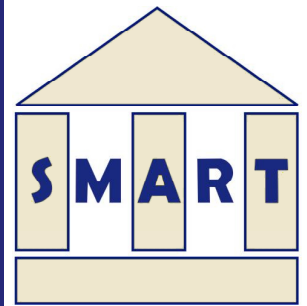




Work package 3-3, Deliverable D 323

Selection of a suitable brackish water desalination processes for the LJV

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Note of the authors: A detailed description of the content of this deliverable can be also found in the Chapter 3 of the Final SMART II-Report.

CONTENTS

1.	INTRODUCTION	4
2.	Comparison of water production costs applying different desalination systems.....	4
3.	Desalination and renewables energy	5
4.	Brackish water desalination in the LJV	6
5.	REFERENCES	7

1. INTRODUCTION

The availability of fresh water (e.g. for drinking or irrigation purposes) is a challenge in many regions around the world. In order to compensate the fresh water scarcity more energy consuming alternatives for the treatment of saline (sea or brackish) water sources have to be considered. Energy requirement of a particular desalination process is one of the main factors affecting its cost and further implementation. Desalination of seawater is the most important process used to reduce the water scarcity problems in coastal zones in the world. The application of desalination technologies (principally thermal and membrane based desalination) accounts for a worldwide production capacity of 24.5 million m³/day (Lattemann and Höpner 2008).

The Jordan Valley is generally classified as arid, with rainfall not exceeding 300 mm per year in the north and less than 150 mm in the south (Al-Jaloudy 2006). The low Jordan Rift Valley (LJRV) area hosts a relatively high quantity and variety of brackish water resources, ranging from weak seepages to substantial groundwater bodies. The brackish water bodies represent the natural outflows of the extended aquifers underlying Jordan. Desalination of these resources could contribute to increase the quantity and improve the quality of the regular water supply for the local population (both domestic and agricultural). The salinity of these sources varies from a few hundreds up to over one hundred thousand mg/L of salt (frequently over 2000 ppm).

2. Comparison of water production costs applying different desalination systems

Thermal desalination systems are able to produce water with very low (≈ 10 ppm) TDS (total Dissolved Solids) compared to 400 to 500 ppm in the RO system. However RO system have been improving their technology during the last decade, resulting in developing high performance membranes which require less pressure (less energy), have longer lifetime, and lower cost. This has made RO a more economical process than other desalination methods (Al-Karaghoul and Kazmerski 2013).

When low-temperature or waste heat is available, for example as by-product of the electricity power plant, or when desalination of high saline water (more than 60,000 ppm) is needed, the choose can then shift to the thermal desalination process (Al-Karaghoul and Kazmerski 2013). A brief summary of average production cost of the main desalination processes is shown in Table 1.

Table 1: Water production cost of the main desalination processes (Al-Karaghoul and Kazmerski 2013, Mezher et al. 2011, Miller 2003, Asirc 2005). See also Deliverable 322.

Desalination process	Water	Cost of treated water (US\$/m ³)
MSF (Multi Stage Flash Distillation) 23,000 – 528,000 m ³ /day	Seawater	0.56 to 1.75
MED (Multi Effect Distillation) 91,000 – 320,000 m ³ /day 12,000 - 55,000 m ³ /day Less than 100 m ³ /day	Seawater	0.52 to 1.01 0.95 to 1.5 2.0 to 8.0
RO (Reverse Osmosis) 100,000 – 320,000 m ³ /day 15,000 – 60,000 m ³ /day 1,000 – 4,800 m ³ /day	Seawater	0.45 to 0.70 0.48 to 1.62 0.7 to 1.72
RO (Reverse Osmosis) 40,000 m ³ /day 20 – 1,200 m ³ /day Small plants few m ³ /day	Brackish water	0.26 to 0.54 0.78 to 1.33 0.56 to 12.99
ED (Electro Dialysis) Large capacity Small capacity	Brackish water	0.6 1.05-1.2

3. Desalination and renewable energy

Desalination processes (membrane based as well as thermal based processes) require large amounts of energy for the water production. In the countries with conventional sources of energy, oil and gas, the water scarcity problem is often solved by large sea water desalination plants powered with conventional energy. In the non-oil producing countries, the small-scale units could use alternative energy sources in order to limit the use of fossil fuels (Ghaffour et al. 2011). However, total worldwide renewable energy desalination installation represent less than 1% of total desalination plants, probably due to the high capital and maintenance costs required

by renewable energy sources (RES) (Papadakis 2007). Examples of RES are: solar thermal, solar photovoltaic, wind, and geothermal technologies

There are several possible combinations of desalination and renewable energy sources, but experience shows that some seem to be more promising in terms of economic and technological feasibility than others. However their applicability strongly depends on the local availability of renewable energy resources and the quality of water to be desalinated. In addition, some combinations are better suited for large size plants, whereas some others are better suited for small scale application (Tzen and Morris 2003).

The general tendency is to combine thermal energy sources (solar thermal and geothermal energy) with thermal desalination processes and electromechanical energy technologies with desalination processes requiring mechanical or electrical power. The following combinations are the options most commonly used when desalination units are powered by renewable energy (Papadakis 2007)

- Photovoltaic or wind-powered reverse osmosis, electrodialysis or vapour compression;
- Solar thermal or geothermal energy and distillation processes.

The combination of renewable energy sources and desalination remain economically promising for remote regions, where connection to the public electric grid is either not cost effective or feasible, and where water scarcity is severe. As the desalination technologies improves, and as fresh water becomes scarce and fossil fuel energy prices rise, renewable energy desalination becomes more viable economically (Al-Karaghoul and Kazmerski 2013).

4. Brackish water desalination in the LJV

Available desalination technologies are able to supply high quality water from saline water sources (seawater, brackish water) at relatively low cost. However, the cost of desalination must consider the water supply, water transport, water production, proximity to existing water distribution infrastructure, environmental issues (noise, air pollution) and waste disposal/treatment (e.g. brine). Taken into consideration the cost of desalination, the application of desalination technologies should be consider not only as a separate solution but in the framework of an IWRM (integrated resource management)-concept, which includes fresh water use and availability, waste water treatment and re-use, education, socio-economic evaluation, quantification of regional water balance, etc.

Of the mature technologies available for desalination, reverse osmosis is becoming the technology of choice with continued advances being made to reduce the total energy consumption and the membrane performance (Asirc 2005). In consequence, the scarcity of fresh water, the availability of high quantities of unused brackish water resources, the disposition of renewable energy sources and the geographical location makes the LJRv a high potential region for rational membrane based desalination technologies.

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