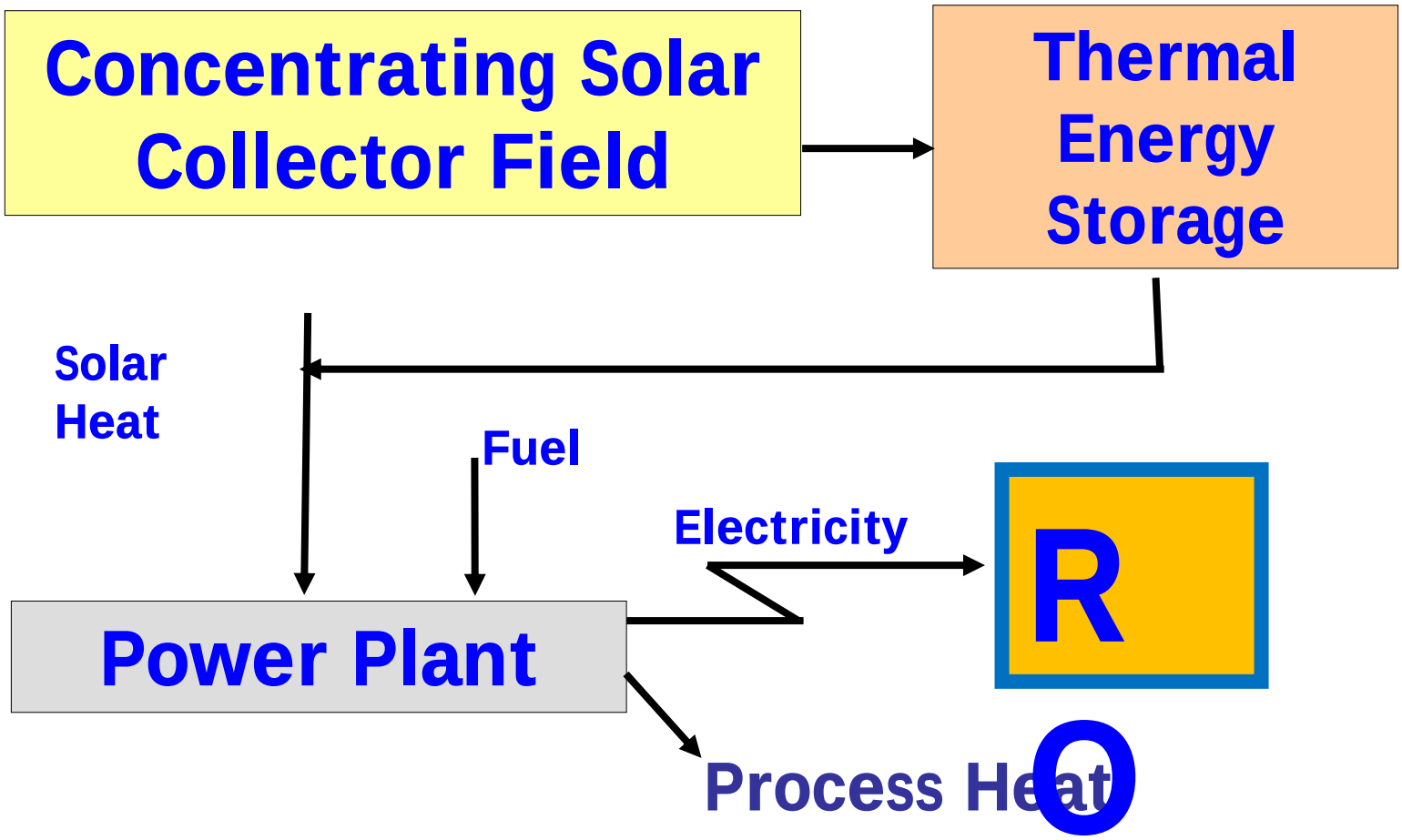
linear Fresnel

parabolic dish

concentrating solar collector systems

Source: Franz Trieb et al, CSP for Seawater Desalination AQWA-CSP (2007), German Aerospace Center, Study commissioned by Federal Ministry of Environment

Solar / Hybrid Electricity & Combined Heat & Power



After MENAREC 4, Damascus, Syria, June 20-24, 2007

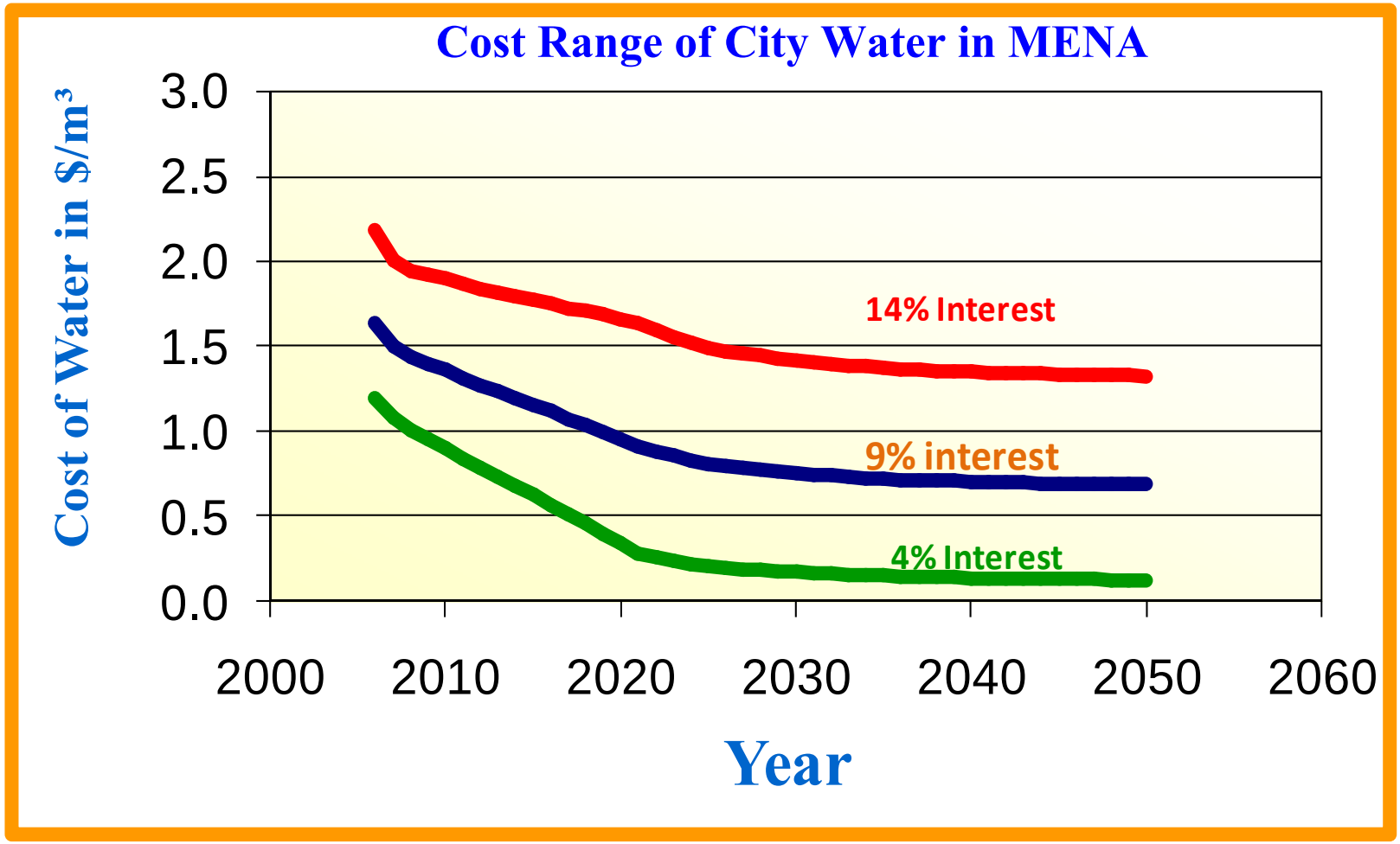
Cost of CSP Desalinated Water using Combined Heat Power System

- CSP plants producing both power & water can sell electricity at a competitive price & at the same time deliver water at moderate prices;
- By 2015, water from CSP desalination will be considerably cheaper than water from desalination powered by fossil fuels;
- In the medium term (2030), it can achieve a price of <0.10 €/m³ that would be competitive even for irrigation.

Source: Franz Trieb et al, CSP for Seawater Desalination AQWA-CSP (2007), German Aerospace Center, Study commissioned by Federal Ministry of Environment

Franz Trieb, MENAREC 4, Damascus, Syria, June 20-24, 2007

Cost of Water desalted by CSP in Cogeneration with MED for 4,9 & 14% Rate of Return, Electricity Cost 4 ct/kWh



Source: Franz Trieb et al, CSP for Seawater Desalination AQWA-CSP (2007), German Aerospace Center, Study commissioned by Federal Ministry of Environment

Potential Areas of Intervention by SWIM-SM

rinciple: SWIM, including the SM & Demo Projects is a demand driven program of the EC. All suggested areas of intervention are presented for deliberating, commenting & amending.

.Raising Awareness:

Raise awareness of decision makers on options for **sustainable desalination** in addition to their efforts in realizing effective WDM to maintain an adequate level of water supply (beyond 2020);

Potential Areas of Intervention by SWIM-SM

2.Building Capacity:

- Build capacity of water officials & environmental economists to conduct opportunity cost analysis of desalination projects & to apply virtual water concepts to support high levels decision making;
- Build capacity on identification of environmental aspects & performance of EIA for desalination plants on-shore & in-land;
- Build capacity on the economic valuation of environmental externalities & societal costs associated with desalination;
- Build capacity of water officials on integrating sustainable desalination within national IWRM plans, whenever applicable.

Potential Areas of Intervention by SWIM-SM

3. Technical Assistance:

- Establish an Expert Group on Desalination (EGD) to serve as an advisory board to PCs on desalination issues in general and CSP in particular;
- Provide technical support on technology assessment & advise to selected PCs on existing techno-economic feasibility studies carried out by international organizations and/or firms;
- Develop a guideline to identify & assess environmental implications associated with desalination in PCs;
- Economic valuation of environmental externalities associated with desalination.

Synergy

The present project will seek complementarities & synergy with regional & national initiatives, programs & projects with cross cutting issues of interest on desalination.

Some regional initiatives to be considered for synergy include:

- Horizon 2020 Initiative (H2020)
- MED EUWI
- UfM processes, including the draft Strategy on Water in the Mediterranean, and programs
- Sustainable Med / World Bank
- GEF Med Partnership
- Middle East Desalination Center (MEDC) in Oman
- League of Arab States through its technical arm “Arab Center for the Studies of Arid Zones & Dry Lands (ACSAD)” to implement desalination component of Arab Water Strategy

Thank you for your kind attention

Merci pour votre attention

مع خالص شكري وامتناني

For additional information please contact:
Sustainable Water Integrated Management – Support Mechanism:
info@swim-sm.eu